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P. Throckmorton, "Thirty-three Centuries under the Sea," National Geographic, May 1960 (Vol.117, no.5), pp.682-703.

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Fish fanciers pay up to $10 for a young discus; mated pairs sell for as much as $350.

trolled by hormones, as is the milk production of a mammalian female.

Among vertebrates, this "lactation" of both male and female is possibly unique. Until research explains the full significance of the phenomenon, the discus—the fish that "nurses" its young—stands as a small but arresting biological wonder.

Piggyback passengers feed on a parent's secreted "milk." Fins resembling insect wings lend a whiskered look to the adult's face.

Darting From One Parent to the Other, Babies Gain Lunch and a Free Ride

As soon as they can swim, discus fry instinctively begin to feed on a slimelike secretion that covers the parents' bodies. Microscopic examination shows that this coating comes from large mucous cells in the epidermis. Smaller cells on the body of a nonbreeding discus appear less productive.

Intelligent but timid, a tank-dwelling *Symphysodon* soon learns to recognize its owner. But if disturbed, the captive dashes madly about the aquarium and may even kill itself by banging its nose against the glass.

Fish fanciers pay up to $10 for a young discus; mated pairs sell for as much as $350.

Off the coast of Turkey, the oldest shipwreck ever found yields relics and secrets of the Bronze Age

Thirty-three Centuries Under the Sea

By PETER THROCKMORTON

THE POWERFULLY BUILT man at the near-by table glared at us, then grunted something to his companion. He had the look of the sea about him, and gestures that come from one used to having commands obeyed. The glass that he raised to his lips was dwarfed by his huge hand.

I glanced at my friend Mustafa Kapkin, whose ear was cocked to what they were saying. We had come to that waterfront cafe to find the skipper of a sponge boat who had brought up an ancient bronze statue and a clay urn from the sea. That stretch of sea bottom, we thought, might be a likely site for some underwater archeological exploring.

Skin Diving Gear Causes Sensation

We had just arrived in Bodrum, home port of most Turkish sponge divers who work the waters of their nation's Aegean shores. Yet already the village was buzzing about the Aqua-Lung, compressed-air bottles, and underwater cameras we had brought on the bus from İzmir. And the air was filled with rumors about the undersea treasure we were after.

For us, it was the beginning of a two-year quest that was to lead, eventually, to the discovery of the oldest undersea wreck yet located—a ship that rode the waves 33 centuries ago, before the time of Homer's *Odyssey*, and ripped her ribs on a jumble of rocks off the Turkish coast.

That Bronze Age ship is at least eight hundred years more ancient than any found heretofore. And the words written here are the first personal account of this remarkable find. Through detailed notes and photographs of the wreck, outstanding archeologists at the University of Pennsylvania and at Princeton University have definitely placed the discovery in the late Bronze Age, about 1400 B.C.

But sitting uneasily in the scrubby cafe—really little more than an arbor roof supported on classic columns—we could not have guessed that such an end was in store. Now I was absorbed in the table near by.

"What are they talking about?" I asked.

Mustafa flushed. "The man with the big hands and lantern jaw is saying that our Aqua-Lungs are for tourists, and that a real

In Eerie Gloom, a Sponge Diver Slogs Through a Jungle of Broken Pottery

Shattered wine jars from ill-fated argosies litter the Aegean floor off southwest Turkey. During two years of underwater exploration in a graveyard of ancient ships, the author charted 38 wrecks, including a Bronze Age vessel some 3,300 years old. Laying aside his bulging bag of sponges, this diver examines the graceful neck of a Roman amphora.

ANSCOCHROME BY PETER THROCKMORTON © NATIONAL GEOGRAPHIC SOCIETY

Aqua-Lung Mermaid Scrapes Sand From the Ruins of a Bronze Age Ship

Atop this rocky ridge in the Mediterranean's misty blue depths, explorers uncovered the oldest shipwreck ever found, the remnants of a galley that sank about 1400 B.C. Divers with crowbars spent hours prying loose copper and bronze artifacts concreted together after three millenniums in the sea. Limestone-encrusted copper ingot shaped like an oxhide appears in the lower right foreground.

Treasury of Bronze Age relics includes two copper oxhides; bronze picks, chisels, axes (center row); broken amphora (lower left), and a metal object believed to be a mirror (lower right corner). Sally Hinchcliffe inspects the collection.

JOHN COCHRAN (LEFT) AND KODACHROME BY PETER THROCKMORTON © N.G.S.

diver wouldn't be caught dead in one. Also that he doesn't like skin divers."

I laughed, and the burly man looked toward us. Then, to my consternation, he lurched to his feet and started in our direction.

The cafe's proprietor rushed out and grabbed his arm, and from the smattering of Turkish at my command I could tell he was pleading: "No, no, Captain Kemâl. . . ."

With a bull-like shrug of his shoulders, the husky captain shook off the restaurant owner and kept coming.

I got up, put on the best smile I could manage, and put out my hand.

He looked me hard in the eyes for a moment. Then he grinned and shook my proffered palm. I motioned for him to sit down.

For the next four hours—over raki, a Turkish apéritif, and savory roast fish and shish kebab—Capt. Kemâl Aras told us tales about diving, the price of sponges, brushes with that dread of all divers, the bends, and fantastic things he had seen in the sea.

"And if it's pots you're looking for," he said, "In Allah's name, I can show you pots."

Turkish laws restrict foreigners from making extended trips on boats of that country's sponge fleet. But through the help of the İzmir Frogman's Club, a group of Turkish skin divers, I got permission to spend a month aboard Captain Kemâl's 38-foot sponge boat and make a survey of underwater antiquities in Turkish waters.

Mandalinci Tackles the Deep

So it was that on a warm afternoon in July, Mustafa and I hoisted our gear over the gunwale of the *Mandalinci*. Mustafa, at age 37 one of the top industrial photographers in Turkey, shared my interest in underwater camera work and archeological exploration. Together we hoped to prove to Kemâl that Aqua-Lungs were good for something besides tourists. The captain was after sponges; undersea relics would be only incidental.

The *Mandalinci*—its name means "tangerine" in Turkish—was a weathered old *trechandiri* (page 697), one of those highly maneuverable, double-ended sailing boats developed in the Aegean archipelago.

Her hold was layered on the bottom with sea-worn gravel for ballast, and much of the space was taken up by an ancient air compressor. Her cookstove was half an oil drum lashed near the stern, her engine an antique single-cylinder diesel that would start, I learned, only after prolonged heating with a blowtorch. It could push the old boat along at a maximum four knots. In a fair wind, with sail helping, she could do seven.

Ancient Jar Becomes Water Tank

But, decrepit as she looked, the *Mandalinci* was shipshape and clean, kept that way under the tight discipline of Captain Kemâl and his mate, "Uncle" Çiasim Arslan. (In Turkey, older men are often called "uncle" —*amca*.) Other divers in the crew were young Ali Zorlu, who was dressed in a spanking new double-breasted suit, and "Uncle Şeytan"—Uncle Devil. His real name was Ahmed, but he was called *şeytan* because "only a devil could have had so many narrow escapes and lived."

Ahmed walked with a bad limp from an attack of the bends. He liked to dive, he told us, because under water he did not limp. A couple of ship's boys completed the crew.

My eye fell on an amphora lashed to the foot of the mast. I stared in surprise. Its double handles, narrow neck, and tapered shape stamped it as one of the typical jars used in classical times for holding oil and wine.

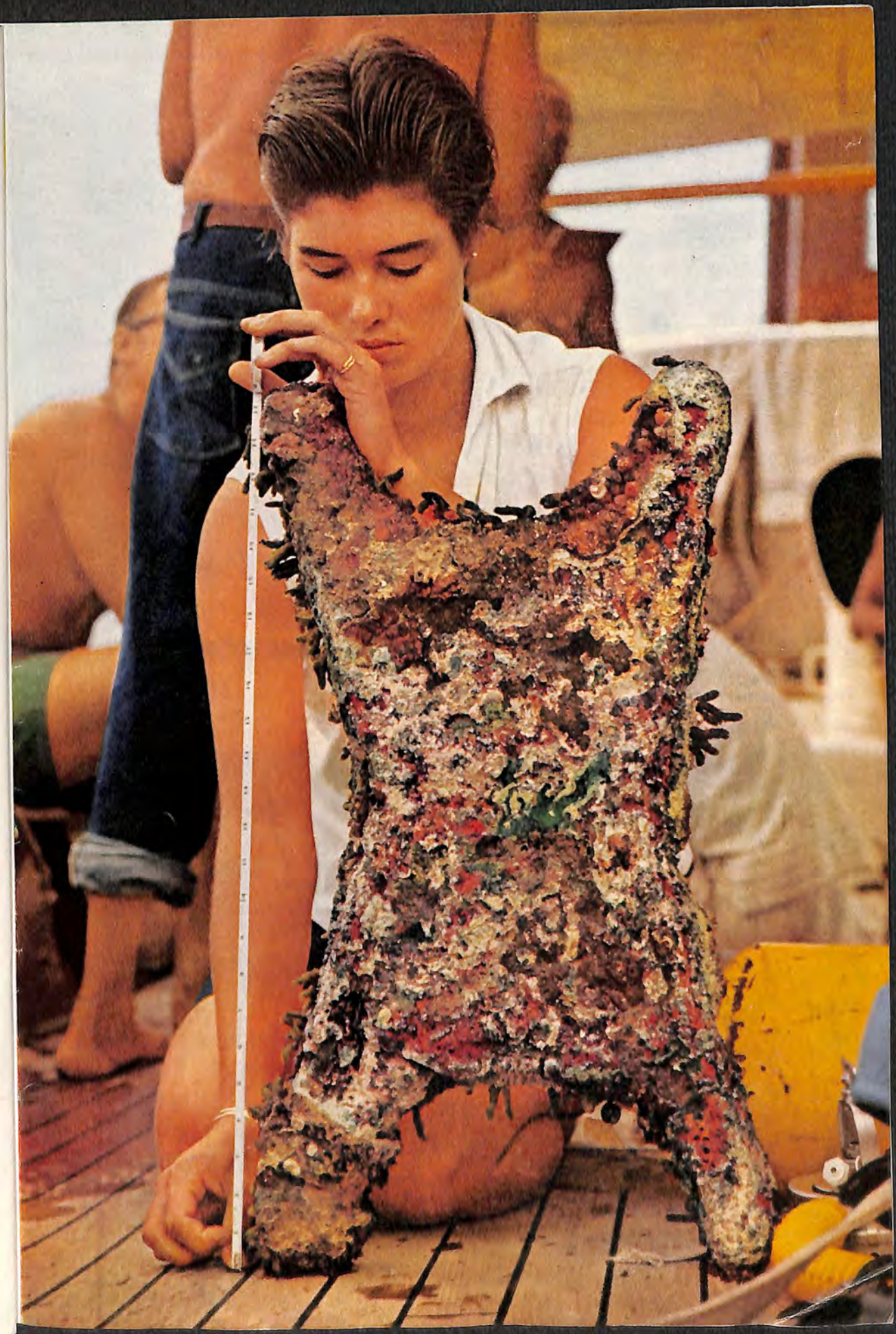
Probably Roman, I guessed, dating from about the 2d century. It held the *Mandalinci*'s water supply.

Captain Kemâl grinned at my wonderment. "The old jars are better made than the modern ones," he explained. "Cheaper, too. We can get all we want for nothing—just pull them up from the bottom."

Our expedition, I thought, was off to an auspicious start.

It was evening before all the equipment and supplies for the trip were aboard. At dawn the next morning we got under way, and I watched the shoreline drop behind.

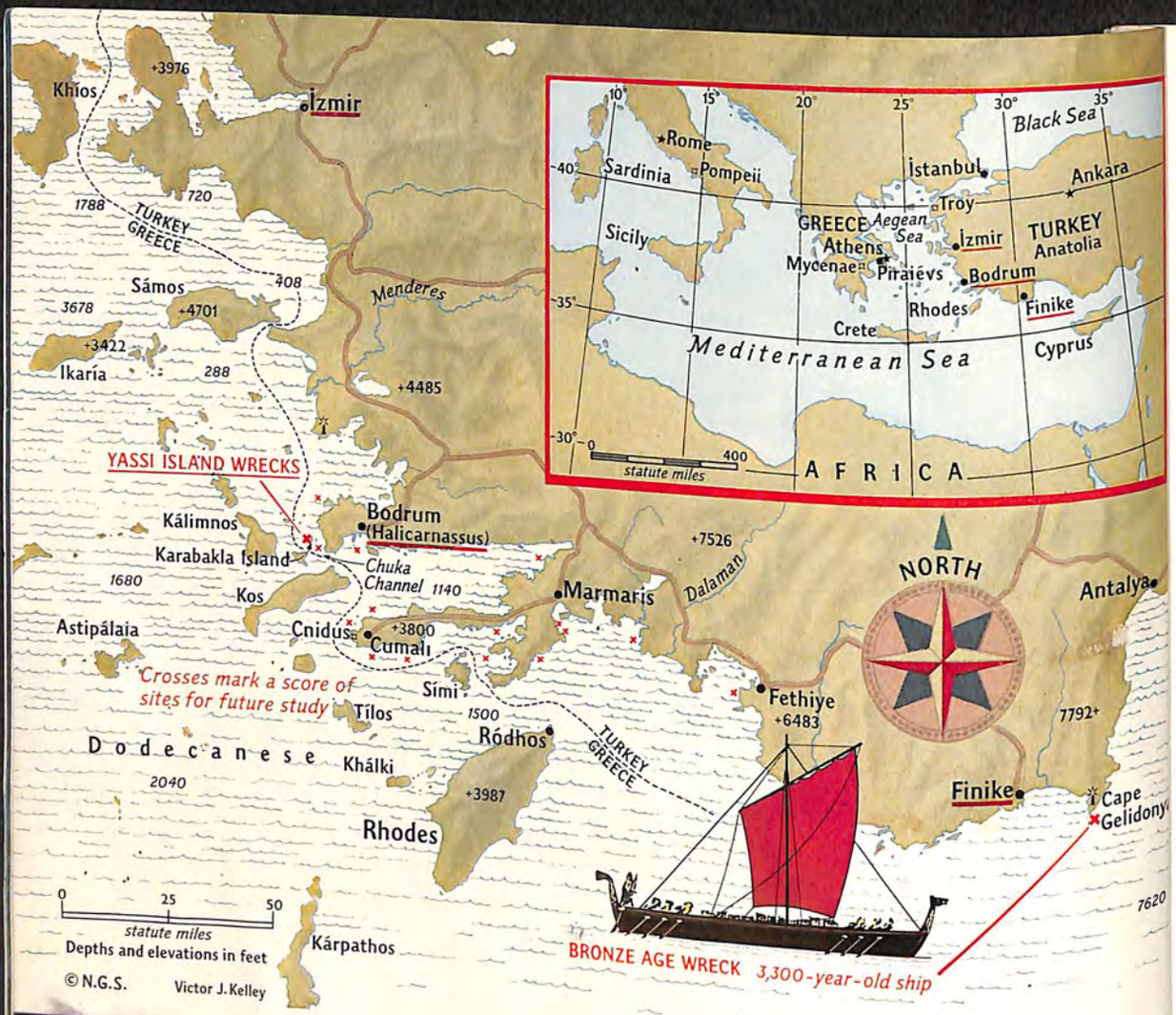
Bodrum is a little port hanging to the coast at the edge of an amphitheater of thousand-foot hills. They sleep now, but those hills



Bronze Age Bullion, a Four-legged Metal "Oxhide," Emerges From the Sea

Flat and rectangular, with a leglike extension at each corner, the ancient oxhide is believed to have represented, in metal, the value of a cow or an ox. This crusted copper ingot, smelted in Cyprus before written history began, may have ridden a galley en route to Mycenae or Troy. Corrosion has flaked off possibly 10 pounds, leaving 48 pounds. Susan Phipps applies the tape measure: 24 inches.

EKTACHROME BY JOHN COCHRAN © NATIONAL GEOGRAPHIC SOCIETY



have seen the glories of the past, for Bodrum is the site of the ancient Halicarnassus. That fabled city was the birthplace of Herodotus, father of written history. It was the location of the famous Mausoleum, built to honor the Carian king Mausolus, and one of the ancient Seven Wonders of the World. The city was sacked by Alexander the Great in a victory that helped open his way into Asia.

On a peninsula that juts into the bay stands a castle built by Crusaders more than five centuries ago (page 690). Its walls contain stones cut in classical times, many even taken from Mausolus's now-obliterated tomb. The castle was named for St. Peter, and the town that grew up around it on the ruins of ancient Halicarnassus was called Petronium. In time this was corrupted to Bodrum.

Two hours' run from Bodrum lies Yassı Island, in the Chuka Channel. There, a hundred yards from shore, Captain Kemâl cut the engine. Çiasim put on the lead shoes and copper helmet of the boat's lone diving suit and dropped overboard.

Ten minutes later came the signaling tug on the lifeline that meant he had found the spot the captain had promised to show me. I donned snorkel and mask and slipped over the side into the channel's crystal-clear water.

There, below me, was a fantastic mass of amphorae, some broken and some complete, lying on the bottom only 25 feet down. Çiasim, his back turned, was standing in the middle of them.

Friendly Taps Startle a Diver

I swam down to him and rapped the familiar tattoo of "shave and a haircut, two bits" on his helmet with my knuckles. He nearly jumped out of the water, so startled was he at my tapping. Later he told me that it was the first time in his 40 years of diving that he had had company while under the sea.

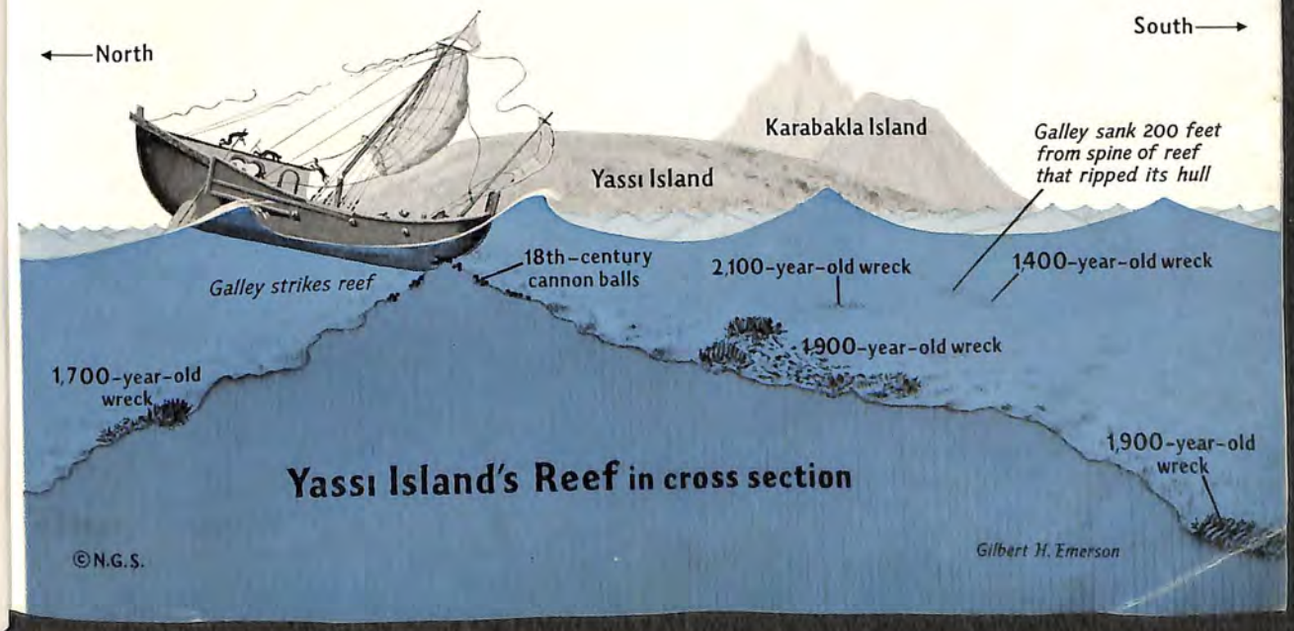
Mustafa came down to look at the pile, and then the captain signaled for all to come up. Ali took over the diving suit from Çiasim, and we moved to deep water on the south side of the island, where Captain Kemâl said there were two more piles of amphorae.

Minutes later—but what seemed like an eternity, in my excitement—I was shaking hands with Ali in 120 feet of water, on top

Floating above a mound of amphorae, archeological draftsman Honor Frost sketches a wreck off Yassı Island. Tiles among the jars may have floored the ship's galley.

KODACHROME BY PETER THROCKMORTON © NATIONAL GEOGRAPHIC SOCIETY

Heavily laden merchantmen sailing out of Rhodes, Cyprus, Rome, and other Mediterranean trade centers swarmed to the island-dotted waters off Turkey in ancient times (map, opposite). Yassı Island's treacherous reef, its crest rising within six feet of the surface, took many a ship to its grave. Some vessels, hulls split wide open, sank immediately, spilling their cargoes on the reef. Others, like the 1,300-year-old galley depicted below, strove in vain to reach Yassı's beach. Their bones still rest on offshore slopes in depths ranging from 20 to more than 100 feet.



of the wreck of a big amphorae carrier. There were literally scores of jars lying in sea-encrusted piles. I did an Aqua-Lung dance of glee, and then Ali led me to another, even larger wreck!

Here were huge globular amphorae of a type I had never seen before, each one almost perfectly round, with two small handles. This wreck was also strewed with iron objects, some of which turned out to be ancient anchors. A scale of barnacles encrusted the jars, and sea worms had built their tubular homes in twisting patterns on their surfaces, but their ancient beauty was unmistakable.

Yassı Island, however, was to offer even more. In subsequent explorations we have found evidence to indicate that at least 15 additional wrecks lie near the island's shore —a veritable graveyard of ancient ships!

And little wonder. Just a hundred yards from Yassı Island's western edge lies a treacherous reef. Its crest, six feet below the surface, is almost invisible, especially with the sun in the steersman's eyes, his ship running before the prevailing wind. Today the reef is marked on charts, but it still takes its toll of ships, the latest a sponge boat sunk atop a pile of cannon balls from an 18th-century Ottoman frigate. The two deep wrecks we saw that first day have since been identified as Byzantine cargo carriers of the 6th and 7th centuries.

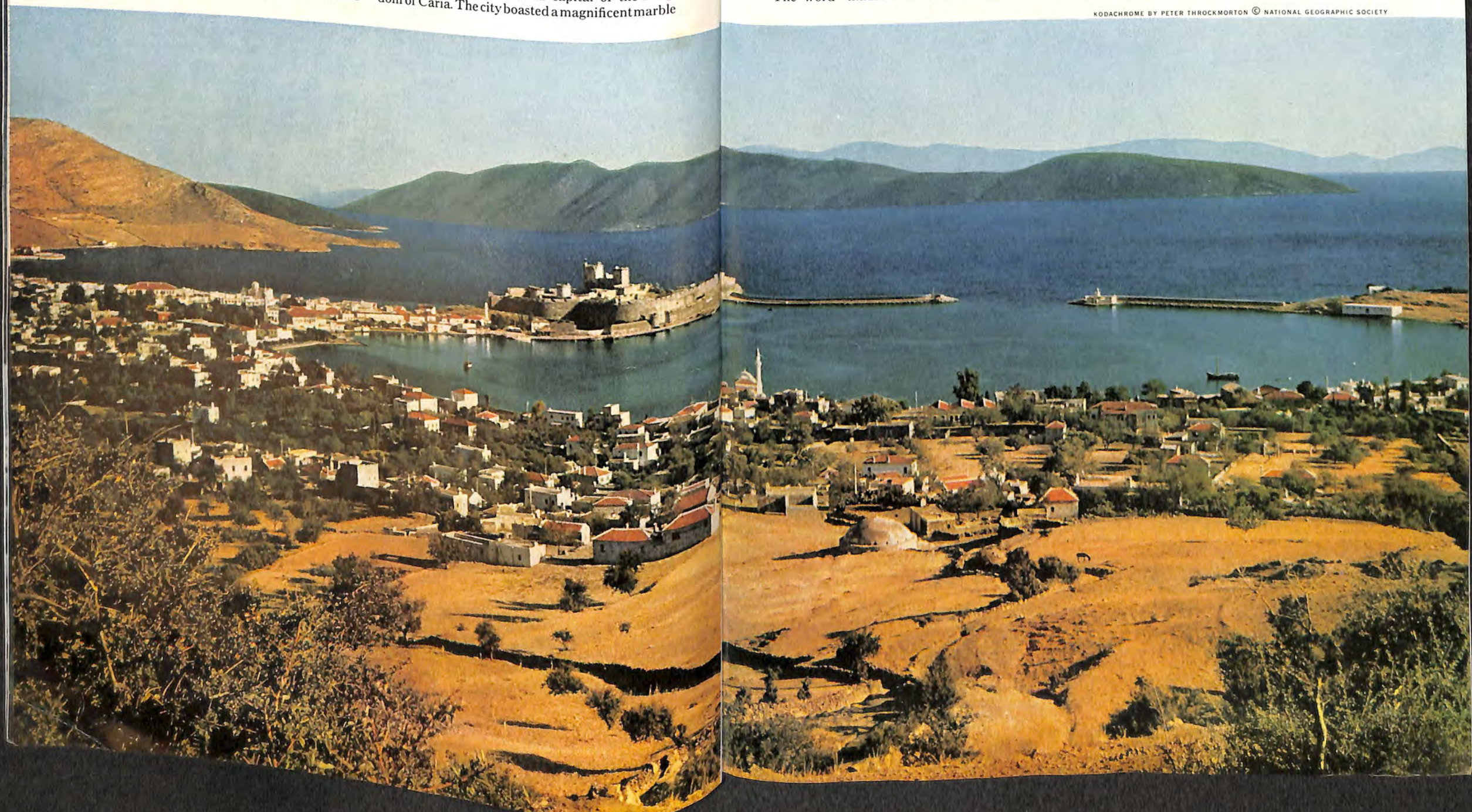
At least two other big cargo ships—used by the wine carriers of Rhodes—came to grief there in the last half of the 1st century. One littered a hundred square yards of bottom several feet deep in smashed amphorae. The other came to rest in one piece, her deck cargo of 5,000 wine jars still stacked as they were the day she left Rhodes. A handful of civilizations—Greek, Roman, Byzantine, and Turkish—have left relics on that savage reef.

As I write these words, I can think calmly of these discoveries. But that first day with Captain Kemâl on the *Mandalinci* was a frenzy of photographs and dives and excitement. And of frustrating conversations trying

(Continued on page 695)

Bodrum, Home of a Turkish Sponge Fleet, Stands Atop the Ruins of Halicarnassus

Birthplace of Herodotus, father of written history, Halicarnassus was a fabled capital of the Kingdom of Caria. The city boasted a magnificent marble tomb, one of the ancients' seven wonders, begun for King Mausolus by his widow about 353 B.C. The word "mausoleum" derives from his name. Centuries later Crusaders used stones from the ruined edifice to build the massive castle of St. Peter commanding the harbor.



Susan Phipps Buoys an Amphora With Air. Like a Rocket, the Jar Will Shoot to the Surface

Divers working off Yassı Island found it a back-breaking job to lift the jars, which weighed as much as 100 pounds. Shells and pebbles, seeping in through broken seals, displaced the wine long ago. Some amphorae contained octopus nests.

Substituting air for muscle, the divers made their Aqua-Lungs work for them. Dumping out the silt, they piped their own exhaust into the jars. Rising slowly at first, the amphorae gained speed with every foot until they popped out of the water.

Archeologists theorize that tapered bottoms made it easier for stevedores to move the jars about on deck. Ashore, the amphorae could be planted upright in soft earth.

Similar relics have been recovered from the ruins of Pompeii. In 1952 Capt. Jacques-Yves Cousteau and his fish men salvaged an entire cargo of Greco-Roman amphorae off Marseille, France (see NATIONAL GEOGRAPHIC, January, 1954).

Bubbles form a cloud above Miss Phipps as she inflates a jar. A hole in the base allows a trickle of air to escape. Black reef fish exhibit no fear of the stranger in their midst.

JOHN COCHRAN

Two thousand years of sediment spill from Rhodian amphorae saved by the author (left) and Rasim Divanli of the İzmir Frogman's Club. Brilliant marine encrustations faded after exposure to sunlight.

Outsized roof tile recovered from a Byzantine wreck gets a cleaning. Honor Frost, who helped bring up the tile, wears a snug neoprene suit that holds body heat in the chill depths (page 688).

After scraping away the sea growth, Miss Frost will make an archeological drawing of the slab.

Lump of sea-worn wood may have been part of the cap rail of a Byzantine argosy, the globe-shaped amphora an item in her cargo. John Righter examines the relics from the 1,200-year-old wreck.

to explain to Kemâl and the other divers the importance of what we had found.

Life on a sponge boat quickly becomes routine. When there happened to be a wreck in areas where the *Mandalinci*'s divers were harvesting sponges, Mustafa and I photographed and made notes. When there were no wrecks, we speared grouper for the cook pot, dove with our Aqua-Lungs to add a few pounds of sponges to the day's catch, or settled into the little boat's routine.

If there was a man down in the diving suit, the *Mandalinci*'s old engine ran at half power. It droned a steady, sleepy vibration, never changing except when the man at the tiller kicked the throttle ahead to stay over the diver. The lifeline between diver and boat was no bigger than a clothesline, but very strong and carefully made from hard-twist manila. That lifeline was always tended by one of the older men, usually either Kemâl or Çiasim, who sat, impassive, attention fixed on the diver, fingers holding the strand with delicacy to respond to the diver's signals.

Chants Mark Diver's Progress

The air hose was always in the hands of Samy, the oldest of the ship's boys, and he in turn was watched by the man on the lifeline—and cursed roundly when the hose wasn't held exactly right: just slack enough for the diver to be free, but tight enough so that it could not catch on underwater obstructions.

Time was punctuated by the ship's boy singsonging out the diver's depth, which he read off in fathoms from a gauge attached to the compressor. One knew by the boy's chant when the diver was climbing down rocks, as the depth call changed rapidly.

"Seven. Going on nine. Going on twelve. Still twelve. Going fourteen. Going seventeen. Steady at seventeen. Sevent-e-e-n."

Occasionally, the man tending line would glance at an old alarm clock, the only timepiece on board except my wrist watch. After an hour, he gave three strong jerks that signaled the diver to ascend. In five minutes the net bag, bulging with sponges, would be aboard, the diving suit switched to another man, and the *Mandalinci*'s crew settled back to another hour of watchful waiting.

The sponges, gleaming black balls, were piled up around the mast. By nightfall we had collected what would amount to about ten pounds, cleaned and dried. This was an average day's catch, worth about $50.

By noon the first day out I was hungry, but saw no sign of cooking. I asked Mustafa: "What about lunch?"

"Divers never eat during the day," he said. "It's supposed to bring on the bends."

So that day, and every other day of our voyage, we staved off our emptiness diver-fashion, with a cigarette and a hunk of bread. Hunger for us, as for the men of the crew, became an accepted part of the routine.

At suppertime the ship's boys set out the "table"—a piece of canvas laid on the foredeck—and the men sat down in order of rank.

Captain Kemâl presided; Mustafa and I, as guests, flanked him. Then came Çiasim, who had spent the previous hour over the oil drum and a fire of wood gleaned from shore in the morning by the boys. At the foot sat the other divers.

The meal was usually *çorba*—a soup made from tomatoes, fish, and peppers—a salad of more peppers with tomatoes and olive oil, a lobster or a grouper caught during the day, and that seaman's staple, boiled beans. Bread was hardtack, made edible by dipping into a pan of water that stood ready by the canvas.

The boys stayed in the background. They would eat the cold and greasy leavings after they had cleaned up the foredeck. As compensation, perhaps, or as concession to the appetites of 14- and 15-year-old boys, they were the only ones on board who could get an extra bite from the ship's larder during the day without earning a scowl from Kemâl.

Mandalinci Roams a Lifeless Coast

When night fell, we would anchor in a cove, or behind an ancient breakwater such as the one at Cnidus, where the ruins of a city that once sheltered thousands of people lay around the harbor. The sail would be spread on the *Mandalinci*'s foredeck, and we'd roll up in our blankets in some corner. Or sleep ashore on a sandy beach.

We seldom saw another boat or another human being. The coast we cruised along was beautiful, with great mountains that loomed sheer out of the sea and deserted valleys where grew wild figs that we sometimes picked on trips ashore in the dinghy. It was a life like that which must have been led by the sea raiders of Homer's time—raiders who may have hauled their black-hulled ships onto the very beaches where we slept.

So the days went by, pleasantly—and profitably. In addition to several well-preserved wrecks, we found many sites worth further

investigation someday. And our notebooks were full of jottings about other wrecks, on other parts of the coast, gleaned in evening talks around the mast or campfires ashore.

For we were accepted now as divers, not tourists. We had proved we could pick sponges and live on a sponge boat. Divers along the coast gave us information, even though they might think our search for broken pots and sea-rotted pieces of wood was *deli*—crazy. Some even became interested in archeology themselves—a tribute to the stories, cribbed from Homer, which Mustafa had told around our campfires.

"Rotten" Bronze Hints at a Treasure

When our month's cruise was over and we were back in Bodrum, Mustafa and I were invited to spend an evening with Kemâl and a sea captain friend of his from İstanbul. The talk turned to dynamite and its use in salvage jobs. I was sitting half asleep, unable to follow much of the conversation. Then I was snapped alert by the word *bakır*, Turkish for copper.

"What was he talking about?" I asked Mustafa.

"Some things they found in the sea."

"What things?"

"Bronze things. He found some pieces of bronze, stuck to the rock."

After ten minutes of confused questioning the story came out. The season before, Kemâl had been diving near Finike, at a place called Cape Gelidonya (map, page 688). He found about two tons of bronze objects—"big bars of metal, but flat, all stuck together on the rock in 15 fathoms of water." Amca Şeytan had taken some pieces and sold them for scrap. But the price was poor, very poor, because the metal was so corroded and rotten.

I lost interest. Big bars of metal; ingots, no doubt. Sounded modern. Probably from an 18th- or 19th-century merchant ship. But something about the story bothered me.

That night, thinking it over in my hotel room, I decided what it was.

Kemâl had said that the bronze was rotten and corroded. Now, I had seen plenty of bronze from wrecked 18th-century ships, and it almost never was so badly corroded that it could be called "rotten." The only bronze I had seen that badly decayed had been from classical times. I began to speculate about the bars: Where had I heard that flat ingots were traded by the Kefti, a seafaring people who lived in the Aegean during the Bronze Age?

Next morning I went through my books and found a reproduction of a painting from an Egyptian tomb of about 1500 B.C., which showed the Kefti bringing tribute to the Pharaoh. Part of the tribute was, unmistakably, flat ingots with leglike handles, looking for all the world like an animal hide.

It was weeks before I got a chance to bring up the subject again with Kemâl and his men of the *Mandalinci*. Did any of them remember the bronze stuff in the sea near Finike? Yes, one of them did; he had taken two bronze boxes from the place, hoping that they would be full of gold. Instead, they held some black, greasy stuff, and were so corroded he had thrown them away in the sea.

I knew I was on the right track when Devil scratched his head and said he had picked up some pieces to sell for scrap. He remembered there had been three of them.

"One was like a spear point. And there was a knife. And a thing like a sword. All of bronze."

"Who bought them?"

"Oh, some junkman; I don't remember."

Kemâl broke in. "Don't worry, Peter. Next

PETER THROCKMORTON

Helmeted diver hands a bag of sponges to deckhands aboard *Mandalinci,* a double-ended vessel that carries motor and sail. Sponge diving is a fading industry in Turkey, says Mr. Throckmorton, who worked beside these divers. "Young Turks want no part of it; too many have been killed or crippled, and the disabled get no compensation."

Exhausted by a long dive, Capt. Kemâl Aras rests on deck before quitting his bulky suit. "Sponging is a grim business," reports the author. "Divers live with the fear of the bends. Diving too often, too deep, or too long can cause paralysis or death. After coming up, the diver watches his body with the attention that a mechanic gives to a racing car."

year when we dynamite the stuff for salvage, I'll save you a piece."

On an impulse I turned to Kemâl. "Promise me you won't touch the bronze wreck until I get to see it," I blurted. "I'll pay you double the scrap value, by weight, of everything we recover from her."

Where I'd get the money I didn't know. Nor had I any idea, at the moment, how I'd be able to promote the expedition to hunt for the underwater wreck.

Summer passed. I returned to the United States, thoughts of the bronze wreck and my impulsive promise to Kemâl a nagging voice in the back of my mind. Then, through an archeologist friend in New York, I met Drayton Cochran.

Air Hose Makes a Necklace

Cochran is a New York yachtsman who owns the *Little Vigilant*, a steel-hulled, 70-foot auxiliary ketch (page 700). His son, John, and a friend, John Righter, were experienced skin divers. Another friend, Stan Waterman, was a true professional and an underwater photographer as well. So we formed a team. Objective: a cruise in Turkish waters, with the hope of finding the bronze wreck at Cape Gelidonya.

In June of 1959 we outfitted the *Vig* in Piraiévs, Athens's ancient and still bustling seaport. From Miami, Boston, and New York came crates of air tanks, rubber suits, and the endless minutiae of diving paraphernalia. From Germany there was a new and powerful Bauer air compressor and a special Dräger portable decompression chamber that was a bit of insurance everyone chipped in on willingly.

The Cochran party stepped off a plane at Athens with airline flight bags filled with spare parts—and with 50-foot coils of air hose draped over their shoulders as necklaces. And an attractive last-minute arrival was Susan Phipps, a Floridian whose family knew the Cochrans.

At last the *Little Vigilant* moved out of the harbor at Piraiévs, her crew hosing the

Ankle-deep in Ooze, John Cochran Reclaims Two Perfect Amphorae

Standard container for the ancient wine trade, each amphora held seven or eight gallons. A Rhodian vessel foundering here some 2,000 years ago carried an estimated four thousand jars to the bottom.

SUSAN PHIPPS

gluelike mud of ages from her anchor. Her course was set for İzmir. There Hakki Gültekin, on vacation from his post as Director of the Archeological Museum in İzmir, and Mustafa and another diver friend, Rasim Divanli, were waiting to join us. With them aboard, we headed first for Yassı Island reef.

We checked out our equipment in dives on the wrecks Mustafa and I had spotted with Kemâl. The sight of the amphorae, some a jumble of shards, others as neatly arrayed as the day they were stowed in the ship that carried them, was no less thrilling now than on that first voyage with the *Mandalinci*.

Octopuses Live Where Wine Once Flowed

Seals in the narrow necks of the jars had long since disappeared. Instead of the wine or oil once stoppered within, the timeless motion of the sea and nest-building octopuses had packed down pebbles and sand. Frequently the tenants would jet away in a cloud of ink when disturbed.

The pebble-filled jars were heavy. It sometimes was all one diver could do to hold a jar off the bottom, neck down, while another probed inside to loosen the packed filling. Then the amphora was held over the nozzle of an air hose from the surface or the exhaust bubbles from the regulator of one of the divers' Aqua-Lungs. Slowly, like a primitive balloon, the jar would begin to rise.

Then, gaining momentum, it would take off like a rocket, venting a white stream of sand. At the surface, those waiting in the *Vig*'s dinghy would see the jar pop out of the water, to bob until recovered.

Along the coast we went, probing the wrecks marked in my notebook, until at last we were off Cape Gelidonya. That great cape, crowned by a beacon, thrusts into the Mediterranean with a string of islands jutting from it, just as Kemâl had said.

The islands were forbidding stumps of rock, and they proved as inhospitable as they looked. Their jagged surfaces were so sharp

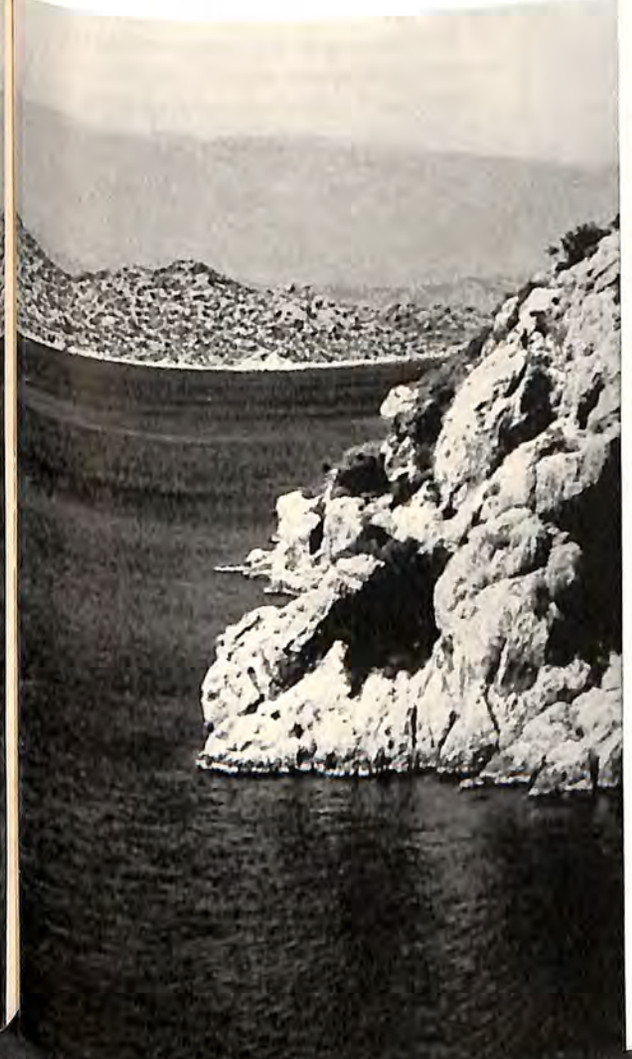
each step slashed our shoe soles; we could not sit down without getting cut. They were waterless, their only vegetation a thorny shrub that clung to eroded hollows. I pitied the shipwrecked sailors of the past who must have struggled ashore there.

The channel where the wreck should be was a passage between the outermost island and another one 200 yards nearer the shore. Kemâl had said the wreck was on an underwater ridge that ran between the two islands.

We spotted the ridge without trouble—a tangle of ledges, clefts, and hillocks as uninviting as the two islands they joined. On each side of the ridge the bottom dropped off to depths of 150 feet and deeper. The crest of the ridge itself varied from 40 to 100 feet down, with occasional pinnacles that soared to within 10 feet of the surface.

It was noon when the *Little Vigilant* first dropped anchor into a mass of boulders on the ridge. That afternoon was spent in reconnoitering and eager speculation.

JOHN COCHRAN



Next morning we all went over the side at once, and swam slowly along the bottom in a long line. Within five minutes the line had broken up into scattered groups wandering in the ridge's jumbled formations. Ten minutes more, and the groups became individuals wandering aimlessly here and there. Soon heads began popping to the surface, each person coming up to see where he was.

"It's a mess," Rasim said. "We could look down there a month and not find the wreck."

First Dives Net Newspaper and Cookpot

During the morning's dives we managed to sweep a good part of the bottom between the ship and the outer island. We found nothing—except an object that looked like a cookpot and a page from a Turkish newspaper.

That afternoon we split up into two parties, one group covering each side of the ridge. I swam with Stan and Mustafa. The area swarmed with fish—and huge boulders. I went around one side of a rock that was the size of a small house; Stan and Mustafa went around the other. When I got past it, my partners were nowhere to be seen, so I carried on alone. Again, nothing.

Mustafa, though, fared a little better. When we were all back on board the *Vigilant*, he displayed a piece of discolored rock. It unquestionably had been stained by decomposition of bronze or copper. He said that it came from a spot such as Kemâl had described as the wreck site—the bottom of a cliff face in 90 feet of water. The area, Mustafa said, looked as if it had been dynamited.

That night we dined in deep discouragement. The others wanted to leave as soon after sunup as we could, but Mustafa and I held out for one last day. Morning came—and passed in another round of fruitless dives. I was beginning to wonder if Kemâl had misled us, or if one of his divers had talked, and another boat had been there before us.

At lunch it was decided the *Vig* would weigh anchor that afternoon. Cape Gelidonya is hard to get to; I despaired of ever getting another chance to come back. Half an hour

Tranquil Kekova roadstead near Finike shelters *Little Vigilant*, the 70-foot auxiliary ketch that carried the author and his companions to the site of the Bronze Age wreck. Crewmen found a city of the dead—hundreds of limestone sarcophagi—on the distant slopes of the Turkish mainland.

before sailing time Mustafa and I made what we thought would be our last dive toward the rock. John Cochran and Susie Phipps also went down for a final look around—and to take pictures of Susie among the groupers.

We combed the labyrinth of formations along the ridge, Mustafa and I, parting seaweed and chipping off bits of rock, hoping against hope. Our reward: Nothing. Dejected, we rose to the surface.

But on board the *Vigilant*, the crew was gathered in a knot around John and Susie. There were shouts of exultation as we clambered to the deck. John was holding in his hand two hunks of bronze, covered with so much limestone concretion that at first glance they looked like shapeless lumps. Mr. Gültekin and I excitedly chipped off the limey crust—fairly easy to do when objects are fresh from the sea, but difficult after the crust gets dry and rock-hard.

Gradually the true shape of the pieces emerged. John had found spear points—unlike anything any of us had seen before, crudely made, with what archeologists call a shoe socket. Undoubtedly they were very old.

"There's a lot more down there like 'em," John said. "And a bunch of big flat pieces of metal, shaped like oxhides."

Ingots! Kefti ingots! Or would they turn out to be something else?

Stan Waterman checked the latest U. S. Navy diving tables that he had gotten through Luis Marden, writer and underwater photographer for the NATIONAL GEOGRAPHIC. As soon as Stan felt it safe, we dived again.

Copper Ingots Signal Victory

The wreck lay in a sandy-bottomed bowl formed by huge boulders, very near where Mustafa had found the discolored stone. Each of us had been within 20 feet of the site.

The ingots—dozens of them—lay heaped on the top of a rock that protruded from the sand, so solidly stuck together that they could be moved only after hours of prying with a crowbar. Between the ingots, under the sand, and under the surrounding ledges, were bronze tools.

When we pried an ingot from the top of the heap, we found under it a hollow, full of bits of wood preserved by the copper salts released in the slow corrosion of the metal bars. There were some crude pottery, bronze axes, picks, and spear points. And, most surprising of all, bits of rope made out of grass, or reed, the original twist still in it.

The way the ship sank was one of those things that happen once in 10,000 chances.

She must have dropped like a stone after gutting herself on an upthrust pinnacle. If she had drifted a few feet farther, she would have landed on the sandy bottom, to be covered and preserved—but probably never discovered by human eyes. Exposed on the rock, she was found, but the ravages of the sea and the centuries have left only bits of her for us to study.

Many of the bronze objects she carried are crudely made and have the look of trade goods—the same sort of things that were traded to North American Indians 150 years ago, or to African natives in recent times. Others, particularly some sword blades and double-headed axes, are beautifully fashioned. The wreck site is directly on the course for Greece, the Aegean Islands, or the western coast of Anatolia, from a starting point in Cyprus (map, page 688).

Relentless Current Plagues Divers

Discovery of the wreck scrapped plans for an afternoon departure. For two more days we dived from the *Vigilant*, under weather that gradually worsened. It was the season of the *meltem*, a steady northerly wind that sweeps the eastern Mediterranean. The seas surged through the channel between the two islands, and the current became so strong it was possible to get to the wreck only by going hand over hand down a rope we had attached to one of the ingots.

We all had moments of panic when our masks were nearly snatched off by the current. Twice divers were swept half a mile down the channel; it took three of us, rowing to exhaustion in relays, to get them back to the *Vig* in the dinghy.

But our notebooks were full of sketches of the wreck site, and we had taken samples of material from it. Further exploration really needed an expedition with special equipment and a stay of several months. We called a halt to our diving, and the *Vigilant* upped anchor for home.

We know that copper from Cyprus was exported in oxhide shapes, and that bars have been found in Sardinia and Mycenae from sites that date between 1600 and 1200 B.C. So we conclude that our bronze wreck has lain beneath the sea for 33 centuries or so—eight hundred years longer than any other wreck previously known.

Experts quickly confirmed our beliefs. Dr. Rodney Young, head of the Department of Classical Archaeology at the University of Pennsylvania, pronounced the ingots "completely characteristic of the late Bronze Age." Dr. Erik Sjöqvist, Professor of Classical Archaeology in Princeton University's Department of Art and Archaeology, found pieces of a dagger and a spearhead to be typical of Cypriot armament of the 15th and 14th centuries B.C.

Wreck Yields Clues, Puzzles

Modern man knows tantalizingly little of the ships and commerce of the Bronze Age. Soon he shall know more—far more, we hope—for in another expedition soon we plan to study the ancient wreck off Cape Gelidonya in detail.

What sort of ship was she? What did she look like, and how did those ancient mariners sail her? For what strange tribesmen did she carry her trade goods? Were the copper ingots destined for a more advanced people after she had finished her coasting? Will chemical cleaning of delicate, still-unidentified lumps reveal silver and gold in a cargo that must have been worth a king's ransom three millenniums ago?

A thousand questions flood my mind impatiently as I await whatever answers may lie in 90 feet of water off the craggy Turkish coast.

Still, my impatience is tempered with gratitude. Except for a sea captain's chance remark, the questions might never have been asked at all.

Labyrinthine pinnacles and overhanging cliffs menaced this diver as she sought Bronze Age relics. So strong was the current that swimmers sometimes descended hand over hand on a rope tied to a copper ingot.

JOHN COCHRAN

Sunrise silhouettes a sentinel in Brasília, newly created capital of Brazil. Pillars

METROPOLIS MADE TO ORDER: BRASÍLIA

By HERNANE TAVARES DE SÁ

Illustrations by National Geographic photographer THOMAS J. ABERCROMBIE

THROCKMORTON

VG

PETER THROCKMORTON
KARAGEORGI SERVIAS 8
KASTELLA, PIRAEUS
GREECE

2

Reprinted from ARCHAEOLOGY, *Vol. 17, No. 4 (Winter, 1964), pages 250-256*

SHIPS WRECKED IN THE AEGEAN SEA

By PETER THROCKMORTON

SINCE 1958, when I began searching for ancient shipwrecks in the Aegean, I have often been asked two questions. The first, "Have you seen any sharks?" is easily answered. We do see them occasionally, and have almost always found them timid, though shark attacks have occurred.

The second question is less easily answered: "Can you locate a specific shipwreck or fleet known to have been sunk?"

In six seasons we have located hundreds of shipwrecks. Two of these, the Bronze Age ship at Cape Gelidonya (see ARCHAEOLOGY 14 [1961] 78-87) and a Late Roman amphora carrier, have been excavated, and seven others studied. About thirty more have been surveyed. With one exception, all of these wrecks were chance finds, located because some part of the imperishable cargo of the ship protruded above the surface of the sea bottom. Like the Antikythera and Mahdia ships with their famous cargoes of statuary, most of them were first seen by sponge divers, who reported them to us. Only a few of the wrecks were located by what would seem the obvious method—looking for them in places where ships would have been likely to sink, such as dangerous reefs at the approaches to ancient ports.

This is not to say that wrecks do not exist in such places. They almost always do. The problem is that a wooden ship's hull exposed to Mediterranean waters is eaten up by ship worms in a few years, leaving only the imperishable parts of the ship and its cargo, such as lead anchors, bronze nails and pottery. When a ship strikes a shallow reef and breaks up, its cargo is scattered and usually becomes mixed with material from other wrecks.

A good example of such an archaeological omelet is on the west reef at Yassi Ada off the coast of southwestern Turkey, where there were at least fifteen shipwrecks in ancient times. The two best preserved wrecks that we had found up to 1963 were those of two Late Roman ships which had struck the reef, sailed on for several hundred yards and then sunk in deep water onto a bottom of mud and fine sand which covered and preserved parts of their wooden hulls but left their amphora cargoes exposed to the sea. We found these by following information received from sponge divers. We would probably not have discovered them in the course of a normal search of the reef.

George Bass of the University of Pennsylvania Museum, who excavated one of these ships, found that she had sunk to the bottom with a heavy list to one side, and that the high side of the ship, when sufficiently weakened by shipworms, had collapsed outward under the weight of the heavy amphoras which comprised the cargo. These held down the sides of the ship so that they were covered over by silt carried in the current. Judging from this case as well as from experience gained from dives on many modern wrecks, I am led to believe that all wooden shipwrecks which lie at depths sufficient to avoid being broken up by wave action will become stabilized in less than fifty years, and that what then survives of a ship under the mud will probably last forever.

In the summer of 1963 the University Museum's survey group worked at Methone, in the southwestern Peloponnesus, on a series of ancient shipwrecks. In the course of research in the region I discovered that many modern wrecks had also gone down in and around Methone. The most interesting of these was H.M.S. *Columbine,* a British sloop of war which sank in Porto Longo harbor in 1824. The wreck was well documented, and through the Public Records Office I obtained a copy of the court-martial of the *Columbine's* captain, copies of her plans and extracts from other documents such as her log books. The court-martial was particularly interesting, since it gave a full account of how the ship had gone down.

In the spring of 1963, with a colleague, John Bullitt, I made a search in Porto Longo for the wreck of the *Columbine.* We failed to find it, but we did find the wreck of the 300-ton schooner *Heraclea,* which had been sunk by German dive bombers in 1940. In the twenty-three years since her sinking, the schooner had almost disappeared underneath the mud. When we examined her more closely we saw that, like the Byzantine wreck at Yassi Ada, she had opened out flat on the bottom and been covered with mud, and that a great deal of the ship remained.

It became evident that the *Columbine,* if she survived at all, had been completely covered. We decided to spend a few days during the summer in an attempt to find the ship, believing that if her condition under the mud was like that of the *Heraclea,* we would have an accurate idea of what happens to wooden ships sunk in similar areas. Our expedition chemist, Richard Russell, was interested in obtaining dated material from modern wrecks for use in comparative study of the chemical and biological phenomena which occur in older wrecks.

Stern of the Austrian brig at Porto Longo. In the hundred years since the ship sank, more than six feet of mud have covered the wreck. The diver is looking into the gunport; his right hand is on the blocks which were used to haul up the gun. The mouth of the airlift is just below his hand.

The court-martial record made it possible for us to pinpoint the place of the wreck within an area less than two hundred yards long by twenty wide. After a day's search our chief diver, Nikos Kartelias, whose long experience in this kind of work has given him a very sharp eye for the smallest unnatural object on the bottom, spotted a tiny piece of heavily concreted wood protruding from the mud.

By probing with iron rods we located one side of a wreck under two feet of mud. We then hooked up the airlift—the underwater suction device which we use as a digging tool—and when we had cleared away the two feet of mud, we were amazed to see the perfectly preserved timbers of one side of the deck and part of the bulwarks of a large ship. Although the upper parts of a number of ribs were eaten away, some of the timbers still had the oiled finish which had covered them when the ship went down.

We decided to dig a trench right across the wreck. A base line was stretched and leveled and, as we airlifted, all timbers found were measured from this line. As the trench progressed and more and more data were added to the plan, we were amazed at the amount of information it provided us. Although impossible to understand on the bottom, the various

The Austrian brig, with the bulwarks cleared of mud. Note that the lower parts of the timbers still shine with their original oiled finish. The upper parts of the timbers and the cap rail have been eaten by teredo worms.

Mosaic photograph of the 30-foot section of the Austrian brig's bulwarks cleared. Note the belaying pin still in place (at extreme left) and the davit on the counter (center).

Shipwrecks continued

timbers were easy to identify on the drawing, which showed that the ship had gone down with a heavy list to port, and that she had opened up and out just like the *Heraclea* and the Yassi Ada wreck. As the wreck lay in shallow water, it seems probable that it had been salvaged soon after sinking, so we were not surprised at finding no material to identify it as the *Columbine*.

After we had finished plotting the section, we decided to work along the line of the bulwarks toward what we thought was the stern of the ship, in the hope of finding material which would definitely identify the wreck. We uncovered thirty feet of bulwarks and found a gunport, the blocks for running up the gun and the ringbolts for securing it still in place, a belaying pin in position in the stern with the chafe marks of the rope it had held still visible, more areas of intact bulwark and, finally, the taffrail and counter of the ship. These last were under more than ten feet of mud.

A comparison of our plan of this wreck with the *Columbine's* plan made us realize that we were not dealing with the *Columbine* at all, but with another ship wrecked at approximately the same time. We searched further for the *Columbine* and found, a hundred yards away, some bits of copper sheathing, brass barrel hoops and some potsherds. These were identified as belonging to the *Columbine*—they were all that remained of the wreck; the bottom onto which she had sunk was rocky.

Study of the wood of both wrecks by B. Francis Kukachka of the U.S. Department of Agriculture Forest Products Laboratory showed that the wreck we had explored was built of Adriatic wood. A search of the public records of the district resulted in the tentative identification of it as an Austrian brig which sank in 1860.

The remarkable coincidence is that both ships had been anchored in the same harbor at the same time of year, both were brigs of about the same size, and both were wrecked because the apparently safe harbor became dangerous when lashed by the siroccos, the much feared southeast gales which strike that coast in winter. The Austrian brig was wrecked on January 22, 1860, the *Columbine* on January 25, 1824. From the records we know that the *Columbine* sank on her port side with her head to the north because of her anchor chain having parted. This is almost certainly what happened to the Austrian brig as well, although we cannot be positive without further research.

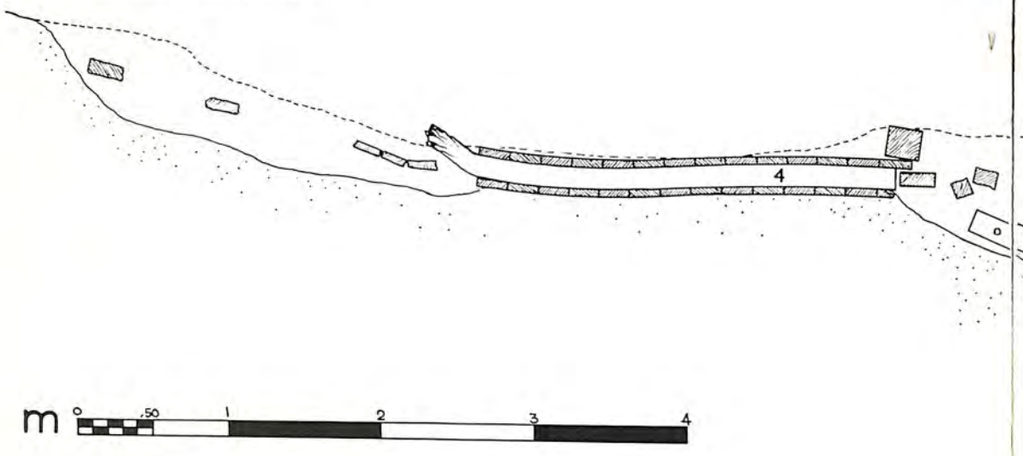
In addition to the reference to the Austrian brig in the Pylos public records, there were noted other wrecks which occurred off Sapienza Island, probably in Porto Longo. In 1847 a ship called *Jerusalem,* under the Greek flag, was lost there. The *America* sank in Porto Longo in the 1830's. The old men of Methone remember from their fathers about another wreck in Porto Longo, that of a ship called the *Congo*. We found what might be the wreck, but did not use the airlift to make certain.

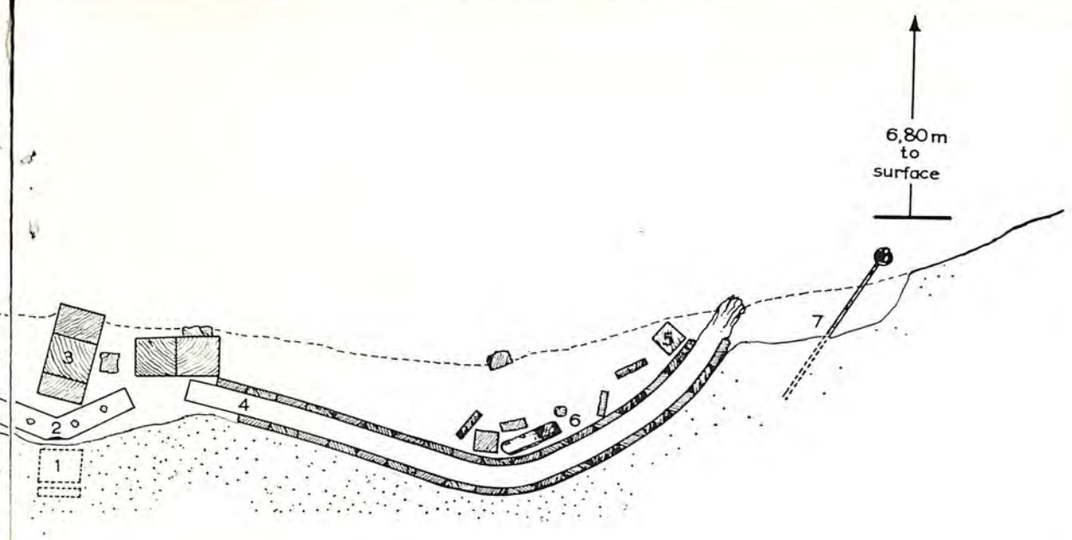
Porto Longo is, in fact, a graveyard of ships. Byzantine pottery found on the rocky shores of the harbor indicates that older wrecks may lie there as well. In the days of sailing ships the harbor was used as a convenient anchorage by ships waiting for a fair wind in order to round Capes Matapan and Malea into the

HERACLEA

PORTO LONGO, AUGUST 1963

SECTION AT MAINMAST





m 0 .50 1 2 3 4

1. Keel
2. Knee
3. Keelson
4. Frames
5. Stringer
6. Knee
7. Chain plate

Level of mud before airlifting

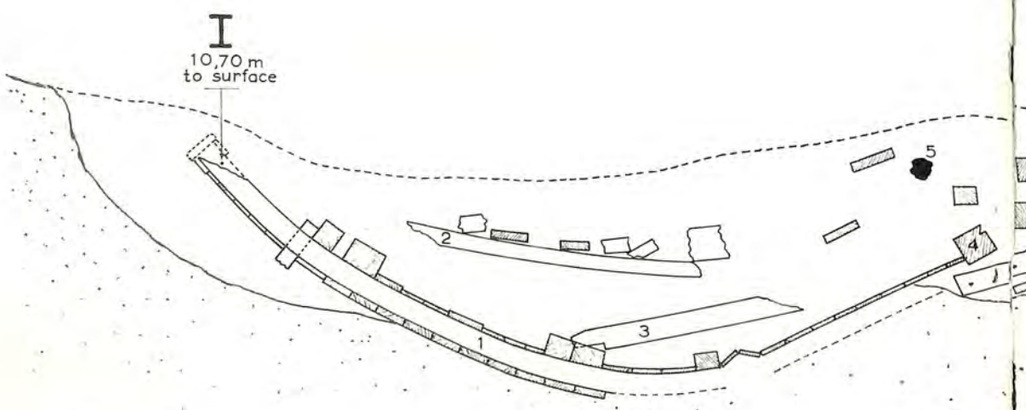
SURVEY BY :
P. Throckmorton
N. Kartelias
C. Maggioros
C. Kalatzis
H. Kotsovos

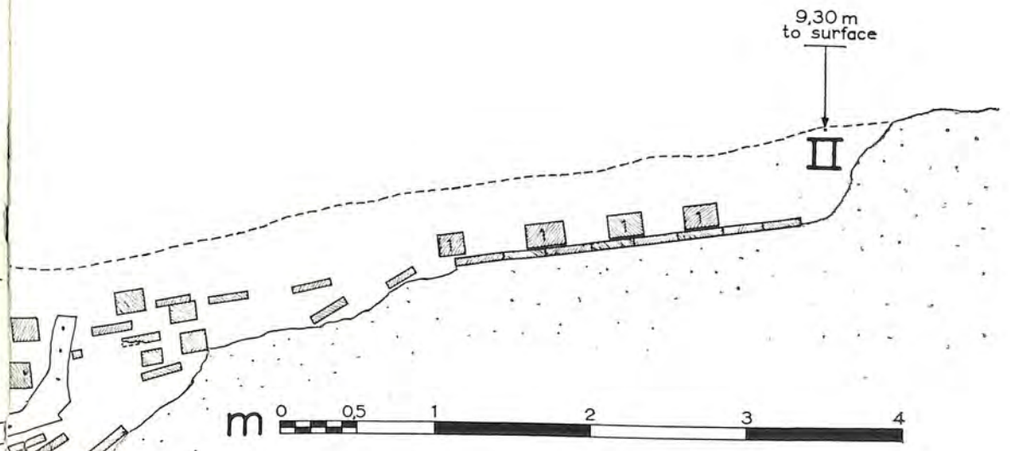
DRAWN BY :
M. Valtinos

AUSTRIAN BRIG

PORTO LONGO, AUGUST 1963

SECTION 9m FWD OF TAFFRAIL





m 0 0,5 1 2 3 4

1. Frames
2. Main deck beam
3. Lower deck beam
4. Keelson
5. Anchor

Level of mud before airlifting

SURVEY BY :
P. Throckmorton
N. Kartelias
C. Maggioros
C. Kalatzis
H. Kotsovos

DRAWN BY :
M. Valtinos

Shipwrecks continued

Aegean. A similar harbor in nearby Skiza Island was used for the same purpose, and its local name—*Caravo Stasis,* "Ship Stop"—is indicative of its traditional use.

As a control we cleared a section through the *Heraclea* and found this 1940 wreck not so well preserved as that of the older Austrian brig. Thus we can expect to find much older wrecks just as well preserved. The best preserved wrecks will almost invariably be invisible to underwater swimmers and must therefore be found by other means. The most likely device for this work is a sonar instrument recently developed by Dr. Harold Edgerton of the Massachusetts Institute of Technology. This sends sound waves through the mud which reflect off objects sunk in the mud and are then registered on a graph. It is our intention, using the sections done in Porto Longo as controls, to see what kind of indication we can get from the unexcavated parts of the *Heraclea* and the Austrian brig. Once we have learned to interpret this kind of sonar data it will be possible to go on to far more interesting areas where conditions are like those of Porto Longo, such as the sites of the battles of Actium and Lepanto. Devices like Dr. Edgerton's will shortly make possible the discovery of the hundreds of wrecks which lie preserved in muddy harbors.

An encouraging point about the wrecks in Porto Longo is that they are well preserved even though they lie in shallow water. At depths not over sixty feet divers can safely spend up to two and a half hours a day under water with little decompression time, a great improvement on the hour and ten minutes each of us was able to spend on the bottom daily at the nearly 90-foot depth off Cape Gelidonya.

What of deeper wrecks? The deeper a wreck lies, the better it is likely to be preserved. Water temperature and oxygen content have a great deal to do with the biological and chemical processes which destroy a sunken ship, and we already have a good deal of evidence showing that deep wrecks are better preserved even though they may lie on a hard bottom. We shall soon begin to experiment with a small submarine fitted with mechanical arms which can lift sample material, and with stereoscopic cameras which can map wrecks that lie deeper than the 150-foot safe working limit for divers. New mixtures of gases which both reduce the danger of bends and extend divers' working depths and times are now being used by navies and in commercial salvage, and before long we shall be using these for underwater archaeology.

The most difficult problem faced both by archaeologists and scholars in relevant disciplines and by the technicians necessary to this kind of work is the interdisciplinary nature of underwater archaeology. Conflicts necessarily arise. A land archaeologist cannot be expected to have the specialized knowledge and skills needed for the intelligent excavation of a ship, nor can the engineer or technician carry out a successful underwater excavation without the supervision or active cooperation of an archaeologist. The connecting links between the two in this challenging new discipline of marine archaeology are the ships themselves, the techniques and the principles involved in gathering the information they contain. We have always worked with the idea that underwater archaeology must be land archaeology carried out under water, and although land methods do not necessarily work under water, land principles do. However exotic and complicated some of our gadgets may seem to the land archaeologist, they are only adaptations of his familiar tools.

The wrecks are there. They can be located, they can be excavated, and they will certainly produce a mass of information. There are no insoluble technical barriers to archaeology under water or to its development as a specialized cousin of land archaeology.

All that remains of a Late Roman ship at Baba Ada, near Bodrum, Turkey. Thousands of fragments of broken amphoras fill every cranny in the rocky bottom.

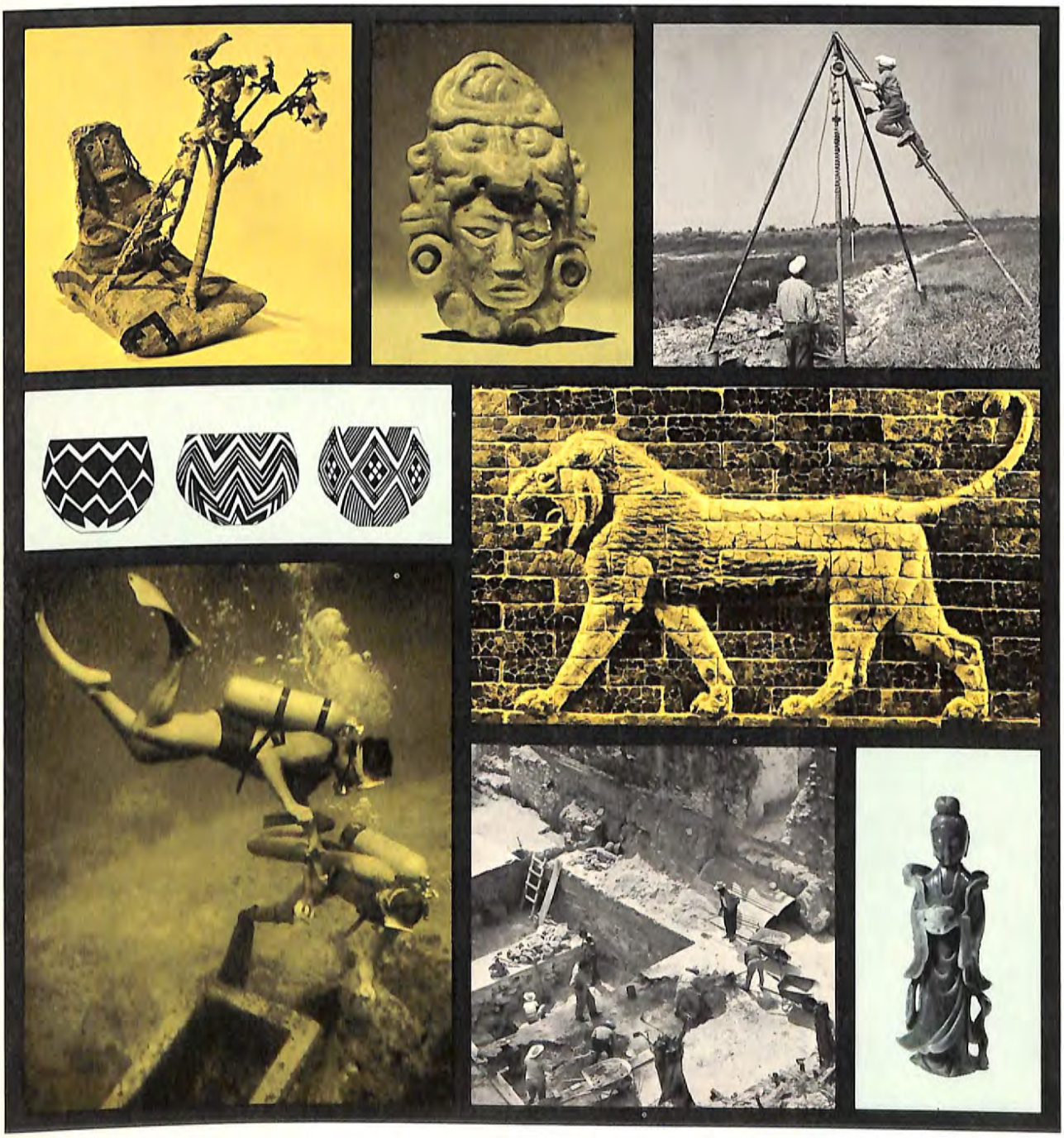
PETER THROCKMORTON is a Research Associate of the University Museum, University of Pennsylvania, and was technical advisor to the Museum's expedition to Cape Gelidonya in 1960. His book, *Lost Ships* (Atlantic Monthly Press), was published earlier this year.

The work at Porto Longo was sponsored by the University Museum, the Littauer Foundation and individual contributors. Admiral Th. Voutsaras of the Hellenic Federation of Underwater Activities furnished invaluable advice and help; the first two weeks spent at Methone in 1963 were under the sponsorship of the Federation. Mr. Nikolaos Fotiou Vassopoulos called attention to the references in the Pylos public records and gave permission to use previously unpublished material. Mr. Takis Demodos and Dr. Costas Kalatzis of Methone provided invaluable help.

THROCKMORTON

Expedition

The Bulletin of The University Museum of the University of Pennsylvania



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Expedition /

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JADE

Its Character and Occurrence

By ELISABETH H. WEST

Blue jade statuette of a standing lady. China. Ch'ing Dynasty, A.D. 1644-1912. Height 10 inches. In the collection of Mr. John M. Crawford, Jr.

Jade, considered as the material used for prehistoric tools and objects of art, has numerous aspects of interest. The special properties of nephrite and jadeite responsible for their characteristic appearance and hardness can be used to distinguish between them, and to differentiate them from other minerals. The occurrences of jade in relatively few localities throughout the world, and the connection between these localities and the areas where jade has been worked, raise interesting questions. Finally, investigation of the history of the working of jade produces evidence of a great deal of skill involved, even at very early periods.

The names of the jade minerals have a complex history. There was no reference to jade in the mineralogical or pharmacological literature of the West before the discovery of America. Then the Spaniards found a green stone, called *chalchiutl* by the Aztecs, being used for decorative carving among the natives of Mesoamerica. They attributed curative properties, especially for the kidneys, to this stone, and named it *piedra de yjada,* stone of the loins. From the French *pierre l'ejade* came *le jade,* and thence the name jade. By the middle of the seventeenth century, when Oriental stone carvings began to reach Europe, the name jade was transferred to them, since Mesoamerican jade was by then extremely rare and nearly forgotten. The mineral name nephrite was first applied at the end of the eighteenth century, deriving from the Latin *lapis nephriticus,* another version of the original Spanish name. Finally, between 1846 and 1881 the French mineralogist Damour established that there are two distinct types of jade mineralogically, that from Turkestan for which he retained the name nephrite, and that from Central America and Burma, for which he coined the name jadeite. The Chinese used the word *yü* to describe jade in the very general sense, meaning hard stone carvings of any kind of stone, as well as nephrite and jadeite. The name *fei-ts'ui,* the Chinese word for kingfisher, was originally applied to fine green nephrite from Turkestan, and then revived in the nineteenth century to describe emerald green Burma jadeite.

The single property of jade which is common to both nephrite and jadeite, and perhaps the most well known, is its hardness. Jade provided almost indestructible tools for prehistoric peoples and a challenge to later lapidaries who worked it into decorative objects of various kinds, chiefly in China and Mesoamerica. However, jadeite and nephrite have little else in common. Even the green color generally thought to be so characteristic of jade has a different quality in each mineral, due to basic differences in structure and composition, and much jade of both kinds is not green.

The mineral nephrite is a calcium magnesium silicate and is a member of the amphibole group of minerals. It is a compact variety of the mineral series tremolite-actinolite, which is a species of this group. Pure tremolite, a calcium magnesium silicate, is white; actinolite, a calcium magnesium iron silicate, is green due to the presence of iron. In tremolite-actinolite the fibrous crystals are separate, while in nephrite they are tightly felted or matted together and the compact, tufted structure which results accounts for its extreme toughness. The hardness of nephrite is 6.5 on the Mohs hardness scale, on which talc is the softest at 1 and diamond the hardest at 10. The specific gravity of nephrite is 2.90—3.01. This represents the ratio of its density to that of water; thus nephrite is about three times heavier than water. The variety of colors ranges from white through yellow, green, brown and gray of many shades, to black. Rarely it is blue. Most of the colors are due to various iron compounds, although white nephrite with high iron content has occasionally been found, so that the means by which it is colored is not yet completely explained.

The mineral jadeite is a member of the pyroxene group of minerals, and is essentially a silicate of aluminum and sodium. The individual crystals of jadeite are interwoven in a complex way, and generally have a granular appearance but they are not fibrous and matted together as in nephrite, so that jadeite is not nearly so tough as nephrite; it is somewhat harder, having a hardness of 7 on the Mohs scale. It is denser than nephrite, with a specific gravity of 3.30—3.36, and this difference in the specific gravities of the two minerals has been used to differentiate them. The typical bright emerald green of jadeite is due to the presence of chromium; the cause of the mauve and bluish-gray colors sometimes found is not certainly known. There are two additional varieties of jadeite. Diopside-jadeite is a species intermediate between jadeite and diopside, a calcium magnesium silicate; it is found almost exclusively in Mesoamerica. The other variety is chloromelanite, a species intermediate between jadeite and acmite, another sodium aluminum silicate, or between jadeite, acmite, and diopside. Chloromelanite is typically very dark green or black, owing to its high iron content.

The identification of objects of jade is possible in various ways. Much information can be obtained if the hardness of the stone in question is

Examples of the different materials commonly known as jade. (Above) Nephrite pendant from Guatemala; Late Classic Maya, A.D. 600-900; height 3 inches. (Upper right) Nephrite core and chisel from the Fraser River area of Canada; length of core 12 inches, of chisel 8 inches. (Below) Jadeite tiki made by the Maori of New Zealand; height 6 inches. These four pieces are in the University Museum. (Lower right) Archaic Chinese symbols of rank. (From left to right) Of black jade; length 13½ inches; Chou Dynasty, 1122-249 B.C.; in the Royal Ontario Museum, Toronto. Of mottled green-brown jade; length 13¼ inches; Shang-Chou; in the John Herron Museum of Art, Indianapolis. Of brownish red jade; length 9¾ inches; Shang Dynasty 1766-1122 B.C.; in the Smith College Museum of Art.

known. An ordinary penknife will not scratch jadeite or nephrite, and this is usually a fairly good confirmation of jade if the limitations of the test are realized. It does not distinguish between nephrite and jadeite, and it should be borne in mind that minerals do exist which are as hard as jade and might be mistaken for it; for example there is an unusually hard, pale green variety of serpentine called bowenite which has a hardness of 6 and an appearance very like jade. Surface alteration, of Chinese tomb jades in particular, can cause the surface of the jade to be soft, so that the area for testing must be chosen carefully. Specific gravity determinations have been used as a means of identification of jade but when the surface is altered, or when there are cracks or holes, however minute, in the object, the results cannot be depended upon. Chemical analysis can give useful information, but requires a gram or so of material which is usually more than can be easily obtained. For complete mineralogical research where the exact chemical composition is desired, and sufficient sample is easily available, it is of course indispensible.

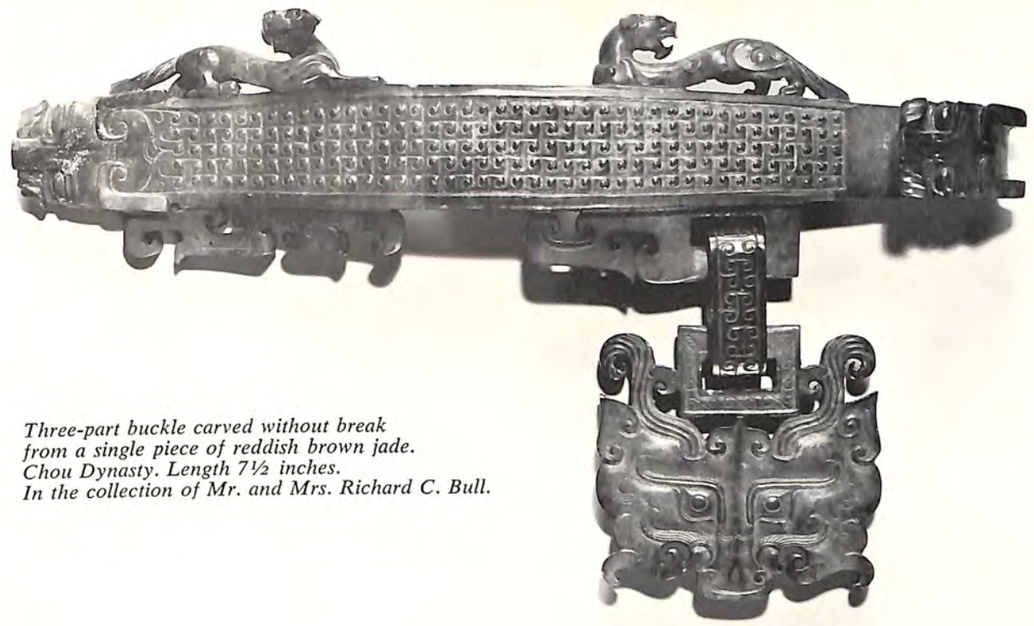
A limited amount of spectrographic analysis of ancient jade has been done; this requires only ten to twenty milligrams of material, which is not difficult to obtain in most cases, and this method might merit more extensive use. Optical methods give the most rapid and definite results. The determination of the mean refractive index, by observing a few grains of the mineral immersed in a drop of appropriate liquid on a microscope slide under a petrographic microscope, can be done rapidly, and can be used to differentiate between the different varieties of jadeite, between jadeite and nephrite, and between jade and many of the jade-like minerals. Perhaps the most definitive optical method is the x-ray diffraction powder method; this is particularly applicable to valuable objects because only a few milligrams of powder scraped from the object are required. A narrow beam of x-rays is allowed to pass through the powdered mineral which diffracts them into a pattern of lines. This is recorded on photographic film which can then be compared with films having patterns of known nephrite or jadeite, or any other mineral. Identification of the unknown depends on the fact that each crystalline material yields a characteristic pattern.

Jade which has suffered some surface alteration has already been mentioned. It is characteristic only, to my knowledge, of Chinese tomb jade and has resulted from changes which have taken place during burial. Numerous references have been made in books and exhibition catalogues to 'jade patina' and 'calcified' or 'calcined' jade. The opaque or cloudy areas referred to usually retain the shape and design of the object although when decomposition has progressed further some of the surface may be lost. Evidently water leaches chemicals from the soil and the resulting solutions attack the surface of the jade. Decomposition products of bodies in the tombs would undoubtedly accelerate this attack. It has been noted that this surface alteration, as determined by x-ray diffraction, is not a different mineral but merely a softened form of nephrite. This observation has been confirmed by the x-ray diffraction examination of several tomb jades in the Freer Gallery of Art which show this altered surface.

The jade with a curious ivory-like appearance which the Chinese call 'chicken-bone' jade may be a manifestation of this phenomenon. This is also sometimes said to be 'burnt jade.' Burnt jade also has an opaque chalky appearance, usually with minute cracks all over the surface. It is known that nephrite when heated to about 1000° C in a dry atmosphere breaks down into diopside, eustatite (a magnesium silicate) and some quartz. In an experiment in the Freer Gallery Laboratory, samples of blue-green and white nephrite were submitted to temperatures up to 1025°C. and both altered to an opaque chalky beige color with no change in the shape of the piece or the decoration of the surface. The chief mineral which resulted was diopside, and several nephrite jades in the Freer which appear to have been burnt also give a diopside x-ray diffraction pattern. Jadeite when heated in a similar manner behaves quite differently; it fuses to a glassy material, the surface smooths out, and if the object is small enough it bends out of shape. Jadeite beads from Mesoamerica have been described which not only are warped out of shape, evidently due to heat, but are dull and crumbly on the surface, perhaps due to exceedingly high temperatures.

Although China has been a center of jade carving for centuries, no jade occurs in China proper. The old idea that the jade first used by the Chinese came from somewhere in China, and that when this ran out it began to be imported from Turkestan, has been shown to be untrue by S. Howard Hansford in his study of Chinese jade carving. For at least two thousand years the nephrite carved in China was imported from eastern Turkestan, the Chinese province of Sinkiang. Nephrite is found in the river valleys on the south side of the K'un-lun mountain range, which runs between Tibet and Turkestan. Two of these rivers, the Karakash (black stone) and Yurungkash

Lady with deer: of white jade shading in places to green and to brown; height 8¾ inches. Ch'ing Dynasty. George Byron Gordon Memorial Collection in the University Museum.



Three-part buckle carved without break from a single piece of reddish brown jade. Chou Dynasty. Length 7½ inches. In the collection of Mr. and Mrs. Richard C. Bull.

(white stone) join a short distance north of the city of Khotan. The earliest mention of the jade trade into Khotan was by Marco Polo in 1272, and a Manchu author writing in 1777 mentions the jade mines in these valleys. The jade workings along the Karakash were described in detail by H. Cayley, an English traveller, who saw them in 1870, and by Ferdinand Stoliczka, a naturalist attached to the Geological Survey of India, who was there three years later. Pits and holes had been dug in the slope and fragments of jade were heaped outside the entrances. The color of the nephrite is described as white, various shades of green of which the pale green was the most common, and occasionally nearly black. Fires were built next to the jade to crack it, after which it could be more easily broken away. In addition to that obtained from the mines, jade was also found in the form of pebbles and boulders, often with a brown weathered rind, either in the rivers themselves which had brought them down from the deposits higher in the mountains, or in the dried-up river beds and alluvial deposits along the rivers. Other nephrite deposits are known in the area farther to the west around Kashgar and Yarkand, notably around the Belurtag or 'Jade Mountain' about eighty miles from Yarkand.

Another source of nephrite in Central Asia is in Siberia. This was never used by the ancient Chinese, although in this century Siberian nephrite reaches the Chinese market. Water-worn boulders, some weighing up to two tons, had been observed in the rivers south of Lake Baikal early in the nineteenth century, and in 1850 a French engineer found nephrite in this area *in situ* along the Onot River in the Botogol mountains south of Irkutsk. Typical Siberian nephrite is deep green with black inclusions which were assumed to be graphite, because graphite deposits were found in the area, but F. W. Clarke and G. P. Merrill in an article in the *Proceedings of the U. S. National Museum* identified them as limonite or chromite. A recent x-ray diffraction test of the inclusions in a specimen of Siberian nephrite in the Freer Gallery Laboratory shows them to be a mineral of the chromite series. The Chinese gave this nephrite the very descriptive name of spinach jade. Other nephrite from this area is white, or green with cloudy white markings. Jade was used in the general area for prehistoric tools, and in the nineteenth century the Russians used it as slabs on the sides of caskets. The artificial flowers made of various minerals by Carl Peter Fabergé often have leaves of what appears to be Siberian jade.

A source of jade used only in relatively recent times by the Chinese is the jadeite occurrence in the Kachin hills in northern Burma. This was first discovered in the thirteenth century, but regular

trade between China and Burma did not begin until the late eighteenth century, at which time the city of Mogaung became its center. Reports on the mode of occurrence of Burma jadeite appeared in the *Records of the Geological Survey of India* from the 1880's on. The best jadeite vein then occurred in the Tawmaw mines in the hills north of the Uru River and, as in Turkestan, fires were used to crack the jade which was then broken up with hammers. The jade was mined from vertical pits which were constantly filling with water so that the operation was inconvenient and sometimes hazardous. Jadeite boulders were obtained from alluvial deposits along the Uru River, and these produced the best jade since the mined material was often damaged by heating. The typical jade from these localities is described as mostly white, sometimes with green spots of varying sizes. A solid green jadeite, both emerald and a darker shade, also occurred, and rarely an amethyst-colored jadeite.

The nephrite of Turkestan and Siberia, and the jadeite of Burma are the only confirmed occurrences of jade minerals in Asia proper, except for a small body of jadeite reported from Japan. Jadeite *magatama,* the comma-shaped beads or amulets typical of prehistoric sites in Japan, are common in second and third century graves. Similar beads have been found in Korea in fourth to sixth century tombs. At the time of the exhibition Masterpieces of Korean Art, which toured the United States in 1957-58, some of these *magatama* were identified by x-ray diffraction as jadeite. The appearance of the Korean and Japanese jadeite is somewhat similar, a mixture of white and pale green in varying amounts. The finding of jadeite in Japan makes the jadeite beads in both Japan and Korea more easily explainable; the only other source of jadeite which might have been used, in Burma, was unknown until a much later date.

There are several occurrences of jade in the Pacific area. The Maoris in New Zealand used nephrite which they called *punamu* for ornaments and tools. Nephrite is found *in situ* and as boulders and pebbles on Mount Cook and elsewhere on the South Island. Jade tools have been reported quite widely throughout Oceania, and on New Guinea unworked loose nephrite and also nephrite celts have been found. The only certain mineral occurrence of nephrite is on New Caledonia, where tools are also found. Jadeite occurs *in situ* in the Celebes, and chloromelanite has been located in New Guinea.

The only other area of the world where the art of working jade approached the quality reached in China is Central America, where jade was used from 1500 B.C. to the time of the Spanish conquest, after which all knowledge of it disappeared. For many years no occurrence of jade *in situ* was known in Central America, but in 1955 jadeite was reported by William F. Foshag and Robert Leslie from Manzanal, Guatemala. This jade is light green and resembles the pale greenish jadeite used for Maya carved faces and Aztec ear plugs. The other two common colors of jadeite found among objects of Central America are an apple or emerald green, the Aztec *chalchiutl,* and a pale pearl gray used mostly for Olmec objects. The finding of jade *in situ* in Mesoamerica settled the question of American jade possibly having been imported from Asia, as had at one time been suggested. Even before this discovery it was known that the jadeite of Central America was usually a diopside-jadeite, while the material from Burma was the single mineral jadeite.

In South America, nephrite is known to occur at a single locality in Brazil, at Babytinga, near Amargoza. Rough nephrite is found elsewhere in Brazil, and nephrite celts are known among the aborigines of the Amazon River. Although jade objects are reported elsewhere in South America there are no other confirmed occurrences of the jade minerals.

The Eskimo of Alaska used jade implements, and native reports of the occurrence of jade on a mountain in the area of the Kobuk River were confirmed by the discovery, in 1883, of what was later called 'Jade Mountain' where nephrite occurs *in situ*. Boulders which are found in the stream beds below the mountain were probably the source of the material for the Eskimo. Alaskan jade is of various shades of green—yellow, olive, grayish, and blackish—and boulders of it show a brown weathered surface.

The Haida Indians of British Columbia also used jade tools; these have been found in several localities, including Queen Charlotte Island. Nephrite boulders are known in the lower reaches of the Fraser River and elsewhere in the area, but no jade has been located *in situ* to date. Jade from British Columbia sometimes resembles Alaskan jade, in varying shades of green, and can also be gray-white with light green spots. It is interesting to note that during the gold rush in the late nineteenth century tons of jade were shipped from there to China by Chinese laborers hired for the gold workings.

Although no artifacts have been reported from the western United States, occurrences of both nephrite and jadeite are known there. Both minerals occur in California. Nephrite pebbles and boulders are found on the coast near Monterey and elsewhere, and a locality in northern California supplies green, white, brown, and almost black nephrite. Jadeite outcrops in San Benito County, first discovered in 1936 and reported by the California Division of Mines in 1950 were the first reported occurrence of jadeite in the Western Hemisphere. Nephrite is also found in Wyoming where it was first discovered in the early 1930's in the area of Lander in Fremont County, both *in situ* and as boulders. Wyoming jade is green, black, greenish brown, and pale gray. A large boulder weighing 2,495 pounds is now in the Chicago Natural History Museum.

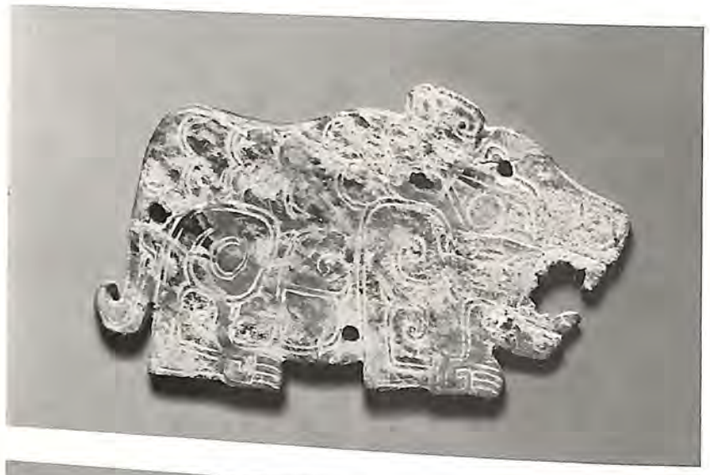
The earliest known use of jade was by the Neolithic Lake Dwellers in Europe. Jadeite, nephrite, and chloromelanite have all been reported as being used for their implements. The earliest report of jade *in situ* in Europe was of nephrite boulders in glacial deposits in Silesia, and there are now known occurrences of all three minerals in Italy, Germany, and Switzerland, as well as in Poland. Until the discovery of naturally occurring jade in Europe it was thought by some that it had been brought from Asia.

Isolated examples of both nephrite and jadeite have been reported from the ancient Near East, including Babylonian cylinder seals, but no occurrences of the minerals in the area are known, and the fact that the articles are of jade has not been confirmed. Some jade tools have been reported from ancient Egypt, but these also are unconfirmed. Recently, Sir Charles Hardinge has reported an occurrence of nephrite in Southern Rhodesia, the first on the African continent.

Because of the hardness of jade, the working of it into tools and ornamental objects required specialized techniques, especially in early cultures when extremely hard abrasives and power driven tools were not available. In some cases it is possible to obtain information about early jade working from analogies with methods used in the same area today, as in China. Sometimes the only information comes from the remains of tools and pieces of partly worked material such as those found in Guatemala.

The most complete discussion of the material and methods of modern and ancient Chinese jade carving is provided by Hansford in his book, *Chinese Jade Carving.* In the workshops of Peking in the 1930's, jade was worked on foot-driven treadle lathes which could hold various tools of steel and wrought iron. Large pieces were sawn first with a wire saw, abrasive being continually added as the sawing proceeded. The abrasives in use at that time were quartz sand (hardness 7), crushed garnet (7.5), corundum or emery (9), carborundum (9.5), and

(From top) White jade pendant representing the Man in the Moon; Shang Dynasty; length 2⅞ inches; in the collection of Dr. Arthur M. Sackler. Bird of partly calcified, light greenish jade; Chou Dynasty; length 1½ inches; in the Smith College Museum of Art. Fantastic animal of partly calcified light green jade; length 2½ inches; in the collection of Mr. John M. Crawford, Jr.



Two pieces for applique from the collection of Mr. and Mrs. Richard C. Bull. (Above) Of translucent, partly calcified white jade, in the form of a bear; Shang Dynasty; length 3½ inches. (Below) Of calcified jade, in the form of a reindeer; Middle Chou; length 3 inches.

X-ray diffraction patterns of the two kinds of jade: nephrite (left) and jadeite (right).

rarely diamond (10). Also used was a mixture of carborundum with loess or calcareous sand which was called *pao yao*. Carborundum, the artificial product silicon carbide, is a modern introduction which is responsible for the high gloss so characteristic of more recent pieces. This is not found in general on earlier jades, although the high polish on some Chinese objects of the third century B.C. and earlier is difficult to explain. Corundum, a naturally occurring aluminum oxide mineral, was probably introduced about the twelfth century, since by the fourteenth century large blocks of jade were being carved; this would have been almost impossible to do without a more efficient abrasive than garnet or quartz. Final polishing, at the time that Hansford observed the Peking jade workers, was done first with a lump of shellac mixed with fine carborundum, followed with a wheel of sandalwood, and then with leather buffing wheels; fragments of gourd were used to polish areas that were difficult to get at. The exact date of the introduction of iron tools is unknown, but it was of great significance in the history of jade carving. The first use of lathe-type rotary cutting and grinding tools was also an important step forward. There is strong evidence that they were introduced by the third century B.C., at the end of the Chou period, although the hand drills used for making perforations were of course in use before this. Hollow jade vessels could be made only with rotary tools, and it has been suggested that this is the reason that such vessels do not occur before the Chou Dynasty.

The jade working techniques of Mesoamerica must be inferred from evidence found at archaeological sites and have been well summarized by Foshag in his monograph, *Mineralogical Studies on Guatemalan Jade*. A jade worker's tomb found at Kaminaljuyu in Guatemala has provided evidence of this nature. The raw material was first broken and trimmed if necessary to provide a piece of jade of the size needed. Sawing was probably done with a metal tool, such as copper, and an abrasive, but hardwood or bamboo saws could also have been used. The selected piece of jade was then shaped with a trimmed hard stone; there is evidence that pecking with a blunt stone tool by percussion was also used. The piece could also be rubbed down into shape on a hard stone; this grinding was used to provide slight modifications in shape and not for major changes. Flat stones with wide grooves on which this rubbing was done have been found. A narrow file-like tool was used as a rasp. Drilling was carried out with both solid drills, possibly jade-tipped rods, and tubular drills of reed, bamboo, or bird bone. Polishing was done against a hard tool, probably jade, in which case no abrasive was used, or against hardwood or the outer surface of bamboo, with an abrasive. The abrasives used by the Aztecs were possibly garnet sand, specular hematite, quartz or any hard stone sand, and crushed jade. The use of the latter is not known elsewhere, and it was found in the jade worker's tomb mentioned above.

Methods of jade working used by the natives of Alaska and British Columbia can also be partially reconstructed from evidence of tools and partly worked material found on sites as reported by G. T. Emmons. In British Columbia, saws of sharp siliceous sandstone have been found, up to one foot in length, three to four inches wide, and a quarter to a half inch thick. There is evidence that boulders were sawn in parallel grooves two to three inches deep and a wedge was put in one groove and struck sharply, causing the piece to break. Flat thin boulders had a deep groove sawn on each face, and were then broken similarly with a wedge. Grindstones of sharp sandstone were used with water to give the final polishing. Similar methods were probably used in Alaska. Sawing was also possible with thin bone saws, with water and sand as abrasive. Pieces were ground into shape with other stones, and slabs could be smoothed by rubbing on a flat stone covered with sand. Drilling was possibly carried out with flint, or with a stick with water and sand.

F. R. Chapman in 1892 in the *Transactions of the New Zealand Institute* gives a description of jade working by the Maori. Pieces of fine sandstone were shaped to give a cutting edge and fastened into frames to provide a kind of saw; wood with wetted sand was also used for sawing. A piece was worked from both sides and then broken with a blow before the cuts met. Holes were drilled with a flint at the end of a split stick used as a bow-drill. Polishing was done with rubbers of fine sandstone or micaceous slate.

In Idzumo Province in Japan we find evidence on the working of beads, some of them of jadeite, both in prehistoric times and at the present day. On one site, unfinished and broken beads, waste material, and grinding and polishing stones were found. The grindstones were of granite, with parallel grooves and large circular depressions, and the flat polishing stones were of various kinds of schist. In modern bead workshops in the same province a toothless iron saw with abrasive was used to cut the raw material, which was also chipped with an iron bar. Drilling was done with a steel awl, rotated while being struck with a hammer. Rough polishing was done on an iron board with carborundum, and a slate grindstone was used for finishing; parallel grooves were made by repeated grinding. It is not known if the ancient workers used the awl for drilling; there is some evidence they used a bow-drill.

From this brief summary of jade working techniques in various parts of the world it can be seen that there are several basic factors on which the development of the craft beyond that of simple tool making depends. One factor is the abrasives available. It is of interest to note that the most sophisticated carving developed in China and in Mesoamerica where abrasives harder than quartz were used, corundum in China, and crushed jade in Mesoamerica. Another factor is the use of metal tools, although the copper saws which were suggested as a possibility in Guatemala would have had to depend for their effectiveness on any abrasive used with them, as copper is extremely soft. In China, iron tools came into use at a date as yet undetermined; it would seem that most of the early jade carving was done without this aid. The third significant factor is the use of lathe-type rotary tools. The forerunner of these might have been the bow-drill which is known to have been used in New Zealand. Hand drills of some description were used in Mesoamerica, but no suggestion has been made of the use of lathe-type rotary drills there; in China they may possibly have been in use since the third century B.C.

As a material of art and archaeology jade is a unique material, of whose use, occurrence and history there is still much to be learned.

A JADE PENDANT FROM TIKAL

By PETER HARRISON

During the 1962 season at Tikal, field work included investigation of the West Plaza, a large ceremonial group immediately west of the Main Plaza and North Acropolis, the ceremonial center of the site. Excavation of Structure 5D-11, a roughly square truncated pyramid on the west side of the Plaza, revealed a tomb buried on the axis of the structure. Tombs so situated are a common feature at Tikal. This one, dated by its ceramic contents to Late Classic times and possibly no earlier than about A.D. 750, was noteworthy because it contained a pendant which is one of the finest jade carvings yet discovered in the Maya lowlands.

The Maya interest in jade was expressed in the grave goods by ear plugs, button-like flares encircling the head, wrist bands of beads, and the pendant which lay on the breast of the deceased where the pale green of the stone was dramatically contrasted by clinging red cinnabar, which had perhaps been sprinkled over the body during interment ceremonies.

The jade pendant, 3½ inches high, immediately after its removal from its position among the upper chest bones of the skeleton. The suspension hole in the object, together with its discovered position, argues that it was used as a pendant.

The author recording the position of the large pottery plates just north of the head of the skeleton within the tomb. Tombs of this date, unlike earlier ones, are large enough to allow one to record the many details in reasonable comfort.

On the face of the pendant is carved the sensitive, realistic portrait of a man adorned with large ear plugs, a necklace of heavy beads, and an elaborate headdress. The crossed eyes of the grotesque mask-headdress help identify it as the sun god "Kinich Ahau." A biconically drilled transverse perforation at the level of the crossed eyes provided a means of suspension. That the piece may have been an heirloom at the time of placement in the grave is suggested by still visible traces of an effaced vertical inscription of four glyphs on the smooth reverse side. Of all the jade pendants yet recovered at Tikal, this is the only one executed in the style attributed to the Late Classic period.

A Babylonian Lion in Toronto

By ROBERT H. DYSON, JR.

Glazed lions molded in relief on baked brick façades are relatively rare on the North American continent. One of the best of them has just been redisplayed at the Royal Ontario Museum in Toronto in its current "Art Treasures" show celebrating the museum's fiftieth anniversary. Noted for many years for its Chinese collection, the museum is currently building its Near Eastern department under the able guidance of Curator Winifred Needler. Since World War II the R. O. M. has been developing an appetite for field work in the Near East, whetted by its possession of such superb pieces as the glazed Babylonian lion of about 600 B.C. illustrated here, which was purchased just before the war from the State Museum in Berlin.

That a piece of wall made twenty-five hundred years ago in the Neo-Babylonian Period should still arouse our interest shows that our reactions to objects with color and form and of mysterious origin differ little from those of our predecessors of a hundred years ago, who undertook the excavation of such famous ruins as Babylon and Susa. Attracted first by the color of these same fragments as a guide to their work, Robert Koldeway, the excavator of Babylon, points this out to us in his book *The Excavations of Babylon* when he says:

> The discovery of these enamelled bricks formed one of the motives for choosing Babylon as a site for excavation. As early as June 1887 I came across brightly colored fragments lying on the ground on the east side of the Kasr [street]. In December 1897 I collected some of these and brought them to Berlin, where the then Director of the Royal Museums, Richard Schine, recognized their significance. The digging commenced on March 26, 1899, with a transverse cut through the east front of the Kasr. The finely colored fragments made their appearance in great numbers, soon followed by the discovery of the eastern of the two parallel walls, the pavement of the processional roadway, and the western wall, which supplied us with the necessary orientation for further excavations.

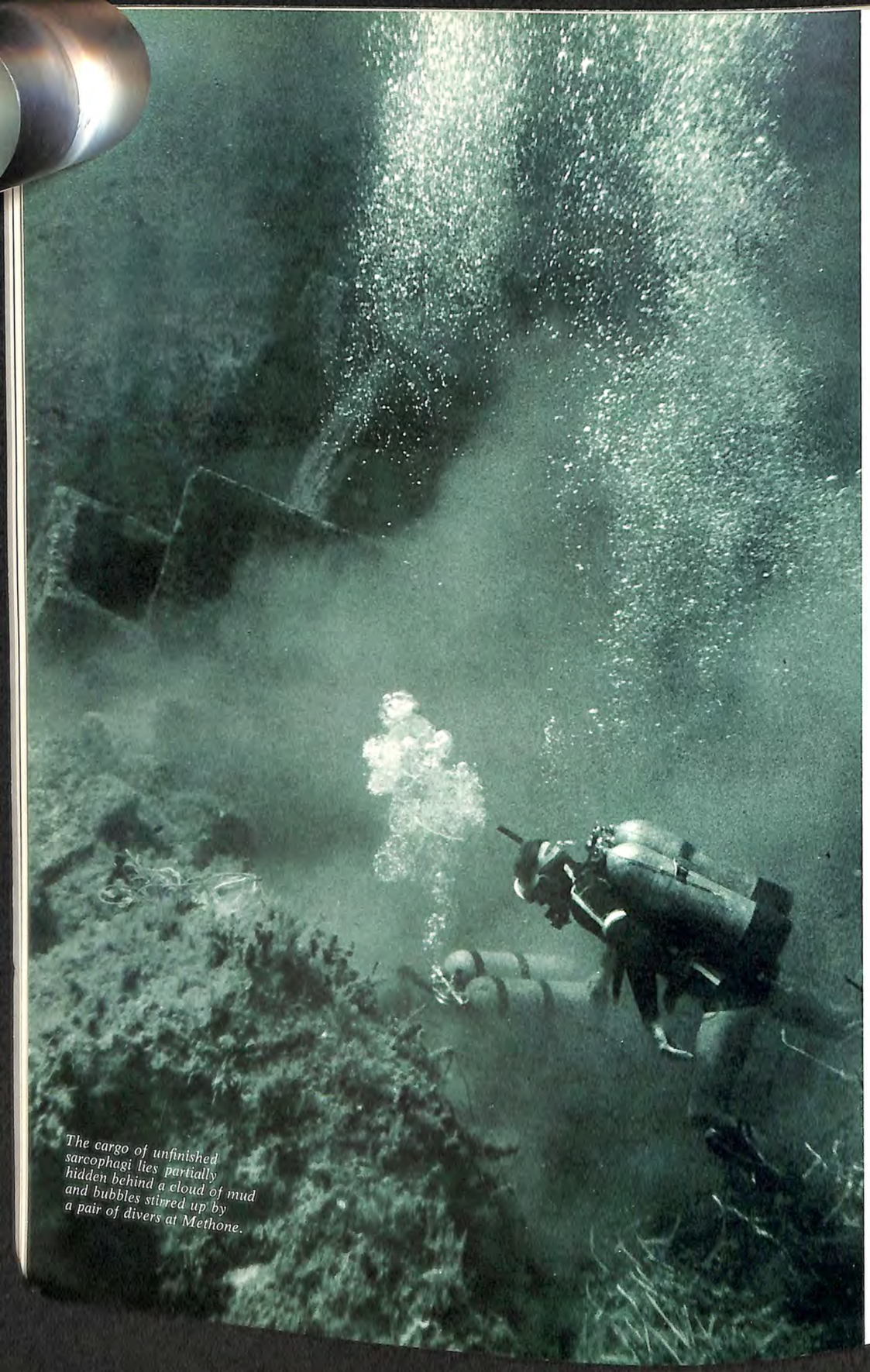
While such comments indicate the procedure which led to the excavation of the areas in which the glazed bricks were found, they give no hint of the complex task of excavating them. A glance at our illustration will show that the panel is made of innumerable small pieces of glazed molded brick reassembled to form the whole. Reassembling the pieces was an arduous task undertaken after excavation.

Some years before, in 1884, similar walls were unearthed by the early French excavators of Susa, M. Dieulafoy and his wife Jane. In her book, *At Susa, the Ancient Capital of the Kings of Persia* (translated by Frank L. White and published in Philadelphia in 1890 by Gebbie), this formidable woman (who on the opening day of excavations seized the pick herself and worked until exhausted!) describes the tedious job to be carried out in the blazing sun and dust: "Every block, broken sometimes into seven or eight fragments, is extracted with the point of a knife, traced on a paper ruled in squares, deposited in a basket on the bottom of which is drawn a number showing its order, and takes its way to camp" where "on rainy days" it was cleaned up! The restored panels now stand in the Louvre. Multiply the number of panels by the number of bricks in each panel (perhaps ninety) by the number of fragments of each brick (perhaps twenty-five) and you can imagine the detailed recording and patience required for the work. Two fragmentary bricks of the same period found at Ur may be seen in our own Mesopotamian gallery.

The work of restoring these panels is matched only by the effort of the potter in producing them in the first place. It has been suggested that the lion figure was modeled to scale either on a single clay panel or on a temporary

wall with a plaster facing. In either instance, the relief had then to be cut apart into individual bricks, so that a separate mold could be made from each. The faces for the lions on the wall along Kasr Street in Babylon were made from a single mold, as shown by the fact that they are all the same regardless of which way the lion faces. The molds themselves had to be fired. The bricks were then cast from them and burned in a kiln. The burned bricks were laid out in order and each one marked at the top with an appropriate symbol to key it into the group. The contours of the animal were next drawn on in black and the areas so defined filled with liquid glaze of appropriate color. In the case of the lion shown here, which is four feet high and six feet wide, the mane is yellow, the body white, and the background blue-green. The fangs, claws, and tuft at the end of the tail are highlighted by touches of yellow. It comes from the throne room of Nebuchadnezzar and is one of a dado of snarling lions around the base of a larger wall decorated with glazed columns, lotus buds, and palmettes. Outside, along the street and on the famous Ishtar Gate, such lions were joined by dragons and bulls, the animal attributes of the gods Marduk and Adad. The lion itself was usually associated with the goddess Ishtar.

Wall panels of colored glazed brick were the decorative technique *par excellence* of the Neo-Babylonians, and the method was used for several centuries by the Persian overlords of Susa. At that site, which like Babylon did not have ready access to slabs of stone for wall reliefs, color was abundant and the repertoire was increased through the addition of archers, winged griffins, and winged human-headed lions. Somewhat earlier, the technique was used in Khorsabad at the Palace of Sargon and the Temple of Sin. Here a panel showed a procession of the king, a lion-eagle, a bull, a fig tree, a plough, and a minister of state. Other glazed panels are known from Assur. It seems quite likely that their origin found itself in the painted stone reliefs of such famous cities as Nimrud and Nineveh (represented in our Museum by the Assurnasirpal relief in the Mesopotamian gallery). Ultimately the wall leads us back to the glazed wall tiles of older Assyrian times and to the early use of glaze on the cylinder seals of the early fourth millennium.



The cargo of unfinished sarcophagi lies partially hidden behind a cloud of mud and bubbles stirred up by a pair of divers at Methone.

Underwater Surveys in Greece: 1962

By PETER THROCKMORTON
and JOHN M. BULLITT

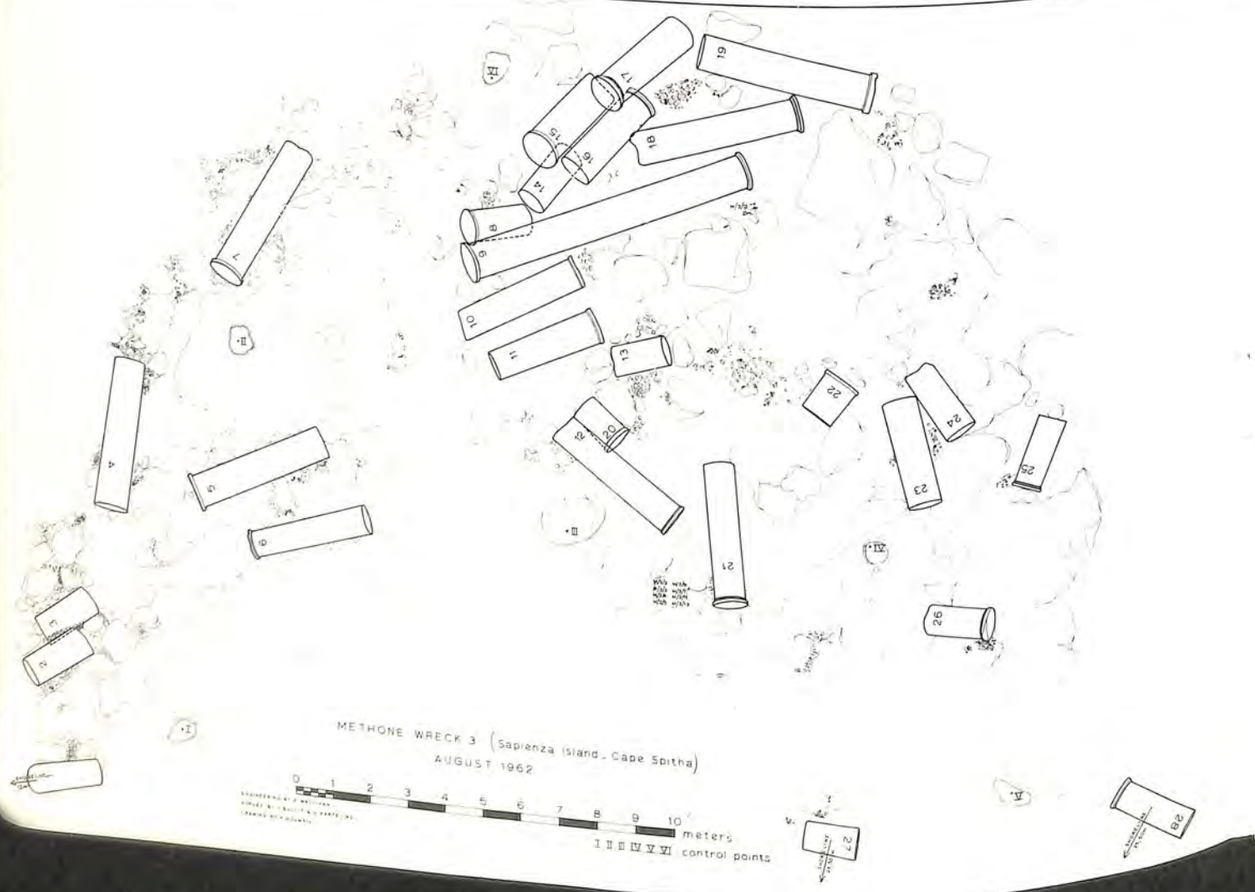
During the winter of 1961-62, Admiral Th. Voutsaras, President of the *Fédération Hellénique . . . des Activités Subaquatiques,* received reports of a group of ancient columns lying on the sea bed off Cape Spitha, the northernmost point of Sapienza Island, about a mile from the small port of Methone on the southwestern Peloponnesus. Amphoras and amphora sherds were also reported to have been found by several net fishermen in the area.

The windswept corner of Greece is situated on what has long been a major shipping route. For centuries, passing mariners have tried to escape the fierce and sudden storms of the Ionian Sea by rounding the "corner" and sailing through the channel between Sapienza Island and the mainland into the sanctuary of the harbor; the small, blinking light now on Cape Spitha warns modern ships of the dangers which accompanied this maneuver. And Methone was more than an occasional refuge; its strategic location was prized by contending nations. First settled in Mycenaean times, its long and violent history included a succession of sieges, bombardments, and occupations. During the Middle Ages, its period of greatest prominence, Methone became an important port of call for the Venetian navy.

Today, Methone's historic remains have almost completely disappeared except for the layers of architectural elements built into the walls of the great Byzantine-Venetian-Turkish castle which dominates the village. But one of the traces of unidentified and forgotten buildings which survives in the castle is the large fragment of an Oriental pink granite column, 3.67 meters high, standing in front of the keep; it is part of a monument set up by a Venetian admiral, Francesco Bembo, in about 1494. The column may well have come from an early Christian basilica of which no other trace remains above ground. The reports reaching Athens last winter of a shipwreck of columns and of numerous amphoras plainly suggested that the waters of Methone still hold historically important debris from many forgotten catastrophes.

Admiral Voutsaras obtained the necessary permissions for a survey team to investigate the Methone region under the supervision of the Hellenic Federation. A small but diversified group of specialists was assembled by one of us (Throckmorton), who served as technical director of the survey and its photographer. The six man team consisted of four experienced divers (Nikos Kartelias, a Greek ex-navy diver who represented the Fédération; Roger Wallihan, an American who provided essential engineering skills; and the authors); a trained draftsman (Pierre Goumain, a French architectural student at the University of Paris); and a skilled mechanic (Michaelis Baltinos, a Greek citizen on leave from his job as a commercial jet pilot in Brazil). The expedition was financed through the University Museum by

Divers measure the circumference of one of the columns in the column wreck.



grants from the Littauer Foundation and from individuals. During August and September, this international and largely volunteer team (only Mr. Kartelias received a salary) conducted the first survey of an underwater archaeological site ever made in Greece.

Upon arriving at Methone, we established our headquarters in a lean-to beside the crumbling and picturesque walls of the castle, and then contacted local fishermen. Before the end of the day we found ourselves swimming among heaps of columns in thirty feet of water off Cape Spitha. There was no question about their coming from a shipwreck; they were scattered over a twenty by thirty meter area which at its nearest point was ten meters from the cape and more than forty meters at the outside edge of the mass. We saw no evidence of any building having been erected on the rocky point nearby. In one place, the column pieces lay close together and were apparently in about the same position as they had been when stacked on the deck of the unfortunate ship that had carried them. Other pieces had evidently been rolled by heavy seas until they became wedged between outcroppings of rock.

We initially counted nineteen fragments and one complete column, but in subsequent dives we discovered eight more pieces hidden beneath a heavy growth of seaweed and hardly distinguishable from the neighboring rocks. We decided that the only practicable way of recording and studying the site was by drawing a carefully measured plan. The area was too large to be encompassed by a single photograph, and, because of distortion under water, a mosaic photograph would have been inaccurate. There were pecularities in the lengths and shapes of the columns which could be understood only by studying a plan based on precise measurements.

But to make a plan of so large an area amidst limited visibility and heavy interference from current and surge presented us with a novel and challenging problem. Our time and funds were limited; we were not equipped with surveying instruments specially adapted to underwater work; and we had no precedents to guide us. Because of the area's extent we could not use a drafting frame like the one built at Yassi Ada in Turkey by George Bass.

We considered various possibilities. Finally, our surveyor, Mr. Wallihan, a professional civil engineer on leave from the U. S. Army Corps of Engineers, decided that a tape survey of the kind sometimes undertaken on land would be a practical solution and would yield an accuracy comparable to that of land surveys. We improvised the necessary instruments from a carpenter's level purchased at the village hardware store, a sheet of plexiglass, half a dozen lead diving weights, and a roll of plastic measuring tape. We cleaned the sea growth from the top of each column and fastened a numbered tag to it. Having selected six control points from the surrounding rocks we then triangulated each end of the columns from these points and carefully measured the length and diameter of each column. As a check upon our accuracy, an overlay photograph consisting of more than one hundred vertical photographs was shot and assembled. We recorded over fourteen hundred measurements before we were satisfied with the accuracy of our survey; Mr. Goumain then completed the final drawing.

Before we finished the survey of the column wreck we discovered six more scattered column fragments some sixty meters to the south of the main site. We found these to be of the same diameter and of the same kind of granite as the columns in the main group. Unquestionably, they belonged to the same cargo, but the pieces are small and so far removed from the central mass that we did not include them on our plan.

When we compared the samples of granite we had chipped off the broken edges of several of the columns with the granite of the Bembo monument we found them to be the same; the measurements were also similar. Geologists inform us that granite of this kind does not exist naturally anywhere in the Peloponnesus and that it probably does not come from Greece at all but from near Aswan, Egypt. If it is Greek granite, it can only come from Xanthe or Cavalla in the north, or from the island of Mykonos, a long way from Methone.

Study of the plan indicates that the columns are from a ruined building and are not part of a shipment from a quarry to a building site. All of the columns but one are broken. The unbroken column, no. 9, is eight meters long and weighs over fifteen metric tons. Column no. 1 and several others have rounded ends as if they had been used as bollards on a pier. All of the broken columns have irregular breaks and were probably broken when a building fell or was torn down. It is tempting to suppose that they broke when they rolled to the bottom as the ship disintegrated, but a close examination of the measurements shows this to have been impossible. The fragments cannot be fitted together.

For example, the fragments lying beside column no. 9 seem to belong together. No. 17, with its double astragal, is certainly the upper end of a column like no. 9, and it seems at first glance

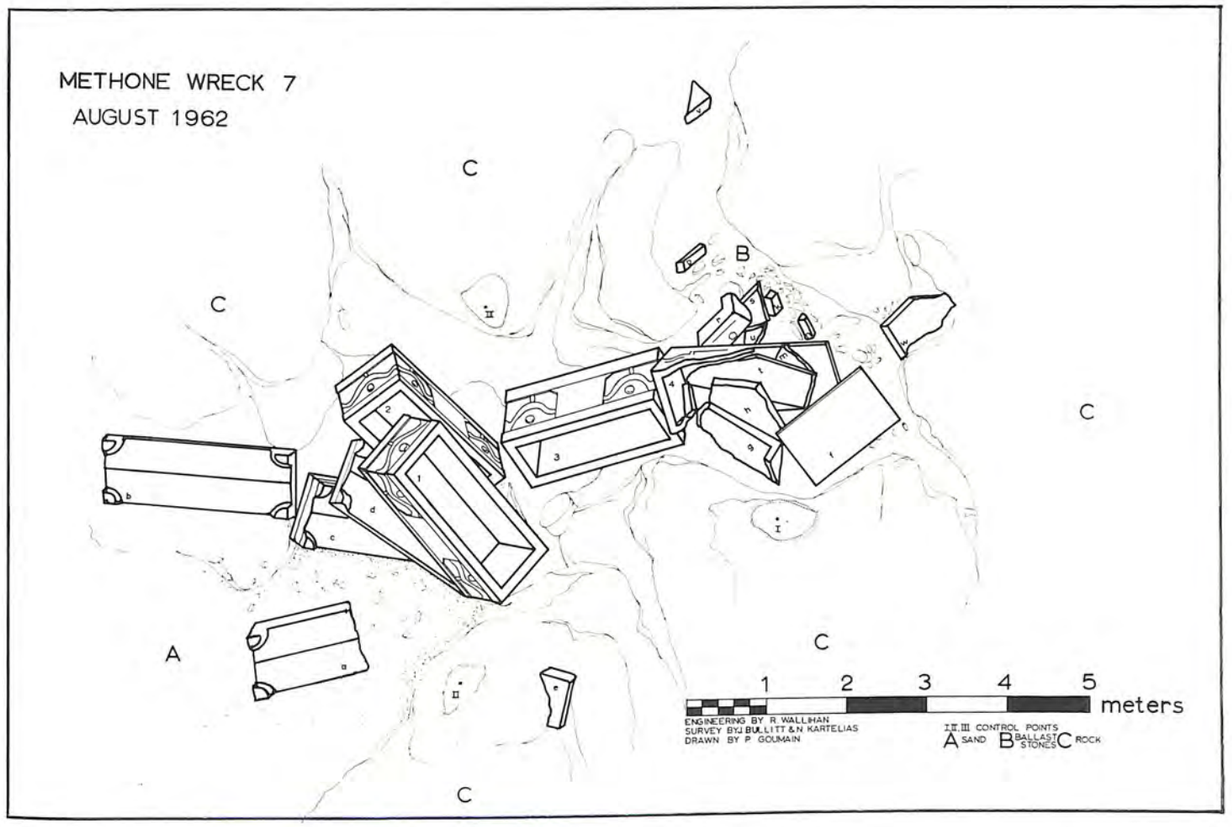
As Nikos Kartelias measures the astragal of a column, Roger Wallihan records the data on a sheet of plastic which is taped to a plexiglass "board."

to fit onto no. 19 which, with its single astragal, must be the bottom half of a column. Their combined lengths, however, measure only 7.50 meters, some 50 centimeters short of the length of no. 9. All of the other "obvious" reconstructions fail in the same way. It is unlikely that a group of columns having approximately the same diameter should vary so much in length. Accordingly, it seems certain that these fragments are parts of sixteen, and possibly more, columns and that the missing parts were not in the same cargo as the group we have surveyed.

The measurements make it possible to calculate the weight of the cargo and to give an interesting indication of the carrying capacity of the ship. The main group weighs 122.95 metric tons, and the combined weight of the columns in both groups is 131.50 metric tons. This is well within the carrying capacity of a large modern *caique* from 30 to 40 meters long, a ship slightly larger than the amphora carrier now being excavated by George Bass at Yassi Ada.

It is unfortunate that, unlike the wreck at Yassi Ada, nothing of the ship's hull remains. The wooden parts of the hull must have been smashed and washed away by wave action soon after the ship sank. All that remains of other cargo are a few potsherds which have been washed into clefts of the rocks among which the columns lie. A series of handles from about ten identical jars was raised. They are late Roman in character and are similar to pottery found in a wreck carrying a similar cargo of architectural elements discovered and investigated by Piero Gargallo and Gerhard Kapitan in Sicily. A careful search with metal detectors in the wreck area might reveal additional material with which to date the wreck more exactly and perhaps solve the mystery of who was freighting a cargo of pink granite columns, where they came from, and what was their destination.

The column wreck was only one of many ships that ended their careers on the rocks of Cape Spitha. Our fishermen friends told us of other locations along the east coast of Sapienza where one might find the cargoes of ships which had struck the Cape in a north wind, been damaged, and then foundered farther down the coast. A mile south of the Cape, trawler captain Lucas Masarello had found many amphoras in his nets after trawling over a muddy bottom, 30 meters deep and several hundred meters off shore. His report interested us because wrecks on a muddy bottom at that depth are usually well preserved. We dove at the place indicated and found scattered jars and what seemed to be ballast stones which probably came from a ship that has disappeared under the mud. The jars are mediaeval. When we had raised two jars and were convinced they were of the same date, we left the site because we lacked the equipment necessary for locating the wreck under its protecting blanket of mud. A mediaeval wreck could be of great interest since none has been recorded.

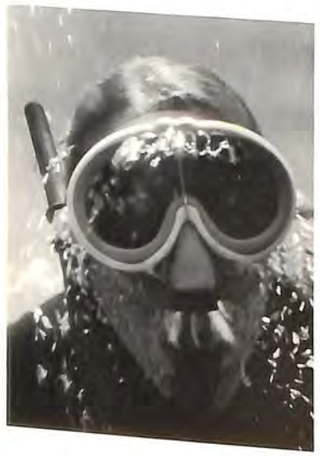


George Papathanasopoulos and John Bullitt dive to inspect the sarcophagus wreck.

A search down the west coast of the island brought to light dozens of amphora necks, the earliest dating from the third century B.C., several of the Roman Period, and many of late Roman or Byzantine times. A wreck which might be worth investigating in the future is badly broken up in shallow water and is probably Hellenistic or earlier. But our most interesting discovery at Methone was made when diver Kartelias went fishing one evening south of the column wreck site and found a heap of granite garland sarcophagi several hundred yards offshore.

There are four of them heaped in a gully in the rocky bottom. One is badly broken, perhaps by the shock as the ship struck, but all of its constituent pieces appear to be together. Their lids lie under them in a heap except for one broken lid half of which lies a few feet away from the main mass. A small pile of waterworn stones from some distant river bed fills the upper part of the gully. These ballast stones, typical of shipwreck sites, are good evidence that the sarcophagi are from a wrecked ship of which the timbers have been

Using sights mounted on a weighted spirit level, a member of the expedition takes a bearing on a surveying rod held by another diver in the wreck (outside the picture).



In the picture above, John Bullitt surfaces from a dive without aqua lung; at the right, he is shown recording measurements taken with the meter tape which hangs over the garlanded end of one of the sarcophagi.

Air is bled from extra diving tanks into a plastic balloon in order to raise the lid of a sarcophagus . . . A few minutes later the balloon bursts.

eaten by seaworms and destroyed by wave action. Mixed with the ballast stones are fragments of broken pottery and the roof tiles which are almost always associated with Roman Period shipwreck sites. A Roman glass unguent jar which can be assigned to the second or third century A.D .dates the wreck.

The sarcophagi are evidently unfinished, as the garlands are only roughed out. On each side, between the two garland designs, an unmarked space appears intended for an inscription, but none is inscribed. It is known that sarcophagi were often roughed out and shipped off to be finished at their destination, but this is the first find of the actual wreck of a ship carrying such a cargo.

The sarcophagi were drawn in place following the same procedures we had used on the column wreck. When the drawing was finished we attempted to lift the half lid, which lay in the sand at the deepest end of the wreck, in the hope of finding more dating material or fragments of the hull preserved in the sand underneath. We calculated that the piece of granite weighed about one ton; our largest lifting device, a plastic balloon which could be inflated with air underwater from a diver's mouthpiece or an extra air bottle, was designed to lift only five hundred pounds. But when we had attached this deflated balloon to the lid and began to fill it with air the lid slowly and ponderously rose with one end resting on the bottom. In the hope of adding the few additional pounds of lift that were needed in order to move the lid quite out of the way we squirted into the balloon a little extra air. The strain was too great for the "shroud lines" of the balloon; they broke all at once with an earsplitting shock. The balloon soared to the surface and its airy contents swiftly expanded into an awesome, mushroom shaped cloud of silver bubbles. Fortunately, no one was hurt either by the lid, which fell off to one side, or by the balloon which might have carried an unwary diver so rapidly to the surface as to rupture his lungs. Unfortunately, the sand on which the lid had rested revealed no further materials.

In addition to making the two surveys and examining the mediaeval and Hellenistic sites, the expedition searched several other underwater areas near Methone. Hundreds of amphoras and other pottery of various dates, but mostly Roman and Byzantine, were found in the harbor where we also discovered traces of the Turkish ships sunk by Admiral Miauris during the Greek revolution of 1825. In the channel between Megalo Sakuli Island and the mainland, two miles north of Methone, we found what appears to have been a Roman fleet anchorage of the first and second centuries B.C. Just before leaving Sapienza Island for the last time, we found what could be material from the *H.M.S. Columbine*, a 22-gun British warship which went ashore on Sapienza in the early nineteenth century.

All materials raised were drawn, photographed, and then deposited in the museum at Pylos.

TIKAL

THE NORTH ACROPOLIS AND AN EARLY TOMB

By WILLIAM R. COE
and JOHN J. McGINN

What is it that motivates anticipation of a rich tomb as the trench is cut further and deeper back in time? The excavator knows the lure and now and then stops to ask himself the values to be gotten from the elusive tomb, from the rotted bones, the things worn by and later deposited with someone of another people and world than ours. On the heat struck North Acropolis of Tikal, Guatemala, we and our associates desperately wanted to find deep in our excavations a tomb that would give us a glimpse of what, at one point in time, was current, valued, and pertinent to one individual who once commanded and controlled the site which has so preoccupied us since 1956. In April of 1962, fifty-five feet down in our great trench through the temple-rich North Acropolis, we found what we term Burial 85, a rich interment and in fact the oldest of such sumptuousness yet recorded in the Maya lowlands. Its discovery came late in the season (as too often important things do).

To go back to the beginning, the North Acropolis work in a sense was begun in 1958 (see Shook, "The Temple of the Red Stela," *Expedition* Vol. 1, No. 1), but it was not until 1960 that important excavation was started on the Acropolis proper. This massive construction, really a great platform supporting eight temples and fronted directly by three more, was chosen for major work because it gave most promise of having been the end product, by around A.D. 600, of a long complex growth. By probing its levels of growth, we might encounter the very early beginnings of ceremonialism and architectural settings that emerged during Classic times

Deep excavation was begun in 1960 on the North Acropolis in this trench between two large Early Classic buildings. Various Acropolis floors have already been penetrated.

(A.D. 300-900) as the outstanding features of lowland Maya life. A common and proper query has been, How old is Tikal? A deep cut into the high North Acropolis might reveal vestiges of earliest occupation, with the appearance on higher Acropolis levels of increasingly complex buildings, climaxing about A.D. 200-300 with the formally arranged, varied temples of Early Classic times. The archaeologically typical elements of such times were the massive, elaborately decorated buildings, the corbelled vault, the stela-altar cult, the cached offerings of exotically chipped stones, and, finally, polychrome pottery. But did these elements appear suddenly around A.D. 300 at Tikal? Or did they perhaps have earlier beginnings which could be exposed only by a long-term excavation? When and where did the elements commonly identifiable as lowland Classic Maya originate?

The problem of Tikal's origins is really part of a much larger one. Was Maya lowland culture an exotic, tropically nurtured development with its own roots, non-expansive, remote, and resistent to outside influence? Did it, like other Mesoamerican cultures, grow independently as a shoot from some temporally deep cultural stratum common to all? Or did the lowland Maya in their rain forests take this and that foreign strain, then combine and recombine them, here and there inventing something of their own, to produce the strange, extravagant world in which Tikal, we believe, so long dominated?

By the end of the 1962 winter season, the third one of work on the Acropolis, the 140-foot long central trench had already done much towards clarification of early details. The main trench and ancillary trenches have so far revealed twenty-three buildings underlying the final stage of the Acropolis (that is, the latest floor and the buildings directly associated with it). Thirteen Acroplis floors have been penetrated to date. As was expected, the Acropolis proved to be a highly complex product of many centuries of steady growth, of abandonment of an old floor and the buildings on it, the laying of a new plaster floor and the construction of new edifices and a great stairway down to the North Terrace below, and so on, until around A.D. 600, the Acropolis culminated in its final form. By the end of the 1962 season, it had become apparent that, in cutting down through the massive superimposed constructions, we were no longer encountering Classic polychrome potsherds in the construction fills. Nor were we still finding the cached offerings of eccentric flints and other materials so frequent in Classic contexts high up in the Acropolis. Nevertheless, as we cut farther down, the elaborateness and Classic appearance of the discovered structures were no less apparent. Things were not getting simpler, or cruder, or increasingly formative. Peculiar patterns of plan, evident in the Classic levels, were obviously present deep in the Acropolis. Similarly, the Classic trait of purposefully (ceremonially?) razing and mutilating the old structure before building the new over it was found to go as far back in time as our excavations have carried us.

One of the two oldest structures yet found had been exposed in a large test pit in 1960 by Edwin M. Shook. Its great central stairway was flanked by the mutilated remains of great masks. Whether this building was vaulted or not (the roof had been ripped off by the Maya prior to abandoning the building forever) was and still is a problem. The 1961 and 1962 seasons on the Acropolis have been devoted to trenching on an enormous scale to fill in the construction sequence between this stratigraphically early building (referred to as Str.5D-Sub.1) and the final, late Early Classic stage of the Acropolis. What faces us in 1963 is the carrying of the trench and the record of all that it intersects to bedrock. Once there, will we find the beginnings of the Acropolis and perhaps of formal, elaborate ceremonialism itself at Tikal and conceivably in the lowlands in general?

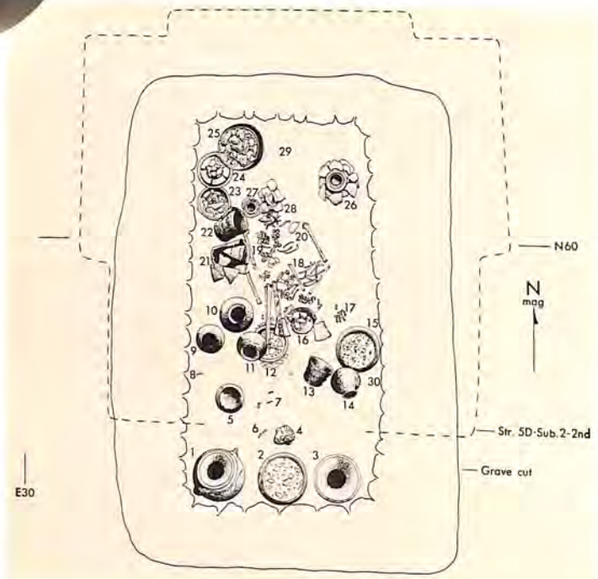
Work during these past two seasons has been within what is usually referred to as the "late Pre-Classic." Where we are in time is largely determined by the ceramics encountered. Late Pre-Classic pottery is quite unlike the general run of Early Classic pottery. Late Pre-Classic pottery is best known for its waxy or soapy feel, for

In 1960, beneath the ninth floor back through time, what remained of the upper zone of an early building, Structure 5D-Sub.1, appeared. Edwin M. Shook, standing on a ladder, is clearing projecting wall masonry.

By 1962, a trench had been carried down through all the buildings south of Structure 5D-Sub.1, seen in the background beneath protective sheets of tin. Looking north.

Looking south, with the platform on a pole-and-thatch building in the foreground. Underneath this platform was another which overlay the pit dug for the early burial.

The two platforms were largely removed, exposing the rock filled pit of Burial 85. The persons in the pit are standing at the level of the burial chamber roof.



Plan of Burial 85 at a scale of 1:40, showing the arrangement of the objects and skeletal remains within the vaulted chamber.

its complex profiles, and frequently for close-set parallel wavy lines on its exterior or interior. There is an intermediate ceramic phase between the Pre-Classic and Early Classic called Proto-Classic, in which one outstanding feature is the use of four symmetrically placed swollen mammiform feet. In the deeper levels of the Acropolis, structure fills (earth, rubble, old trash, and so forth) consistently lack sherds identifiable as Early Classic. As we excavate, the sherds from the fill of one building platform or floor are segregated from those from the fill of the succeeding platform or floor. Relative dating comes about through the identification of the latest pottery in each fill. The assumption is that, if the latest pottery in the fill of a building is Proto-Classic, then the structure was built no earlier than the time of breakage and discarding of such pottery and *probably* (if the fill sample is large enough) construction was contemporary with the use of such pottery. With our fairly specific knowledge of the developmental sequence of lowland Maya pottery, it is possible to date ceramically various points in the Acropolis construction sequence. For instance, there is fairly good evidence from other sites that Proto-Classic tetrapod mammiform vessels were produced in the first few centuries A.D. and that Late Pre-Classic pottery was made prior to this.

However, we were still faced by the strong possibility that the fill used, say, in a building platform, had been brought to the North Acropolis from very much older construction debris dumps or even occupation middens, and that pottery current at the time of building the platform need not have entered into the fill itself. Bits of charcoal collected from this same fill could of course be run in our Carbon-14 laboratory for an absolute date. But what actually would the result "absolutely date?" First of all, it would provide an average date for cutting all the trees that produced the wood that was burnt and which somehow eventually entered the source or sources of the fill brought to the Acropolis and used in the particular platform. If our C-14 result was, say, 300 B.C., we could only conclude that the building was constructed no earlier than this and in fact at any time after it, but always keeping in mind what structures, what pottery, and what C-14 results were stratigraphically above the platform. And could we preclude the possibility that a C-14 date on fill charcoal from a building above and thus later than the platform would not be older than the hypothetical 300 B.C. date from the platform?

Where we were in absolute time at major levels in the excavation was becoming a very worrisome problem. The discovery of certain specific features however could solve the dilemma. We might with luck locate a platform whose pole-and-thatch building had been burnt and the remains left at the time of its abandonment and the start of new construction. Radiocarbon analysis of the charcoal would give us a good control on when the building was erected or when its thatch roof was last renovated. Similarly, the location of a pit cut into a floor of a building during its terminal days and containing the charred remains from ceremonial fires could give us a date that would be about contemporary with the building activity that immediately followed such ceremonies. One problem however would be to make sure that the wood burned in such a terminal ceremony or sacrifice was not a tropical hardwood with centuries of growth (the core wood from a log of such wood will give a very much earlier date than the wood close to the bark). Better yet for our purposes, would be a building that burned and collapsed on a mass of contemporary pottery. If we could date such pottery "absolutely," the pottery when found elsewhere would have in a very real sense a built-in radiocarbon date for its manufacture and use.

But perhaps the most useful discovery would be a tomb in which a lot of truly or roughly contemporary pottery and other materials were set on the death of the buried individual. We would have the grave traits to consider, along with pattern of layout of offering, as well as the method of disposal of the body. If charcoal, by some manner provable as contemporary with the burial, could be recovered from the grave, a lot more than pottery could be firmly dated. The tomb would either be found to have been cut into an old floor or structure just prior to building a new structure; or the tomb might have been cut into the structure during its use, the floor then patched, and the structure continued to be used. In either case, the structure and its various floors, and the structures elsewhere on the Acropolis on these floors could each be given an excellent "fix" in time and within the ceramic continuum of Tikal as a whole.

A few days before Easter, which incidentally is the local labor holiday, the first indications of the stratigraphically deep tomb appeared. It was late in the season. We were miserable in the annoying steady drizzle of that particular week. Our sections had been carried down to the thirteenth oldest Acropolis floor, which supported the early building found in the 1960 test pit. We had reached for this season a logical stopping point which happened to coincide stratigraphically with what the clue pointed to, namely, the long awaited and, by that time, desperately needed tomb. Still, the prospect of having to dig down to it ourselves (the two of us and whoever of the Project staff were not to depart for a brief Easter vacation) was something to be considered.

By the time the holiday had begun, we had determined that the tomb had been cut through the tenth Acropolis floor back through time, and that the tomb and the floor cut had been obscured by a platform, nine feet square, which was covered by a later platform, necessarily somewhat larger but of essentially the same form. The apparent tomb cut was actually larger than the earlier platform and, where it was exposed in front of the platform, the cut had been neatly patched by a plaster surface. Both platforms had been painted red. Each had carried a pole-and-thatch building. The burned remains of the latter were found buried in front of the platform in a curiously sealed pit (this was an additional dating dividend). Moreover, these superimposed platforms were directly in front of the 1960 early building, Str.5D-Sub.1, but on the latest of three floors added about this important building during its use. The tomb (the apparent size of the cut in the floor argued that it could be nothing else) would therefore date from a time relatively late in the occupation of Str.5D-Sub.1.

Jade mask, 5 inches high, with shell inlay eyes and teeth.

The tomb should then fall in time between the date of the construction of this important building and its eventual razing and burial. South of the two superimposed platforms was a long series of major building substructures that were built during the same time span as Str.5D-Sub.1 and the small sequent red platforms directly fronting it. These building substructures were associated with polychromed stucco mask-flanked stairways that led down to the North Terrace and Great Plaza below.

The latest platform overlying the anticipated tomb was planned, sectioned, and photographed. The weather improved fortunately but the bodily shock of wielding picks and shovels dissipated less quickly. The excavation debris was piled as close as feasible with the expectation that the returning workmen on Monday would wheel it all away (with some amusement, they did). The earlier platform was soon fully exposed and it too was recorded in plan, then cut through to expose its sectional construction, then demolished and dumped nearby. The rectangular cut into the tenth Acropolis floor had finally been exposed. Its long axis was north-south, measured about eleven feet, and occurred, as previously noted, at the base of the stairway leading up into Str.5D-Sub.1. During the use of that most important building, someone of consequence had died—presumably a ruling priest—and had been buried at the foot of what may have long been *his* primary temple.

Three large vessels standing at the south end of the tomb, with the jade mask lying on the tomb floor.

By this time, we were exhausted. The trench is so deep that only the sun, heat, and limestone glare enter. At this point, Marshall and Kathleen Becker dropped their work among ancient Tikal house structures and joined our somewhat maddened team. It was decided unilaterally that Mr. Becker would have the honor of excavating the tomb proper (while we recorded) if he aided in extricating the seemingly solid boulder fill packing the old excavation through the floor. We were no longer so confident that a tomb lay at the bottom of the pit. Reluctant muscles had just about quieted the reasoning brain. Both Mr. and Mrs. Becker turned to and, sparked by their enthusiasm, we started heaving out the rocks, dirt, and boulders. The trouble was that we had no assurance that all of us wouldn't find ourselves momentarily plummeting down into the tomb if it was hollow and if in fact it existed. The fill was handled more and more gingerly as we proceeded down. Eventually, the clue appeared. Trying to span the excavation with outstretched legs to avoid weight on the center line of the old pit, we noticed loose earth trickling down below and disappearing. A void had to exist directly beneath us. Some type of roof was there. And one couldn't be sure that it wasn't about to collapse and smash all that we had hoped to recover.

As it turned out, a portion of it had already collapsed, fortunately for some cause other than our probing. The central line of the tomb was spanned by large roughly rectangular capstones, as though possibly the tomb was vaulted. The gap left by the ancient fall allowed us, by practically standing on our heads, to peer down into the gloom of the chamber. At the south end of the chamber stood three immense red pottery vessels, two looking somewhat like fire hydrants. Directly north, on the chamber floor, face up, lay a solid jade mask, human and naturalistic. That somehow made up for our labor. Whatever else occupied the chamber (for it to be a tomb, we needed a skeleton) must lie beneath the fallen roof material, although here and there along the bases of the chamber masonry walls we could see fragments of red and black pottery vessels. It was clearly time to stop and think.

The first move was to set up horizontal and vertical controls necessary to plan and section the chamber and its contents. Nails and lines were strung at convenient points and their locations accurately plotted on graph paper. Everything that would be found could be plotted in relation to these stable points, then removed, after being identified on the plan. Becker nimbly fitted himself into the chamber and went to work with a finesse gained from considerable experience in graves elsewhere at the site. We plotted and photographed locations as he exposed them. Working with brushes and penknife, Becker gradually worked his way north. First, the shell inlays for the teeth and eyes of the mask were located, then a few finger or toe bones, and more and more dark red cinnabar-impregnated fluff that appeared to be the remains of textile. Further pottery came to light, all monochrome, and some, like the large vessels in the south part of the tomb, of a strong Pre-Classic cast. In the center of the chamber, the brown fluff was heavy and was found to overlie and underlie human bones and one vessel in which human pelvic fragments occurred. A nearby bowl contained a thin layer of painted stucco, suggesting that the pottery bowl had supported a stuccoed gourd. Among the fluff was discovered a stingray spine, then a tubular jade bead, and finally fragments

of a once large perforated Spondylus shell, the interior of which had been scraped to reveal the valued orange of the shell. More and more pottery came to light. The textile remains were traced farther and farther north. This fluff consistently overlay and underlay the human bones. Arm, hand, foot, pelvic, and vertebral bones were cleared and plotted. The lower leg bones were found just south of the pelvic fragments. North of the latter were vertebrae and the right and left arm bones. Eventually there could be no doubt that entirely missing were the femurs, or thigh bones, and the entire head including lower jaw and teeth. Perhaps for some odd reason they had been removed during the funeral ceremony and set aside among the vessels packing the northwest portion of the chamber floor. Becker turned his attention to them. These were largely red dishes of fine, simple shapes. Some were nested, one above the other. The missing parts of the skeleton were momentarily forgotten as the dishes were removed. Between some of them, lining the dish bottoms, were many tiny charred slivers of wood, more than enough for two good C-14 samples, and thus hopefully a splendid temporal check on the tomb and everything to which it could be proved to relate.

The head and thigh bones never did appear. The tomb yielded twenty-six vessels, some of magnificent size and proportion, as well as a jade mask of truly incomparable size and quality. Together with the stuccoed material, the stingray spine, jade bead, and Spondylus shell, we additionally had an incomplete skeleton. It was also quite clear that the tomb was in fact vaulted. This, it was realized, could well prove to be the earliest, yet detected use of the vault.

By the end of the summer of 1962, there was time to sit down and consider really what Burial 85 amounted to, both within itself and beyond. The carbonized wood slivers from the tomb vessels had been identified as pine, a relatively short-lived tree, the cutting of which could not have been very much earlier than the installation of the tomb. The burned pine was analyzed at the University's C-14 laboratory. The original determination allowed a third century B.C. date; this was subsequently raised in time by recalculation, with the result that Burial 85 appears to have been made about the time of Christ. The tomb pottery has been carefully studied by the Project's ceramist, Dr. Patrick Culbert, who indicates the whole lot to be clearly part of the local Late Pre-Classic ceramic complex. In overall study, we find no contradiction of what seemed probable in the field, namely, that the mature male in this tomb was a "bundle burial" without his head or thigh bones. These parts could well have been retained by the survivors as relics. It is almost certain that this is a primary burial, that is, that the individual was interred in the flesh. Presumably the grisly chore of severing the head and upper legs was conducted somewhere else than in the grave itself. The dark fluff so widespread over the tomb is the remains of the wrappings. The trunk appears to have been seated within a vessel and the whole wrapped, with the lower legs placed vertically against the stomach. This bundled, mutilated personage was set in the chamber facing south, the same direction as the small red-painted platform that was built over the tomb cut. What then of the jade mask? Various peculiarities of its position and that of the shell dental inlays do suggest that it could have been originally attached to the bundle itself, possibly as a substitute for the individual's head. At some point in time, the bundle fell backwards towards the north, spewing its contents over the tomb floor. The mask, if attached to the bundle, must have broken off previously, for it lay south of the original sitting position of the bundle. Its fall conceivably threw the bundle off balance, causing the latter to fall to the north.

The date obtained from this tomb has been substantiated by two others: one obtained on what are believed to be pole-and-thatch material from the latest of the two superimposed platforms over the burial; the other, a pit dug into the room floor of Str.5D-Sub.1, and wood burned within it, presumably just prior to the abandonment and burial of this whole important early stage of the Acropolis. However, the heavy rubble and earth fill, at some points sixteen feet thick, which was placed over these structures to ballast a new floor and a new Acropolis produced

a great deal of charcoal, some of which was analyzed in the C-14 laboratory. The result was, surprisingly, about three centuries *earlier* than the tomb date and others noted (which we trust to be real). This terrific discrepancy (various others have appeared in the Acropolis fill series) illustrates how serious would be our error if we were unfortunate enough to have to depend entirely on C-14 results obtained from such inherently uncontrollable fills. Yet this is often the case in Mesoamerican sites. Regrettably, the tendency has been to employ dates so derived in interpretation as *current* dates, that is, that they

do in fact indicate the times of deposition of the respective fills from which the charcoal samples come. If discrepancy was on the order of a half-century, or even a century, the matter would not perhaps be serious. But if the implications of our "test-case" discrepancy of three centuries are applicable elsewhere but not clearly allowed for, the risk is great of thoroughly distorting all conclusions dependent on time and correlation.

Burial 85, once in proper ceramic and chronological perspective, can tell us a great deal. Burial 85 extends use of the vault back some three centuries in time. Perhaps five hundred years separate it and the otherwise earliest signs of relic retention (see *Expedition* Vol. 4 No. 1, 1961 and its report on the headless individual in a late Early Classic Burial 48). The use of the mutilating stingray spine, the scraping out of Spondylus shells and their use as pendants, and indeed the employment of sumptuous offerings for the dead are major and minor traits that can now be proved to extend centuries further back in time than previously demonstrated. The individual was important, so important in fact that parts of him were considered sacronsanct. It seems hard to avoid the conclusion that he was just as important as the people later entombed at Tikal. The latter probably rightly have been seen as "priest-rulers." The implication of exceptional status and authority, even wealth, is equally applicable in the case of the Burial 85 personage. In other words, society and its control may well have been the same at this relatively early date as they were later during so-called Classic times. Certainly the spot chosen for his interment was central for Tikal as it then existed. While by Late Classic times, the religious precincts of Tikal had been spread widely with linking causeways, there is every reason to believe that the facilities for religious, if not social, control were concentrated on the North Acropolis during the Early Classic and Pre-Classic times.

Acropolis constructions at about the time of Christ were large, magnificently embellished with polychromed stuccoed masks flanking stairways and equally flamboyant upper façades. It is still uncertain whether or not any of these early buildings were roofed by vaults. Contemporary architects certainly knew the principles involved but as yet the vault may have been exclusively a tomb feature. Perhaps only later and then, in a daring way, were they used on buildings. One should also note that one of the most outstanding elements in Classic architecture, the so-called apron molding, is present in these early levels. What we do lack in this general picture of early "Classicism" is evidence of hieroglyphic inscriptions and stelae and altars. We have a few fragments of stone sculpture from early fills; one surely is a substantial fragment of a full-round carving of a squatting human or animal figure. This is not to say that we can definitely preclude stelae, altars, and inscriptions in this part of the Maya world at a time earlier than that characterized as "Early Classic." Occasionally sherds will be found to be decorated with things perhaps describable as "glyphoid." But something much more substantial will be needed to prove that the personage in Burial 85 once commanded the carving or painting of a text, or the erection of a plain or carved stela. One can only say that it would be strange if he did not, considering the context of ritual and aesthetic sophistication in which he operated.

In 1963 we return to Tikal to continue the Acropolis trench (among other things). The work from 1958 to 1960 in the Great Plaza and North Terrace, fronting the Acropolis, showed us bedrock at various points. If bedrock does not rise or fall as it moves north beneath the Acropolis, we can say that some fourteen feet of still buried construction awaits exposure in 1963. The Burial 85 tomb was cut down into two earlier structures or floors about which we now know nothing. There is every reason to expect that the extraordinary industry responsible for the six hundred years of construction, which we have already cut through, will hold true throughout the still unknown early portion of the Acropolis sequence. How much time intervenes between where we are now and the first human activity over bedrock in the area of the Acropolis? Forced to the wall of prediction, we can only say possibly a few hundred years.

Our first task is to expose a developing "ceremonial complex" in all possible, fully controlled, physically interrelated detail. Conceivably, the lowest level of the Acropolis will be found to be so generalized architecturally as to make it difficult to speak of it as "ceremonial." But with time, as structure and floors were piled on earlier ones, a clearcut pattern leading to "Classicism" may be seen to emerge. Possibly then we shall be in a position to approach realistically the question of whether the lowland Maya made their own straight path to unquestioned greatness or whether they brilliantly traveled a deviously influenced route with complex origins elsewhere in time and space. To be able to document, as in the Acropolis, long incremental development is alone worthwhile. Yet, to be able to account for it, while following on the first goal, is, one suspects, the prospect that keeps us going.

EXPEDITION NEWS

Three major problems occupied the attention of the Hasanlu staff during the past summer. These were: (1) the clarification of the seventh-sixth century materials of Period III (the "Triangle Ware Phase"); (2) excavation of a new quarter of the ninth century Citadel; and (3) a probe into the underlying levels of the second millennium. The results of all three investigations were satisfactory and a preliminary appraisal suggests that the new information indicates that Hasanlu is a far more important site than had been thought. This suggested conclusion stems from the discovery of a new stratum, dating to around 1500 B.C., below the grey pottery "Button-base Phase." It is characterized by a buff ware painted with red bands and triangles—a pottery common in design and form to that of northern Mesopotamia of the same period. This pottery would appear to be the remnant of a "Hurrian" or related occupation of Hasanlu.

The new excavations show, furthermore, that this north Mesopotamian occupation was abruptly terminated by the appearance of a grey-ware culture characterized by distinctive tankards with button or disc bases, but otherwise sharing all of the main ceramic wares with the following period. We have, therefore, the sudden appearance of an alien culture around the end of the thirteenth or beginning of the twelfth century B.C. This Button-base Phase appears as the forerunner of the greatly expanded culture of the following Grey Ware Phase dating to the tenth-ninth century B.C. The ceramics of this later culture, as now visible in the accumulated results of this and previous summers' work, appear to be related typologically to the Hallstatt Iron Age pottery of Central Europe and the Balkans.

A third major Burned Building was uncovered, clearly of a domestic nature yet preserving the essential features of the two larger Burned Buildings already excavated. The building plan seems to combine certain North Syrian features with features customarily associated with the megaron type of house. To add to the general indication that we may be dealing here with an Indo-European intrusion into what is known historically as the Mannaean area, we have now discovered an elaborate Citadel entrance on the west with extended walls running down the slope to protect the two approaching roads. The plan, only generally indicated at present, stands in contrast to the more characteristic gates in Mesopotamia which are set into the fortification walls themselves.

There are historical arguments for placing the Persians in this area upon their entry into Iran but the date suggested has usually been in the ninth-eighth century B.C., at which time they controlled part of the Mannaean area and even had Assyrian governors. It begins to look as if these three cultural groups are represented at Hasanlu in our Period IV. Should this appearance be substantiated by closer study, we should have, for the first time, one of the two possible indications of the arrival of the Persians in Iran, the other being the newly discovered Marlik Tepe farther to the east.

George Bass writes: "While visiting Bodrum to pick up supplies for our underwater excavation of the Byzantine shipwreck, I visited the coffee house so often used by Peter Throckmorton when he was questioning sponge divers about the locations of ancient wrecks. This time we made quite a land find! One of the villagers brought a vase to me for identification, and at first I couldn't believe what I saw. It was certainly Mycenaean, but I knew that only two Mycenaean sites are known in all of western Turkey. Later I visited the spot where the vase was found, accompanied by Machteld Mellink and Haluk Elbe, our commissioner, and we saw at least six opened Mycenaean chamber tombs. Pottery and beads from the tombs indicate for the first time that Caria was inhabited in the Late Bronze Age, although this runs counter to the results of a number of thorough explorations of the area. A month later, I visited the same coffee shop and this time was shown a jeep full of Late Protogeometric, or Iron Age, pottery—again a rather unusual find for Caria. This came from a stone-lined tomb not far away. We wonder what other wonderful finds will come out of this coffee house."

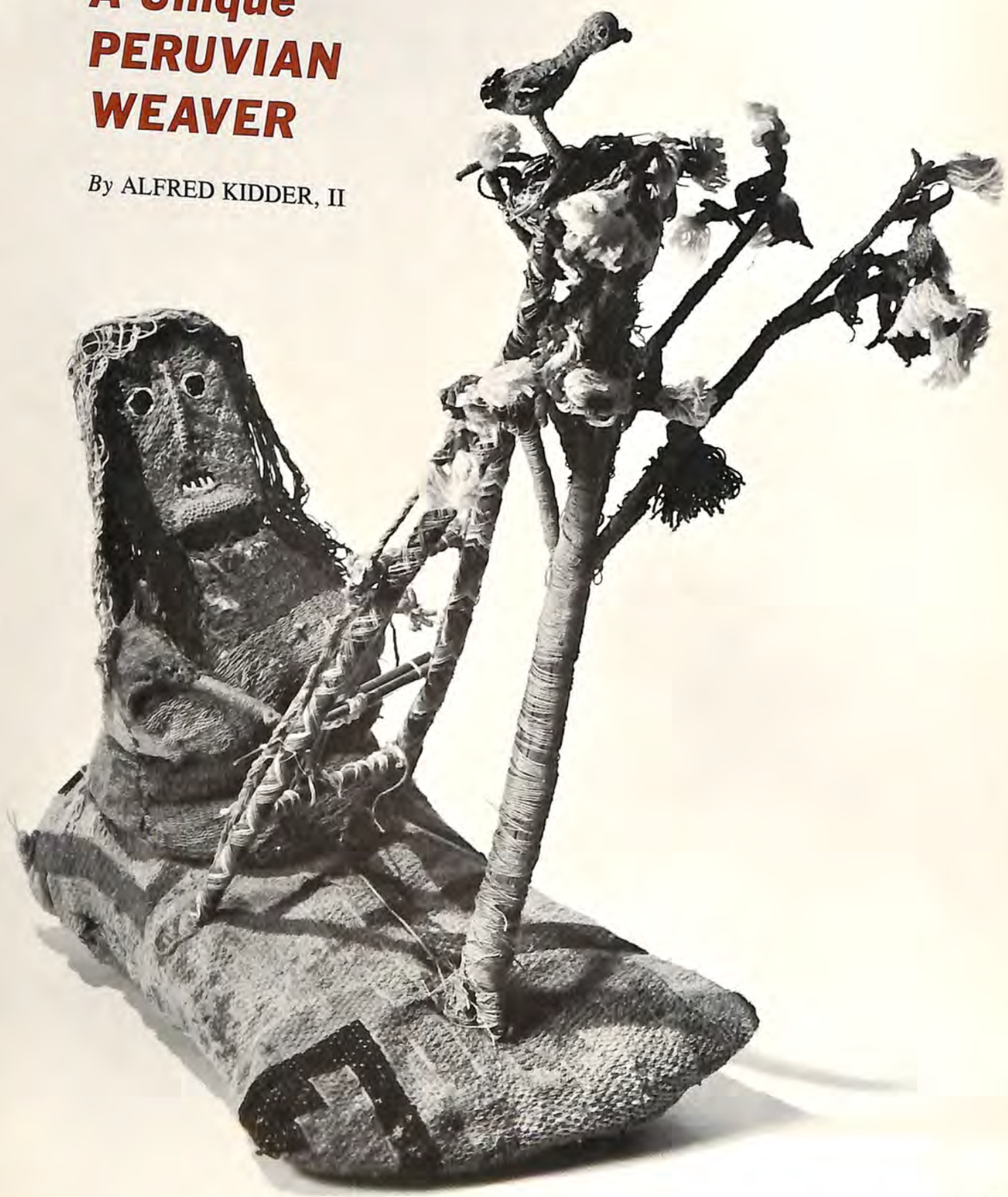
Leaving in December, 1961, G. R. Edwards embarked on activities in Corinth, at Gordion in Turkey, and at Curium in Cyprus. The focus in Corinth was on the preparation of a publication of Corinthian pottery of the Hellenistic Period primarily derived from a large public building, the South Stoa, destroyed by the Roman general Mummius in 146 B.C. The chronology of the archaeological objects of this advanced period is almost as little understood by archaeologists as perhaps that of Palaeolithic times. Hence the publication of this pottery, connected with a firmly dated historical event, should shed light on a problematic and too little known historical period.

Ten weeks in Gordion extended the Phrygian level and overlying layers on the City Mound to the south, west, and north, and saw the excavation of a potential site on the slopes not far from the "Midas Mound" for the placement of a Gordion Museum which may take the form of one of the great Phrygian buildings excavated in 1959-1961 (see *Expedition*, Vol. 4, No. 4). Highlights of this short season will appear in a subsequent number.

At Curium during the summer, Dr. Edwards collaborated with Professor Robert L. Scranton of the University of Chicago toward a publication of the architecture of the Sanctuary of Apollo excavated by the late George H. McFadden, and as a byproduct assembled the necessary excavation data toward a publication of the inscriptions of Curium prepared by Professor Terence Mitford of St. Andrews, Scotland, which will shortly be ready to submit to the American Philosophical Society for publication.

A Unique PERUVIAN WEAVER

By ALFRED KIDDER, II



The "Weaving Lady" seated at her loom under a pacay tree. The tree is 18 inches high from the base of the pillow, which is 13 inches long.

The Museum has recently acquired a very unusual specimen. It is a pillow on which is seated an effigy of a woman working at a loom suspended on an A-frame which leans against a tree. In the tree there is a bird's nest with a long-legged fledgling standing in it. It is difficult to find a single word that describes this curious and, in one specific way, unique object. Those of us who have worked with it in order to put it on exhibition have been calling it informally the "Weaving Lady." We have no information whatever as to its exact provenience but we do know that it comes from Peru and that it was quite certainly a grave offering. This is apparent because of its good condition and the fact that it is inconceivable that it could have been so well preserved had it not been carefully placed in a grave or tomb somewhere on the arid Peruvian coast. By comparison with similar effigies, we can also be fairly certain that it comes from the Chancay Valley just north of Lima and, by the style of the textile covering the pillow, we are also quite certain that it dates from a late period, probably from the one known as Late Chancay. This would make it approximately seven hundred years old.

In the collection of Dr. Fred Olsen, there is a very similar tree, in which there are several birds. It is known that this tree was found in the Chancay Valley and the workmanship is so similar to that of the "Weaving Lady's" tree that we can be quite sure that they both came from the same general locality. The two trees represent the same species. They can be identified by the presence on the branches of small, woven ovals, from three quarters of an inch to an inch and a half long, representing large seed pods. These are characteristic of a native Peruvian tree called *Pacay*. Botanically, this pod-bearing tree is called *Inga pacay*. The pods were, and still are, eaten by the Indians of coastal Peru. The seeds are surrounded by a pulp that has a sweetish and quite pleasant taste. Many remains of the pods have been found in the rubbish heaps along the coast, and the much earlier Mochica people of the north coast made pottery reproductions of them. One from the Museum's collection is shown here.

The construction of the "Weaving Lady" involved five separate operations and the combination of these elements. First, the pillow itself was constructed by covering a mass of leaves and rushes with a brocaded fabric which was simply folded around the stuffing and sewn on both sides and at the back of the pillow, leaving the front unseamed. At first glance, the pattern appears to be embroidered but, on closer examination, it is apparent that it was woven into the fabric on a loom. The basic fabric is of cotton yarn, visible in worn patches and as narrow, unbrocaded strips separating the colored, brocaded areas of the design. These are black, yellow, red, and a faded brown arranged in an interlocking step pattern.

The weaver sitting before her loom on the pillow is, in effect, a doll-like effigy of a woman. Basically, she was constructed of heavy leaves that can be seen just under her chin. These appear to be the dried and scraped leaves of a plant of the maguey family. They resemble the leaves of the century plant. There is a little additional padding of rushes and leaves. Her head was made of some fairly hard but not inflexible

material which could not be identified without cutting the material of her face or headdress. The hair of black woolen yarn is covered by a loosely woven head shawl of yellow and black wool. All the warp threads are yellow with widely separated paired wefts of yellow and black. To make the face, the basic material of the head was covered with what appears to be a cotton fabric only visible just under the chin. This was covered by needlework in pink, red, dull yellow, black, and white in woolen yarn. Both the nose and the chin were built up in relief. It is not clear whether the needleworking was done over a packing to produce this effect, but apparently it was not. The zone of red and yellow triangles and bands extending from the nose downward across the face and beside the eyes must represent face painting, or, with much less likelihood, tattooing. The arms were made of what appear to be sticks with fingers of split rushes, all wrapped around with pink

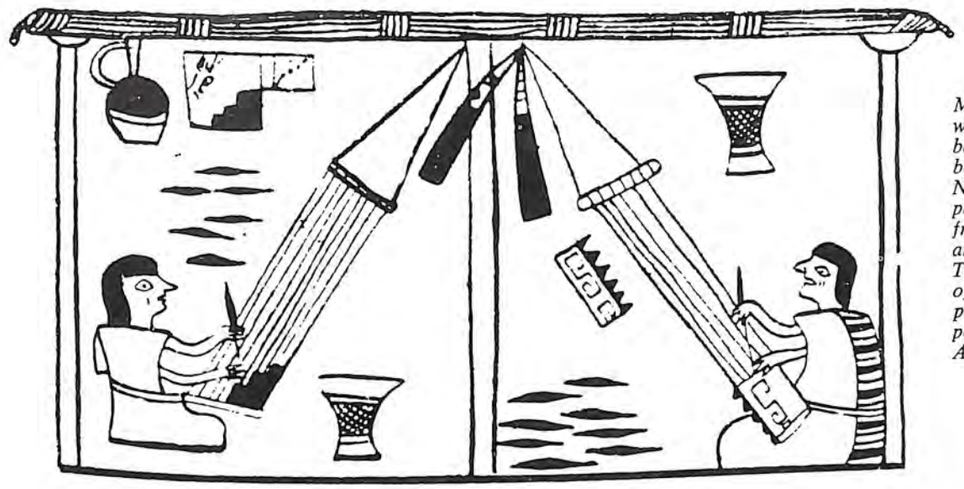
A close-up of the loom and the apparently unique A-frame on which it is mounted. From upper to lower bar the loom is 5½ inches long.

A pacay tree with birds and a human figure at the top from the collection of Dr. Fred Olsen. The only structural difference between this tree and that of the "Weaving Lady" is that the trunk of hers is not covered with fabric.

Pottery whistle modeled in the shape of a pod of the pacay tree (Inga pacay). This is from the Mochica culture of the North Coast of Peru, dating from about A.D. 200. Length, 9½ inches.

woolen yarn. Just how they were attached to the body is not clear since the shoulders are covered by her garment. This consists of a plain-woven fabric with widely spaced cotton warps and woolen wefts in green, pink, and yellow forming bands around the figure. To make the sack-like dress, the cloth was sewn up the left side and over the shoulders and elbows to the forearms, forming sleeves of a sort on each side, and leaving a slit for the neck. This is quite different from the typical poncho-like tunics most characteristic of Peruvian costume. It seems unlikely that it represents a garment actually worn by the Indians. Normally that would be a shirt or a dress made of a single piece of cloth folded in two, with a vertical slit for the neck and the two sides sewn together, leaving armholes at the top—a poncho with the sides nearly closed. Apparently the figure was never sewn to the pillow but was attached to the loom by threads from the hands. At least two very similar figures are known, one of which is also sitting on a pillow. Neither is associated with a tree or loom.

The tree was made of rushes bunched together and wrapped with light brown cotton thread. The branches were made in the same way, with the white blossoms and woven seed pods tied on and, in some cases, simply held in place by the wrapping. All the blossoms are of wool, including a single red one; brown seed pods are also woolen but the yellow seed pods are of plain woven cotton. The base of the tree was set into the pillow through a hole in the brocade. The bird's nest is a crude basket made of split plant fiber, possibly coarse grass, held together by a white cotton thread. The basic material of the fledgling cannot be seen but it is quite firm and may perhaps have been carved from wood. It was covered by pink woolen wrapping on the legs, with a partially wrapped, partially needleworked body and neck of mauve wool. The wings and tail are black and white wool; the eyes are black and yellow wool, as is the needlework beek.



Mochica women weaving on backstrap or belt looms. Note the patterns, perhaps painted, from which they are copying designs. The scene is part of a larger one painted on a pottery bowl. About A.D. 200.

The most remarkable feature of the whole depiction is the A-frame itself. According to Dr. Junius Bird of the American Museum of Natural History, one of the world's leading authorities on Peruvian weaving, this method of supporting the loom is unique in Peruvian culture. The frame consists of two reeds or canes lashed together at the top and held apart at the base by the lower bar of the loom. If our model reflects actual usage, and of this we cannot be completely sure, the lower loom bar would have had to be fastened to the A-frame, not to separate its legs which could easily have been firmly planted in the ground, but to maintain tension on the warps. Each of the canes was diagonally wrapped with woolen yarns to form the decorative pattern. The colors are red, yellow, white, and black. The loom itself is a good example of the typical Peruvian two-bar type. Normally, such looms were attached at the upper end to a tree or post exactly as our model loom is attached to the upper end of the A-frame. The lower bar of the loom, however, was normally equipped with a backstrap which encircled the weaver's body in such a way that she was able to control the tension of the warp threads simply by slight movements forward or backward. In this case, the braided cords of red and yellow wool that support the upper loom bar were continued down the length of each leg of the A-frame and attached at the base. This unique method of mounting the loom provides no control of warp tension except by relashing the lower bar or by adjusting the supporting cords at the top.

There are several peculiarities in the way the miniature loom is arranged. What appears to be a heddle rod under the warp threads was lashed to a shorter shed rod which, in actual use, would have prevented proper functioning of the loom. This may have been done simply to keep these two elements in position in the model. The weaver seems to have begun at both the bottom and the top, which also seems unusual. At the bottom, a few rows of yellow woolen weft thread have been woven across the brown cotton warps. At the top, four or five rows of white woolen wefting have been inserted. The heddle rod, if such it is, is attached to the warps of one shed by white woolen yarn but its position under the warping seems out of place. There is also no batten. These peculiarities may, of course, represent a sort of model maker's license with an attempt being made to give a reasonable impression of a working loom without concern for technical accuracy. Whatever may be the case, the entire setup represents a most interesting divergence from normal Peruvian practice.

We can only speculate as to the purpose for which the "Weaving Lady" with her loom was made. Since there is no doubt that it was found in a grave, one can imagine that it was put together to accompany a woman who had been an active, and very probably, an outstanding weaver. It may, of course, also have been intended to represent a weaver whose services could be utilized in the next world by the deceased of whatever sex. Cloth was highly valued by the ancient Peruvians, attested by numerous references to its production and distribution as tribute in Inca times. For whatever purpose the "Weaving Lady" was made, she is a most engaging and interesting example of the art of the loom in ancient Peruvian life.

DALMA PAINTED WARE

By T. CUYLER YOUNG, JR.

The archaeologist leaves for the field with his mind full of the historical problems he will solve through further excavation. His expedition's entire field campaign has been planned around these problems. Yet he also knows that though further field work will provide some of the answers to the questions posed, it will also raise new questions as yet unasked. Simultaneously as he chips away at the boundary between the known and the unknown, the mass of the unknown continues to expand. Sometimes, through a discovery he could not possibly have anticipated, he is able to take a sudden leap forward—a leap that carries him well beyond his immediate frontiers. Suddenly he recognizes the full extent of his ignorance, the extensiveness of which he has not even suspected. Such a discovery was made by the Hasanlu Project during the 1961 field season.

In earlier seasons of excavation in the Solduz Valley of northwestern Iran, the Project had made preliminary soundings at Dalma Tepe, a small mound some three miles southwest of the great mound of Hasanlu. These soundings revealed the presence of a painted pottery culture of the fifth millennium B.C. unique amongst the cultures of the time in the Near East. Further excavations were planned for 1961 to explore these preliminary discoveries. When these excavations were complete the Project had stepped into the very center of the darkness that shrouds the fifth millennium B.C. in this part of the world.

Several of the many painted vessels recovered from Dalma Tepe during these excavations are illustrated here. The ground color of this pottery is either a light pink-buff, the natural color of the fabric, or is cream slipped. Against this light ground, designs are drawn in a light maroon or a maroon-black paint. The inside of the vessel is usually covered with a maroon-red slip. The fabric is tempered with straw, a technique common in the fifth millennium in northern Iraq and Iran. The ware crumbles easily and is not well fired. None of the shapes discovered is complex or unusual. In short, from the technological standpoint, there is nothing remarkable or unique about Dalma Painted Ware.

Yet when one directs attention to the decoration of this painted ware, it is at once clear that here is an artistic tradition of the highest order. It is its style that makes Dalma Painted Ware unique. The range of motifs used by the Dalma potters is in itself remarkable. Thus far, only geometric designs are known, but within that limitation one finds not only the motifs illustrated here but many others as well. The potters of the period apparently gave their imagination free reign and sought to explore almost every avenue of geometric design open to them.

This desire for artistic exploration and improvisation carried them beyond the limits of sound composition in some instances. The "half and half" vessel illustrated is not a modern draftsman's nightmare, but an actual vessel as found. One half of the pot's exterior is painted with a cross-hatched zigzag pattern, the other half with rows of solid hanging triangles. Each design is in itself artistically pleasing, but the two together can hardly be called an integrated composition.

Another aspect of the artistic achievement of the period is the relationship sometimes emphasized between the painted design and the ground color of the pottery. These artists were experimenting with the effect of "negative painting" found in the interplay of design and background. Given instances where only thin lines of ground color show through the paint, one wonders whether one is supposed to see the painted design or the pattern left in the areas of the vessel that have not been painted. The answer is both, as a kind of optical illusion occurs. The painted design and the pattern left in the ground complement and reinforce each other, making the whole more pleasing to the eye.

The experimental and inventive aspects of the Dalma period are clearly seen not only in the motifs used, but also in their execution. All of these painted vessels are done with a characteristic boldness and stylistic vigor. Within this framework, however, one may compare, for example, precise diagonal lines on one vessel which appear to have been drawn with a straight-edge, with the free and almost wildly modern application of the same motif on another. The vessel in the first instance suggests an artist with a tight, precise, careful mind; in the other, an artist with a loose and rambling spirit. Yet vessels decorated in both of these styles flourished in the same period at the same site. Let the archaeologist who would enforce artistic limitations on the ancients through modern typology beware!

The comparative study of other finds which accompanied this painted pottery and a single radiocarbon date confirm an original guess that this culture dates to the fifth millennium B.C. Thus the Dalma painted ware can be properly placed in the chronological framework of the ancient Near East. Furthermore, the unusual bowl illustrated with a "double W" pattern

framed in a double crescent, which was certainly an import in the assemblage, indicates that the Dalma culture was in contact with other painted pottery traditions. But until further field work is undertaken, the native artistic tradition discovered at Dalma Tepe will remain a unique spot of light deep in the darkness of its time and area. Until the origins and cultural connections of this tradition are understood, we will continue to be impressed with what we do not yet know about the fifth millennium. And so it is that a new discovery, unanticipated by the archaeologist, both shows us how extensive is the darkness which surrounds us, and gives us a starting point from which to ask more questions of the unknown.

The plain of Sybaris, from the south. The hill town at the left is Corigliano.

In Search of Sybaris: 1962

By DONALD FREEMAN BROWN

Down in the foot of Italy, or more accurately under the instep and facing the blue Ionian sea, lies the Greek city of Sybaris—virtually untouched by the archaeologist's spade. Famed ever since antiquity for its great wealth and luxury (our expressions "sybarite" and "sybaritic banquet" acknowledge this fact), Sybaris has held the attention of historians and archaeologists for many centuries. But long before the beginning of modern archaeological research Sybaris had become a lost city, a square mile of buildings buried without a trace somewhere in the silt of an eighty square mile alluvial plain.

This article is a report of the novel methods used in 1962 by the University Museum in prospecting for this elusive city. In order that the reader may understand why we had to use such unorthodox methods, a fair amount of background information is presented first.

The brief but fascinating history of Sybaris, its importance, and its approximate location can be pieced together from the writings of a number of classical authors, chiefly Athenaeus, Diodorus Siculus, Herodotus, Pliny, and Strabo. One of the earliest of the Greek settlements in Magna Graecia (Southern Italy and Sicily), Sybaris was founded about 720 B.C. by Achaean colonists. Building their city between the Crathis (modern Crati) and Sybaris (modern Coscile) rivers on a vast and fertile coastal plain in northern Calabria, the Sybarites prospered rapidly by agriculture and trade, and grew mightily in numbers, largely by controlling or granting citizenship to members of the native tribes of the interior. An important factor in her prosperity was the fact that she lay at the southern end of overland trade routes leading north and west to her colonies on the Tyrrhenian side of Italy, the most famous of which was Poseidonia (Paestum). It would appear that trade between the Ionian Greeks and the Etruscans was amicably and profitably handled by the Sybarites, for it is said that they came to like the Etruscans among the people of Italy, while among the people of the East they liked the Ionians, because (as Athenaeus remarks disparagingly) both were devoted to luxury.

The picture we see of Sybaris at her peak is a colorful one. Ancient writers stress in a rather puritanical manner the luxurious way of life of the Sybarites, but some of their practices seem quite reasonable to modern city dwellers. For instance, they banned noisy occupations like blacksmithing, carpentry, and chicken-raising from the confines of the city. Streets leading into the country were roofed over to protect travelers from the excessive heat of the sun. Anticipating our oil pipelines and aqueducts, they are said to have piped wine from their country estates to wine cellars near the sea shore, whence it was carried to the city in boats.

The ever increasing wealth of Sybaris inevitably bred an indolent upper class devoted to self-indulgence. Public banquets were held at frequent intervals, and cooks who concocted the best dishes were rewarded with golden crowns—and copyrights to protect their recipes for a whole year. Their attitude toward the Spartan way of life is mentioned by several sources. It is said that a Sybarite who had sojourned in Sparta and had been entertained among them at their public mess remarked, "It is no wonder that Spartans are the bravest men in the world, for anyone in his right mind would prefer to die ten thousand times rather than share in such poor living."

The final undoing of the Sybarites, resulting in the total destruction of the city, is attributed by some to their having trained horses to dance at their feasts to the accompaniment of pipes. In the words of Athenaeus, "Now the people of Croton knew this when they made war on the Sybarites, as Aristotle records in his account of their constitution, and struck up the dance tune for the horses; for they had with them pipers in military uniform; and no sooner did the horses hear the pipers than they danced away, and not only that, but with their riders on their backs they deserted to the people of Croton."

Whether this story is true or not, we know that Sybaris was destroyed about 510 B.C. by Croton, her next door neighbor and rival to the south. Strabo says that the river was diverted to flow over the ruins. An abortive attempt to resettle the area by the Sybarites was followed by the establishing of a colony in 446 B.C. in the same place by Athenians, who named their new city Thurii. Some two hundred and fifty years later, in 196 B.C., Thurii came under the domination of Rome and was rechristened Copia Thurii. Undergoing a steady decline, this final city was ultimately buried by the accumulating silt of the two rivers. By the nineteenth century A.D. all traces of settlement were gone, the exact location was forgotten, and the area was a badly drained malarial swamp.

The first archaeological expedition to search for Sybaris, led by F. Cavallari in 1879, investigated mainly the higher land on the margins of the plain, discovering several burial mounds of the city of Thurii. For the next fifty years only isolated burials and country villas of the later cities were found. However, the great moment seemed at hand in the early 1930's when the government in the course of land reclamation dug two great parallel drainage ditches, fifteen feet deep and five miles long, down through the heart of the plain to the sea. But not a single trace of Sybaris and only inconsequential remains of the period of Thurii were found. This fact has been a warning to archaeologists that test

Beth Ralph operating the magnetometer and Froelich Rainey holding the detector bottle.

trenches, even on a colossal scale, may not suffice to detect the location of Sybaris.

The first objects attributable to Sybaris came to light in the shape of an archaic head and other pieces of archaic sculpture found in otherwise purely Roman material excavated by U. Zanotti-Bianco in 1932 from a semicircular late Roman building located about two kilometers inland from the mouth of the Crati river.

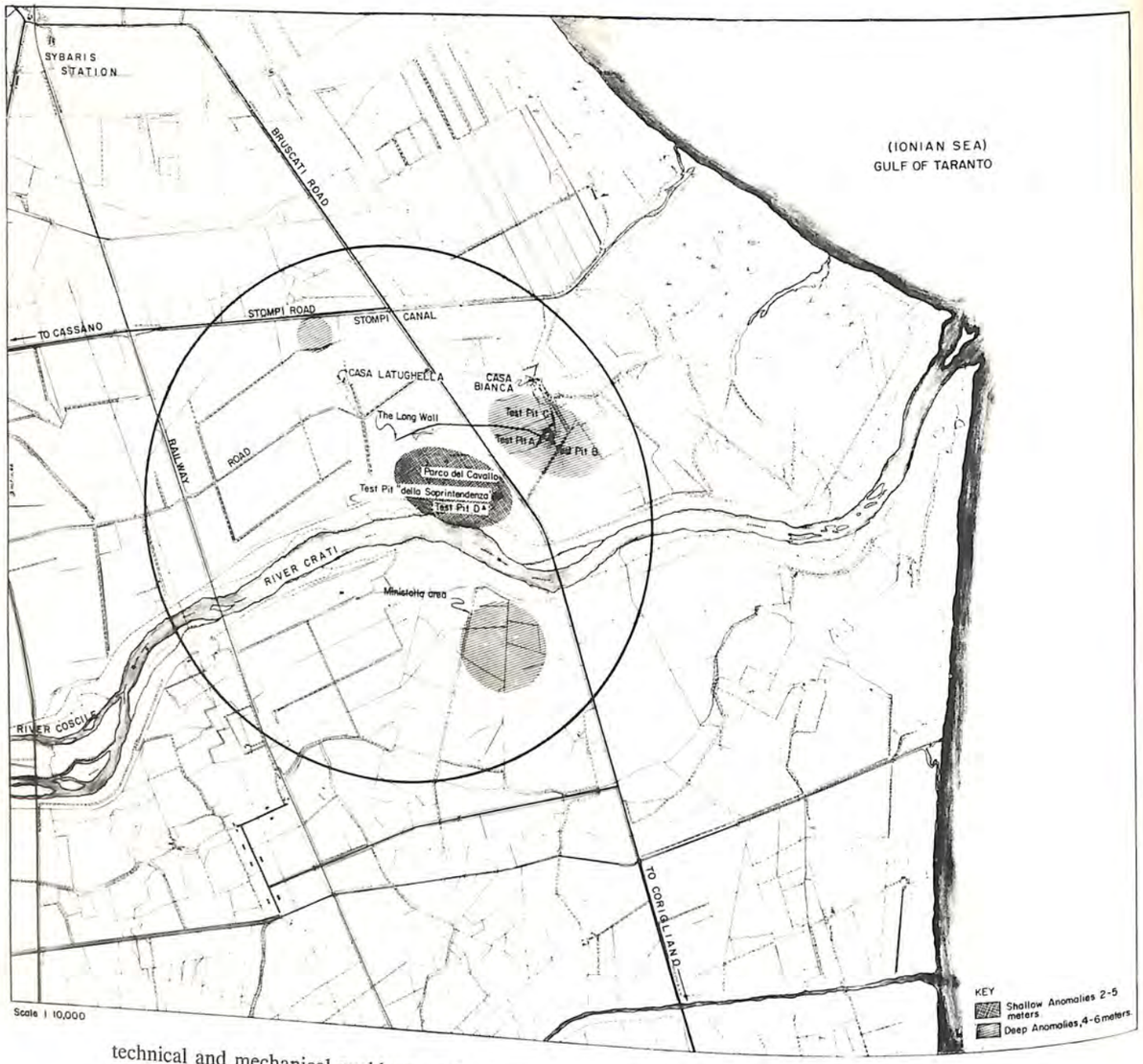
In 1949 I made studies of the archaeological and historical evidence concerning the location of Sybaris, followed by geological and geographical reconnaissance in the plain. These studies led to the conclusion that Sybaris must lie on both sides of the present Crati, some two to four kilometers from its mouth and between the two drainage canals referred to above. Since the Sybaritic stratum was presumed to lie at a great depth below the surface, and since the ground water level lay only a meter or so from the surface, some method of archaeological prospecting other than the digging of test pits seemed advisable. The digging of artesian wells in the plain inspired me to adopt earth boring as a technique for the exploration of the chosen area. With the constant encouragement and advice of Ermanno Candido, a local engineer who in the course of reclaiming large areas for the cultivation of rice had become fascinated with the problem of Sybaris, I made five borings in the Casa Bianca area in 1950. In the fourth of these borings a ten-meter column of earth was extracted, revealing upon analysis, in stratigraphic order, Arretine pottery and other artifacts of the Roman settlement, Hellenistic and Attic pottery of Thurii, and East Greek pottery of Sybaris, the latter datable to the early sixth century B.C.—the first evidence *in situ* of the city of Sybaris.

In 1952 and 1953, while a Fellow of the American Academy in Rome, I conducted two campaigns of boring, with financial support from the Bollingen Foundation and under the auspices of Dr. G. Iacopi, the Superintendent of Antiquities of Calabria. Stratigraphic borings were made in a pattern forming a gigantic X centered just north of the Bruscati bridge over the Crati and with arms over three kilometers long running parallel to and at right angles to the sea shore. The chief result of this effort was the repeated confirmation of the stratigraphy encountered before and the partial delimitation of the archaeological zone of Sybaris and Thurii. The borings also clearly demonstrated that much of the Greek layer lay below modern sea level, proof that the Calabrian coastline in this region has sunk several meters since 500 B.C. This fact explains why the plain gradually became swampy and uninhabitable.

In the nine-year interval that has elapsed, geophysical methods have been developed for archaeological prospecting and have produced spectacular results in tracing buried walls, filled ditches, tombs, and other archaeological features buried at shallow depths. In Italy the Lerici Foundation of Milan, conspicuously successful in locating Etruscan tombs, conducted a brief campaign of prospecting in the plain of Sybaris in 1960. With electrical resistivity equipment about 150 meters of a long wall were traced, the top of which lay scarcely a meter below the surface.

It was thus quite logical for the University Museum, which had organized an Applied Science Center for Archaeology, and the Lerici Foundation to join forces in an attack on the problem of Sybaris. After a preliminary campaign in 1961 (see *Expedition,* Vol. 4, No. 3, Spring 1962), a second campaign was conducted in April, May, and June of 1962 under the general direction of C. M. Lerici and Froelich Rainey, Director of the University Museum, with the latter in charge of field operations. Dr. G. Foti, Superintendent of the Antiquities Department of Calabria, gave official sanction and collaboration. The following were members of the University Museum section of the expedition during all or part of the period: Elizabeth K. Ralph of the Applied Science Center for Archaeology (geophysical equipment), Ellen Kohler (archaeology), James Delmege (photography), John Dimick (surveying), and the author (archaeology and drilling). From the Lerici Foundation were the following: F. Brancaleoni, B. Pastore, and D. Gabrielli (geophysical equipment and drilling), Lucia Cavagnaro Vanoni (archaeology), and Marjolein de Vos (archaeology and drilling). The expedition was honored to have the advice and material aid of Enrico Mueller of Cassano, who efficiently handled many difficult

(Upper left) The McCullough drill being used by Domenico Falcone and Giuseppe Dattoli. (Left) Auger-bit of the McCullough drill being pulled out with its sample by a chain-hoist and tripod. (Above) Extracting the finds from the mud on the auger-bit and laying them out on a board in the order of their stratification. Left to right: Donald Brown, Orio Miggiano, who was the Government representative, and Domenico.



technical and mechanical problems and supplied capable workers.

The general procedure fell into three successive phases: 1, Running lines of readings with the proton magnetometer equipment across various parts of the plain, and marking points at which anomalies occurred in readings of magnetism. 2, Testing the anomalies by drilling to virgin soil and analyzing the continuous soil samples for archaeological content and stratigraphy. 3, Digging test pits with a mechanical excavator at points where the drills confirmed the presence of potsherds of the period of Sybaris and of deeplying walls.

The geophysical phase had a two-fold purpose, the finding of buried archaeological features and the testing of various types of instruments. Thus the plain of Sybaris became a gigantic laboratory in which the advantages and disadvantages of the several instruments operating under differing conditions were discovered. These instruments were designed to register the presence of buried material which differed from the surrounding soil in one characteristic or another: degree of magnetism, electrical resistivity, density, and so forth. Some of the instruments were designed to register also the depth of the buried feature below the surface.

Fresh from the laboratory was a prototype of an ultrasonic device weighing only twenty pounds, which was designed to register on a visual screen the depth from which sonic impulses had been

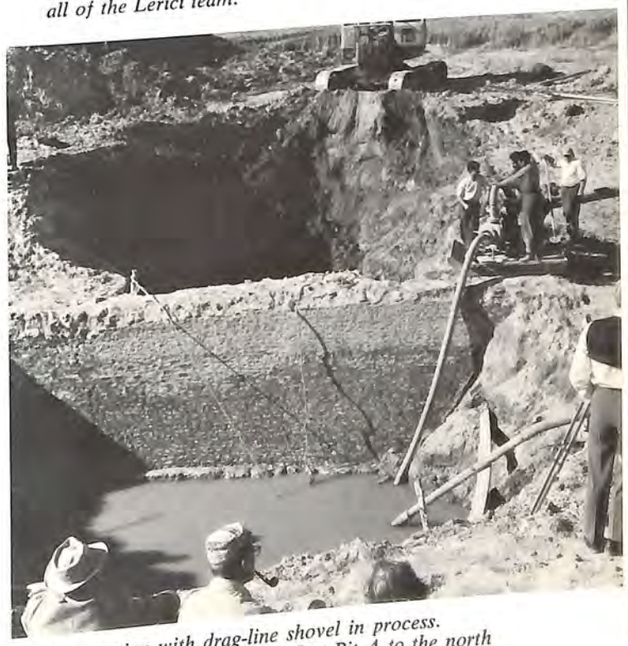
reflected by an object of greater density than the surrounding soil. Although it proved to be insufficiently developed for field use, experiments showed that if it is possible to increase the intensity of the impulses without unduly increasing the weight of the instrument, the operator can make rapid visual observations with greater depth penetration than that possible in the use of proton magnetometers and electrical resistivity devices.

Another instrument tested in this campaign was the magnetic gradiometer, a relative of the proton magnetometer. This too was unsatisfactory because, basically, it is less sensitive than the magnetometer and also because this particular experimental instrument was inoperable when it was sent from the laboratory. A metal detector and a ditch locator were tried out, but neither showed promise for the particular conditions encountered here.

The two instruments which gave the best results this year as in 1961 were the proton magnetometer and the Geohm, a light-weight electrical resistivity device. Since the water table was encountered between one and one and a half meters below the surface, the Geohm had only limited use, for the water in the soil neutralized differences in resistivity. Therefore the bulk of the prospecting was done with the proton magnetometer, which registered anti-magnetic anomalies over non-magnetic stone objects buried in the unusually highly magnetic soil, and magnetic anomalies over heavy deposits of potsherds and brick walls (deposits and structures that, due to "firing," were more magnetic than the soil).

Operating the proton magnetometer with the capable assistance of Dino Gabrielli of the Lerici Foundation, Miss Ralph roved far and wide across the plain, from the Pollinara area in the west to the Casa Bianca area near the sea. The first profiles, each based on a series of readings along a straight line, were made with the intention of finding the total length of the late Roman wall which had been discovered in 1960 and partially traced in 1960 and 1961. It was followed for a distance of about eleven hundred meters without finding clear indications of either end. Numerous anomalies in readings, indicative of buried walls, rubble, and other archaeological material, were found in the Casa Bianca area and the Parco del Cavallo (where the archaic sculptural fragments had been found in a Roman structure). Profiles along both banks of the Crati produced no anomalies, suggesting that the Crati had flowed here even in antiquity. South of the Crati among many anomalies were several caused

Jeep-mounted drill with forced water circulation. The cuttings are being scooped up with a shovel. At right are Franco Brancaleoni and Marjolein deVos and at left (wearing straw hat) is Giuseppe Cesari, all of the Lerici team.



Excavation with drag-line shovel in process. Here it is shown enlarging Test Pit A to the north of the long wall (Greek wall is just appearing under Roman wall), while two pumps try to keep abreast of the ground water rising south of the wall.

(Left) Fragment from the wall of a pyxis of imported Corinthian ware. It was found in the sand south of the Greek wall in Test Pit A, and is datable to before 650 B.C. A pyxis is a cylindrical pottery container for cosmetics or other feminine knickknacks. Height, which is preserved complete, about 2½ inches. (Right) Handles and rim fragments of archaic banded cups which were a common ware in South Italy of the late seventh and sixth centuries B.C. These were picked from the dump of the scoop-shovel, brought up from about the 6-meter level in Pit A.

by an enormous mass of archaic sherds at a depth of four and a half to six and a half meters. In each area where an anomaly in readings was encountered, its position was marked by a stake so that future stratigraphic drilling could determine more accurately the cause of the anomaly.

The second phase of operation was the above-mentioned testing of anomalies by boring. The aim of this work was to extract a continuous soil sample from the surface down to virgin soil below the archaeological layer, in the form of a cylinder or in the twists of a spiral auger. The archaeological material, consisting of fragments of pottery, bits of plaster, roof tile, brick, wood, bone, and metal, was picked or washed out of the soil sample, then bagged and tagged with an indication of depth, bore number, and date. It was thus possible to reconstruct accurately the stratigraphy of each bore, the thickness and depth of the Roman, Hellenistic, Attic, and Sybaritic layers. When obstacles such as walls were encountered, the depth was recorded and the drill displaced a short distance to bore anew. Without the boring, our information derived from the geophysical instruments told us little, except by inference. But the actual objects recovered from the bores allowed us to understand the meaning of the anomalous readings and to make further inferences.

Used in the drilling operations were two types of equipment. A motor-driven helical auger was screwed into the ground, then removed by means of a light tripod and chain hoist. More rapid in operation, but less accurate for determining stratigraphy, was Jeep-mounted wash-boring equipment employing a rotating bit and circulating water to remove cuttings from the bore hole.

A total of over four hundred borings were made during the campaign, most of them with the purpose of checking the anomalies. It was found that strong anomalies were generally caused by buried walls, rubble and other debris of habitation, represented in the borings by solid obstacles which the drill could not pass through and by masses of brick, tile, rock, and plaster and concentrated potsherds in the bore samples.

From most of the bores came fragments of pottery, and it was largely by means of these that we were able to plot the areas intensively occupied by the Romans, the Thurians, and the Sybarites. The archaic pottery of Sybaris, predominantly of East Greek origin or imitation, but including occasional fragments of accurately datable Corinthian ware, was found in several areas, notably Casa Bianca, Parco del Cavallo, Latughella, and south of the river in the Ministalla area. Sterile bores along the banks of the Crati confirmed the absence of anomalies in magnetometer readings.

The final phase of operation was the digging of enormous test pits in order to check the validity of the geophysical and drill findings. We hoped to supplement our anomalies and bags of small fragments by bringing to light actual structures and basketfuls of artifacts. As the conventional hand-digging of a test pit to a depth of seven or eight meters would entail the costly and time-consuming work of sheathing the sides of the pit with heavy planks and operating pumps for long periods, it was decided to dig rapidly with a large mechanical excavator. The machine, consisting of a cab mounted on caterpillar treads, had a long boom and a bucket or scoop suspended from wire cables. With this equipment the sterile overburden could be removed in a day, and walls partially cleared during the next day or two. Then would follow a judicious combination of scooping and hand-digging down to virgin soil. Vertical

(Left) Head of a terracotta figurine of a style manufactured in the vicinity of Tarentum in the fourth century B.C. This emerged from clay which was stratified just above sand in Pit A south of the wall. Preserved height, about 3 inches. (Right) Head of a terracotta figurine found just above pure sand in Pit A. He has the long narrow face of a serious old man, perhaps a philosopher of the Pythagorean School which flourished in Croton in the late fifth century B.C. Preserved height, about 3 inches.

scarps were made by hand so that accurate stratigraphic studies could be made.

The first excavation, Test Pit A, was made in the Casa Bianca area on both sides of the famous long wall. It turned out to be a stone and concrete retaining wall, faced only on the south side and probably constructed in late Roman times. Of undetermined original height, the present remains had a height of over three meters, the top lying slightly more than a meter below the surface. As we dug deeper, we found that it had been constructed on the four remaining courses of a massive Greek wall over two meters thick and preserved to three courses of great square blocks measuring half a meter on a side surmounted by a fourth course (on the north face) of dressed rectangular blocks measuring half a meter by one or one and a half meters. The base of the Greek wall lay almost five and a half meters below the surface. Since the base lay on, not in, the stratum containing sherds of Sybaris, it seems likely that this Greek wall was built by the Thurians.

From Test Pit A, with the water level kept down by continuously operating pumps, came quantities of archaeological material, largely from Thurii, but the lowest part, from about five to six and a half meters below the surface, produced an abundance of Ionian pottery of the early sixth century and a small amount of Early Corinthian ware of the seventh century B.C.

Test Pit B was dug at the easterly end of the wall where other small walls joined it, as was already suggested by proton magnetometer anomalies.

As time was running short and work in Test Pit B was hampered by much Roman debris, attention was turned to Test Pit C, which had already been started a short distance north of A. Here was discovered the same stratigraphy as in A, with a small wall in the Thurian layer beneath which occurred sixth century pottery.

A final test pit, D, was dug in the Parco del Cavallo, where a highly magnetic anomaly had appeared, the opposite of the usually low magnetism indicated by walls. This proved to be caused by a Roman wall made in "opus reticulatum" and bricks with high magnetism, lying on a base of concrete originally faced with marble.

Summing up the results of this unusual campaign, we point first to the experimentation accomplished in methods of archaeological prospecting. The capabilities of several geophysical instruments and two types of boring equipment were demonstrated. The operation of all of these devices is relatively simple, but the interpretation of results may be quite misleading without a complete understanding of what happens under varying conditions of soil and constructions. In this season our experiments, checked by boring and excavation, taught us a great deal about this delicate matter of interpretation.

The use in succession of geophysical detector, drill, and excavator was shown to be an efficient and rapid combination of procedures for archaeological prospecting, particularly well suited for use on the plain of Sybaris.

Substantial progress in the delimiting of the archaeological zone of Sybaris and Thurii was made, and points for future excavation were plotted on the map where anomalies and bore-samples indicated deep-lying structures and archaic pottery. Vast areas of the plain were speedily eliminated as a result of negative evidence from magnetometer readings and bores.

It is certain, however, that another season of prospecting will be necessary before we finally yield to the temptation of a large-scale excavation.

The Authors

ELISABETH H. WEST ("Jade: Its Character and Occurrence") was born and grew up in Beirut, Lebanon. She received her B.A. from Vassar College in 1947, majoring in chemistry. She worked in the Archaeology Museum of the American University of Beirut; took part in the Oriental Institute excavation of Jarmo, Iraq, during the 1950-51 season; studied at the Institute of Archaeology of the University of London, and in 1954 received their Diploma in the Archaeology of Western Asia. Since 1956, Miss West has been Assistant in Technical Research at the Freer Gallery in Washington. She is editor of IIC Abstracts published by the International Institute for Conservation of Historic and Artistic Works, London.

PETER THROCKMORTON and JOHN M. BULLITT: "Underwater Surveys in Greece: 1962." Mr. Throckmorton (right) gave up operating and owning small ships and commercial diving in the Pacific to study cultural anthropology; this interest in people combined with his interest in diving led him to the study of Aegean sponge divers. Two seasons on Turkish sponge boats resulted in the discovery of dozens of ancient shipwrecks including the Bronze Age ship at Cape Gelidonya and the Late Roman ship at Yassi Ada; he has worked almost full time at underwater archaeology since 1958 and has been associated with the University Museum since 1960. His first book, *Lost Ships*, about the Turkish sponge divers and the University Museum's first steps in Underwater Archaeology, will be published this fall by the Atlantic Monthly Press. . . Dr. Bullitt, who is Professor of English at Harvard University, received his Ph.D. degree there in 1950 and has been a member of the English Department since that time. His publications include *Jonathan Swift and the Anatomy of Satire* as well as numerous articles on eighteenth century subjects in scholarly journals; he is co-editor of Samuel Johnson, *Idler*. But English is only one of his interests: he has been Amateur Lightweight Boxing Champion and is an experienced diver, working with Ed Link "excavating" the harbor of Caesarea and with Peter Throckmorton in this survey of Methone.

WILLIAM R. COE and JOHN McGINN: "Tikal: the North Acropolis and an Early Tomb." Dr. Coe (left), Assistant Curator of the American Section of the Museum and Research Director of the Tikal Project, has been associated with the Museum since 1951. His interest is American archaeology, particularly of the Maya area. He has done field work in British Honduras, El Salvador, Bolivia, and since 1956 in Guatemala; and is the author of several reports and popular articles on this work. Mr. McGinn is a student in the Anthropology Department of the University of Pennsylvania; he held the Explorers Club of New York Fellowship for 1962, is archaeologist of the Tikal Project, and is returning to Tikal this season to continue work in the North Acropolis.

ALFRED KIDDER, II ("A Unique Peruvian Weaver"), Associate Director of the University Museum since 1950, obtained his Ph.D. degree from Harvard in 1937. From 1935 to 1950, except for service in the U. S. Army Air Force from 1942 to 1946, he taught anthropology at Harvard and was Curator of South American Archaeology at the Peabody Museum there. His interest is the archaeology of Central and South America, particularly of the Andean region. He has done field work in Venezuela, Honduras, Guatemala, Peru, and Bolivia.

DONALD FREEMAN BROWN ("In Search of Sybaris: 1962"), editor-in-chief of the Council for Old World Archaeology's *COWA Surveys and Bibliographies,* received his Ph.D. from Harvard and is an archaeologist at the Peabody Museum of Harvard University. He has spent close to five years in Italy studying the prehistoric cultures of the Italian Peninsula and investigating the problem of the location of Sybaris. Having pioneered in the use of boring equipment at Sybaris, he was invited to the University Museum's excavation at Gordion in 1955 where he directed boring operations which led to the locating of the little prince's tomb in Tumulus P and the tomb of Gordius in the Great Tumulus.

Suggested Reading

For those of our readers who are interested in new archaeological discoveries and in the most recent studies in anthropology, we have compiled the following list.

JADE: ITS CHARACTER AND OCCURRENCE

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George F. Bass, "A Bronze Age Shipwreck" in Expedition, Vol. 3, No. 2 (Winter, 1961). Philadelphia.

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L. von Matt and U. Zanotti-Bianco, Magna Graecia. Stringa, Genoa. 1961. (There is an English translation by H. Hoffmann.)

A. G. Woodhead, The Greeks in the West. Praeger, New York. 1962.

AMERICAN ANTHROPOLOGIST. World-wide coverage of anthropology and archaeology, with emphasis on anthropology. Published six times a year by the American Anthropological Association, Menasha, Wisconsin.

AMERICAN ANTIQUITY. Articles on current work in New World archaeology. Book reviews. Published quarterly by the Society for American Archaeology at the University of Utah, Salt Lake City. They also publish Abstracts.

AMERICAN JOURNAL OF ARCHAEOLOGY. Largely Classical but also some articles on Near East archaeology. Book reviews. Published quarterly by the Archaeological Institute of America, 5 Washington Square North, New York.

ANTIQUITY. Short articles on archaeology of all Old World areas. Book reviews. Published quarterly for the Antiquity Publications Trust by Heffer of Cambridge, England.

ARCHAEOLOGY. New archaeological work around the world. News of current field work. Published quarterly by the Archaeological Institute of America, 5 Washington Square North, New York.

COWA Surveys and Bibliographies. Annotated index to field work and publications for all areas of the Old World for all periods. Published semi-annually by the Council of Old World Archaeology, Cambridge, Massachusetts.

ILLUSTRATED LONDON NEWS. First reports, well illustrated, of current field work. Weekly. London.

SOUTHWESTERN JOURNAL OF ANTHROPOLOGY. General coverage of anthropology with occasional articles on archaeology. Published quarterly by the University of New Mexico, Albuquerque.

The International Journal of Nautical Archaeology and Underwater Exploration (1973), 2.2: 243–266

The Roman wreck at Pantano Longarini

Peter & Joan Throckmorton
Minos 16, Kastella, Piraeus, Greece

Introduction

The Pantano Longarini was probably once the anchorage known to Greeks as Odissea, to Romans as Edissa, and to Arabs and present day Sicilians as Marza. There is a passage in Cicero *in Verrem* (ii, v. 34) that places the pirate ships in Edissa and the Romans in the harbour, now silted up, of the ancient Pachinos, which is the present day Pachino, a small town just to the west of Cape Passaro at the south-eastern corner of Sicily (Fig. 1). It is not within the scope of this paper, nor the competence of the author, to discuss the ancient topography of the Pachino region. The interested reader can

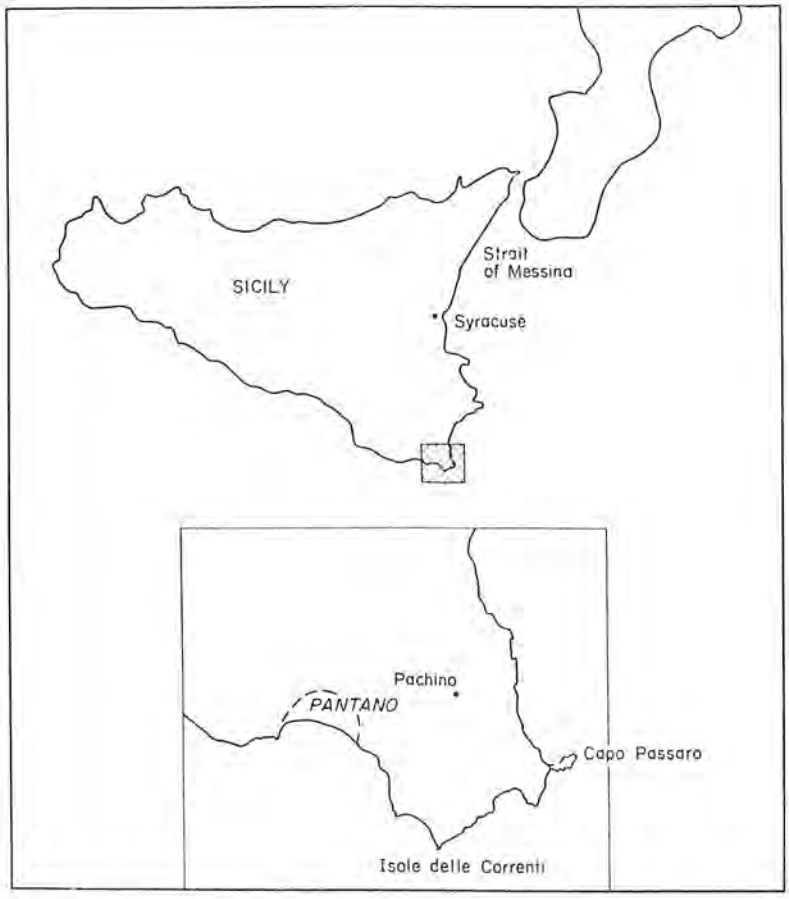

Figure 1. Map of area.

turn to Tomasino Fazello's *Storia di Sicilia*, originally published at Palermo in 1558 (1830), and to Vito Amico's mid-18th century research for a detailed discussion. It is, however, clear from these descriptions that the whole low-lying area was once an extension of the sea. It is now silted up.

The wreck was discovered in the course of drainage operations which were part of a land reclamation project undertaken by Francesco Spatola, an imaginative farmer who had lost his land in Tunisia after World War II. (See Throckmorton & Kapitän, 1968, for a preliminary report on the discovery and its excavation.)

The discovery

The workmen who first uncovered parts of the ship's structure took some of the cypress planking to a local shipyard and tried to sell it, so strong was the ancient timber. Through a series of coincidences not very remarkable in a small Sicilian village, the presence of the wreck came to the attention of the local archaeological authorities. An emergency grant was given by the University of Pennsylvania Museum, and our group undertook to excavate the site for Professor Bernabò Brea, director of the Syracuse Museum, with Gerhard Kapitän, who had brought the site to the attention of the authorities in the first place, and whose initiative made the whole project possible. When the wreck was discovered, Kapitän arranged for radio-carbon dating, which indicated AD 500 ± 150 years, as a date for the wreck.

We closed the end of the ditch (Fig. 2) so that the wreck lay in a shallow pool which could be kept dry with electric salvage pumps. Pumps of this type are essential for such an excavation, as they always keep their prime, and the rubber impellers are unaffected by sand and mud so long as the mud is dissolved in water.

The excavation revealed about 30 ft (9·1 m) of the starboard side of the stern above the waterline of a large ship. The structure extended up to the side of the ditch, beyond which the ditch excavators had dug up and destroyed more than half of it.

Several observations could be made immediately. The ship had an unusual kind of transom stern. The planking and wales which had been worked onto the stern were attached in an unfamiliar way. The ship was very heavily framed with grown timbers, roughly adzed to fit in place, so fitted that there was little space between the timbers. Heavy inner stringers had been fitted inside the frames. As in modern construction, frames and floors alternated, and light pine boards had been fitted between the stringers so as to close in the cargo hold and keep the bilges clean. The ship was iron fastened throughout, with forged iron nails and bolts, which had disappeared but left lumps of black mush surrounded by a concreted mould.

The unique feature of the construction was the manner in which one frame and two deck beams had been worked so that they tucked into slots cut for them in the heavy wales which ran along the sides of the ship. These frames and beams protruded outside the wales, which were massive half trees about 0·5 m thick. 'Through beams' are an important detail of ancient ship construction, which had long been known from mosaics and sculptures, but which had never been studied in an actual shipwreck before.

It was evident from the start that the Pantano wreck was, like the Byzantine wreck recently excavated by the Pennsylvania group at Yassi Ada in Turkey, an example of a transitional period in the history of naval architecture. This type of ship is still in the Roman tradition, but has begun to take on medieval or modern characteristics.

Before discussing the details of the Pantano ship's construction, we should summarize our present knowledge of Roman construction and its development.

Ancient shipbuilding

A good many Roman cargo vessels of several different types have been studied. (See Throckmorton, 1964, 1972.) None of these ships has been reconstructed, even in part, because the amount of material recovered has been small. However, it is safe to make several generalizations.

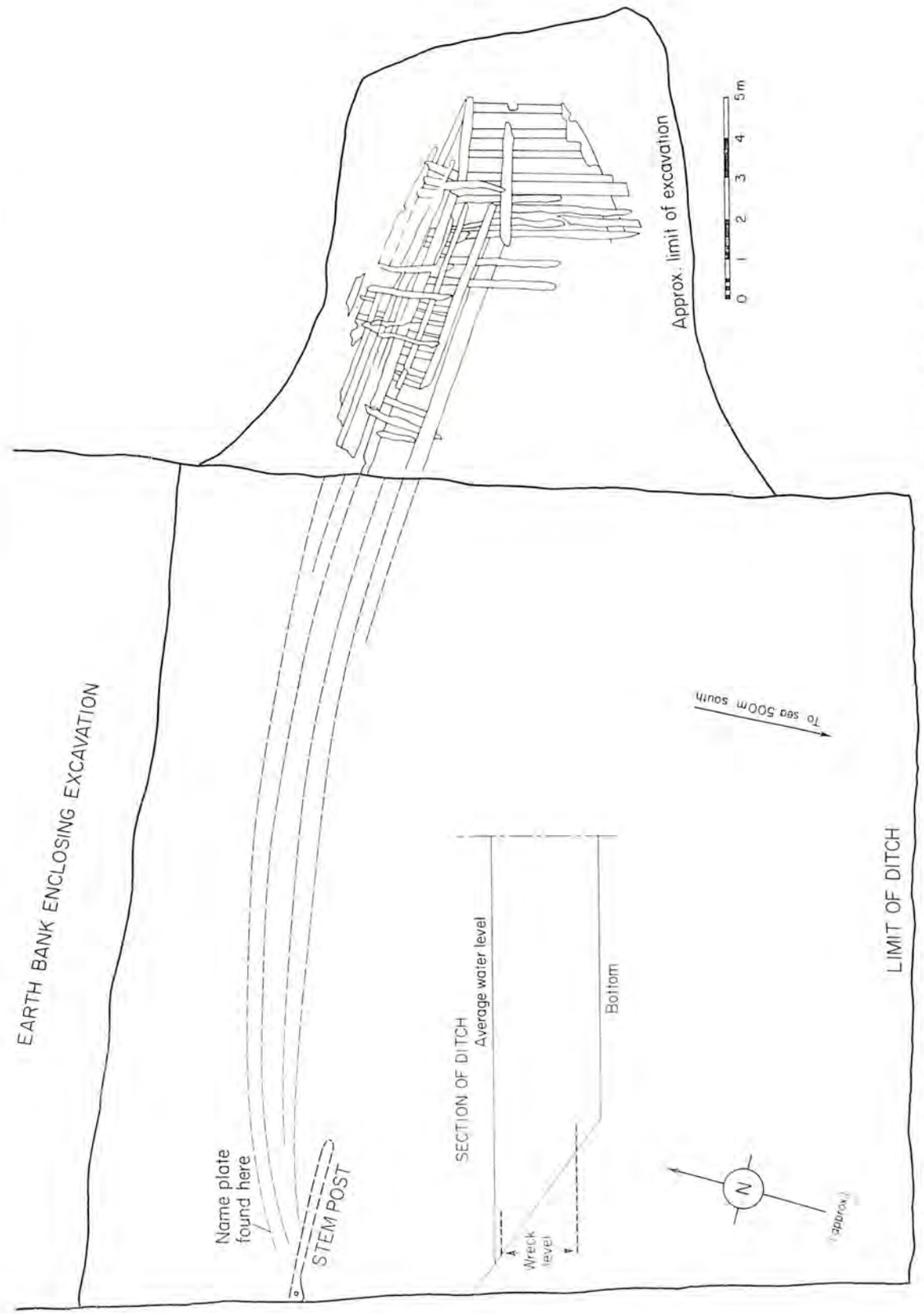

Figure 2. Plan of site from 1965 survey by Helen Wylde, Joe Reinhart and Peter Throckmorton. Drawn by Joan Throckmorton.

All Roman ships found in the Mediterranean to date were carvel built by the shell first method, and were tenoned. It appears that the shipwright, using battens and some system of temporary clamps, faired up the lines of his ship from the keel, as the structure took shape. The planks, set edge-to-edge, were joined together by a complicated system of mortices and tenons set very close together. In some cases these mortice and tenon assemblies are staggered, and there are at least two cases of ships being 'boxed', that is, having an additional layer of planking put on outside the first layer. This occurred at the Dramont wreck (Benoit, 1961: 143) and at Titan. The Torre Sgarrata wreck had 'boxed' patches as well, which were tenoned and attached to the hull with iron nails. These tenoned hulls were beautiful examples of the carpenter's art. The planks were fitted together so closely that they were not caulked.

Once the shipwright had shaped the shell of the hull, he adzed the frames and floors to shape, and inserted them. This construction is very ancient. It can be seen on Egyptian boats of Early Dynastic times, and still survives in Egypt and the Far East. (See Hornell, 1943.)

The transition from shell to skeleton construction occurred sometime after the end of the Roman empire. The most interesting thing about the Pantano wreck is that it illustrates a previously unknown type of transitional ship. (See below, p. 255.)

The excavation

The first step in excavation was to tag every timber as it appeared (Fig. 3). The tags, of laminated plastic, have a black layer in the centre and white layers on the outside. The letters are cut through the white layer on one side. As the plastic is chemically inert and does not change colour, the numbers are permanently visible, unlike painted numbers

Figure 3. Stern 'transom'. Only the starboard side is preserved. The draftsman is sitting on the approximate centre line of the ship. The port side, which was apparently exposed for some time after the ship was wrecked, has been partially destroyed in antiquity.

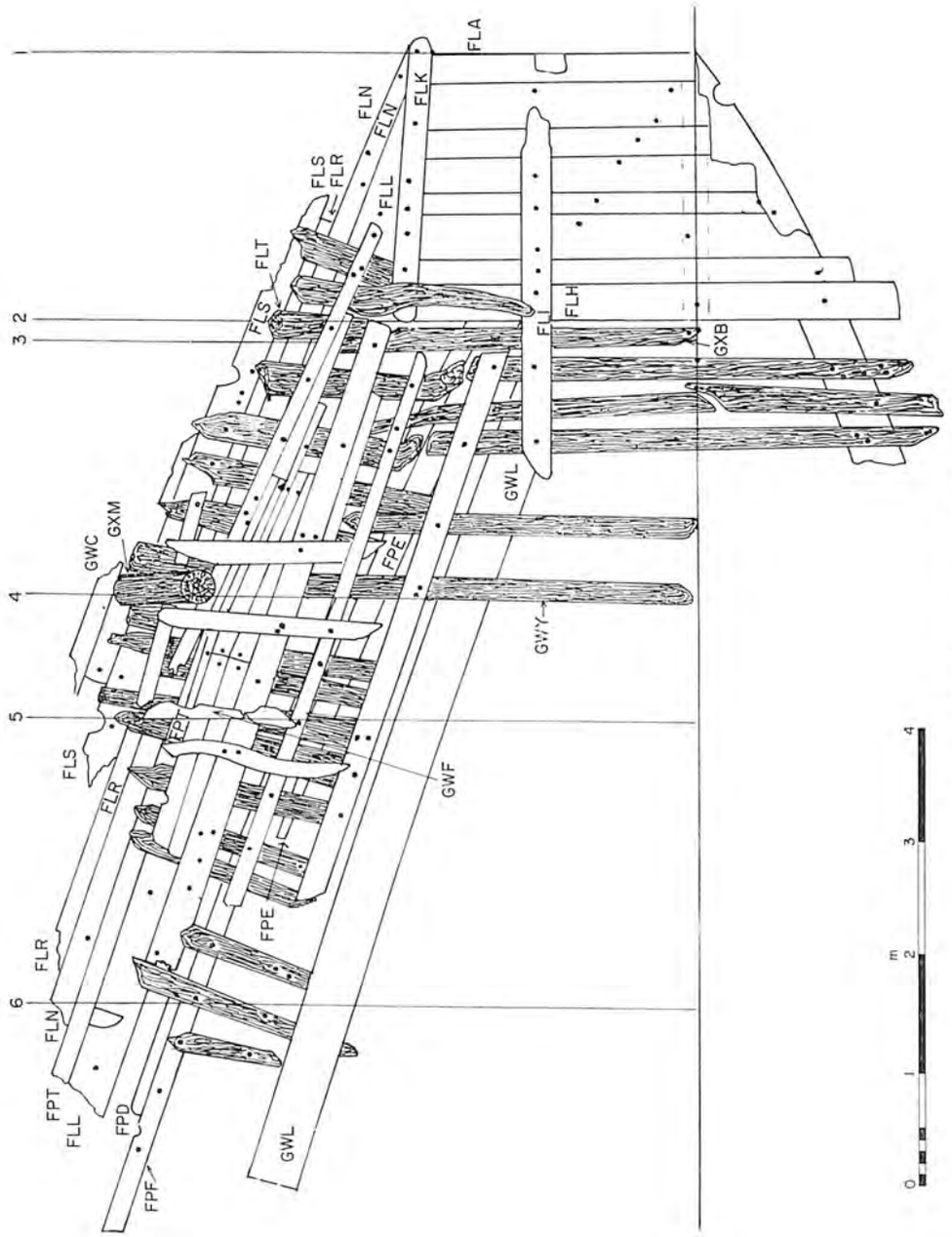

Figure 4. Plan of remaining timbers.

on tin and the like. We developed this system in 1965, for work at Lake Bolsena.

Each tag bears three letters, one of a possible 6000-odd three-letter groups from a combination of three alphabets. This idea was developed by George Bass at Yassi Ada in 1961 and 1962. The three-letter code is much easier to work with than a number code, both because there are fewer units, and because everyone instinctively looks for 2 to follow 1 and so on, thus suggesting a sequence of relationships which may not in fact exist.

Two steps then were carried out, more or less simultaneously. Three stakes were driven into the ground outside the wreck site, and from an arbitrary zero level on one of these, levels of the other reference points (the other two fixed stakes) and of each end of nearly every timber of the ship were then taken. This was done by means of a long plastic tube partially filled with water, the level being noted at the point where the water-air line corresponded with, or lay a measurable distance below or above, the chosen zero point on the first stake. Roughly 350 levels were taken.

Once the levels were known, direct horizontal measurements could be made from each control point and the third side of the resulting triangle calculated so that we could transfer the measurements onto a plan (Fig. 4).

A theodolite would have given a more accurate result, but we lacked a theodolite and the crude water-hose method was better than nothing. Accuracy was sufficient for our purposes, especially as we were eventually to depend for fine lines on the matching of nail hole to nail hole on a model.

At the same time, two of the group drew each timber in relation to those surrounding it, locating and measuring each nail hole and tool mark as well. With a survey group of five (four after Kapitän was obliged to leave) we were working against time. The landowner

Figure 5. Bottom of ship. The waterline wales as they came together under the transom timbers, which have been removed. The wales are outermost; inside them are remnants of bottom planking. These bottom planks were tenoned; note place where skeg (after part of keel) fitted.

Figure 6. Detail of aftermost end of waterline wales. Transom on port side was cut away in antiquity, apparently before wreck was covered by sand.

was anxious to get on with his ditch. The weather worsened steadily, and even had it stayed fine, we had reached the end of our funds. There was no question of returning the next season, since the ditch had to be cleared at once.

As timbers were photographed, measured, drawn, and their levels taken, they were removed in sequence. Once the cypress planking was exposed, we saw that we could count on it very well to tell where frames, floors, and other timbers had been placed (Figs 5 to 7). Nails which had fastened frames to the great longitudinal wales left round marks (incrustation surrounding nothing or a soft substance of decomposed iron) about 0·02 m in diameter (Fig. 8). Other timbers, lighter and less essential to the structural strength of the ship, had been nailed down by nails about 0·01 m square, often driven in pairs. These smaller nails also held frames or floors to the hull planks which lay between the wales, odd and even, throughout the part of the ship which remained for us to study.

There were occasional curious marks which we do not at the moment understand: several triangular or wedge shaped cuts 0·01 m or less deep, and a sort of keyhole-shape cut into one of the wales, adjacent to a half-spade shaped cut. Occasionally much heavier fastenings were used, the spike heads seeming to be up to 0·07 m in diameter.

Figure 7. Planks on either side of the vanished skeg show clearly how it was shaped.

Figure 8. Bolts on lower side of transom.

Notes on drawing the wreck, and its reconstruction (Figs 9 to 15)

We drew up the wreck as well as we could on the spot. Three of us had drafting experience; in the aggregate, this was mainly

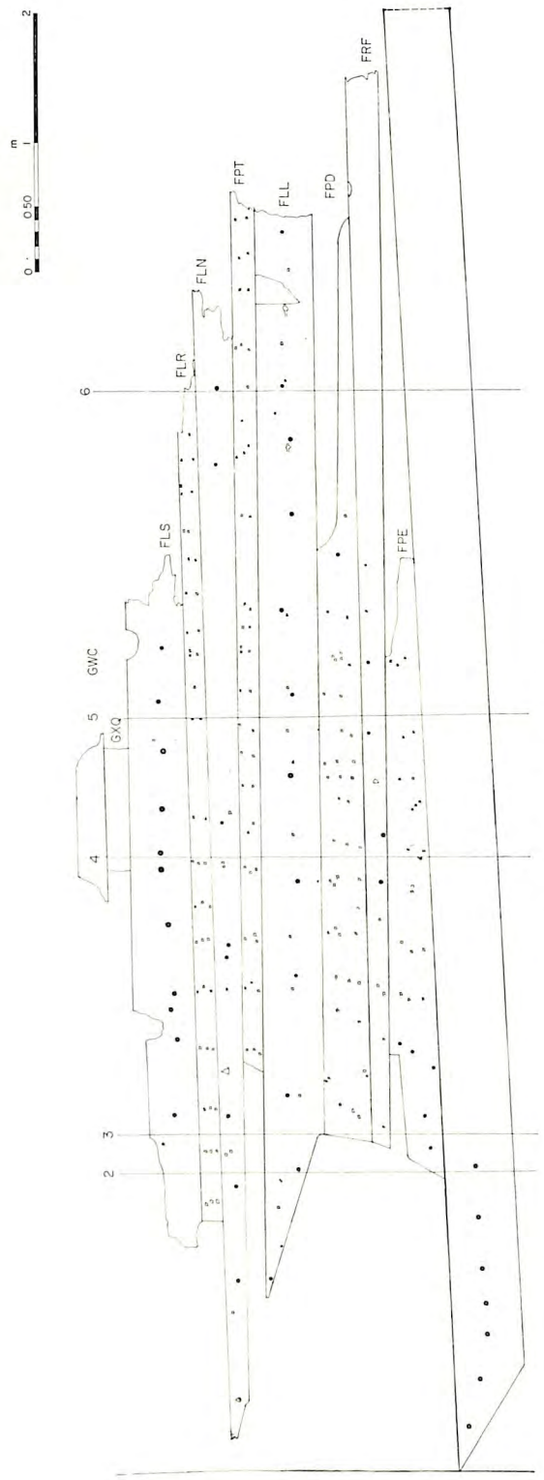

Figure 9. Planking diagram.

underwater. Working on land, or in a swampy ditch, brought its own problems. (Underwater one has always got a vertical line to which to refer, by tying a string to anything that will float, barring very shallow water, very strong current, or a very rough surface. Our muddy site would not stay clear nearly as long as an airlifted undersea site would do. These are just two examples of the comparative peculiarities of working undersea and ashore.)

As each timber was removed from the wreck for storage in fresh water, we drew sections of it, as well as we could manage. We did not get sections of every single timber, as we were short of good weather, time, and money. At the end, when the crane arrived to haul off the timbers by horse and cart, we measured as much as we could as fast as we could.

We feel that the ones we missed, the timbers without precise sections drawn, were those which were nearly the same as those adjacent to them, which were drawn up. Still we would like to return and trace all the timbers onto plastic.

The original method we employed was to stretch a tape from one end of any given timber to the other, measuring the distance from the tape to top and bottom of the timber every few centimetres, noting constructional marks along the way (see Fig. 3). Timber by timber this was reasonably adequate; in the aggregate, it was probably quite satisfactory. Still, one would like a 1:1 tracing in order to *know* that no error had occurred because of windy weather, sagging tape, and so forth.

The wreck had opened out, both from the original catastrophe which sank her and from the weight of sand and mud which had rested on her for so many years. We could not reconstruct her lines on paper, or not very well, as our principal source of precise information about her construction was nail holes: these differed one from another

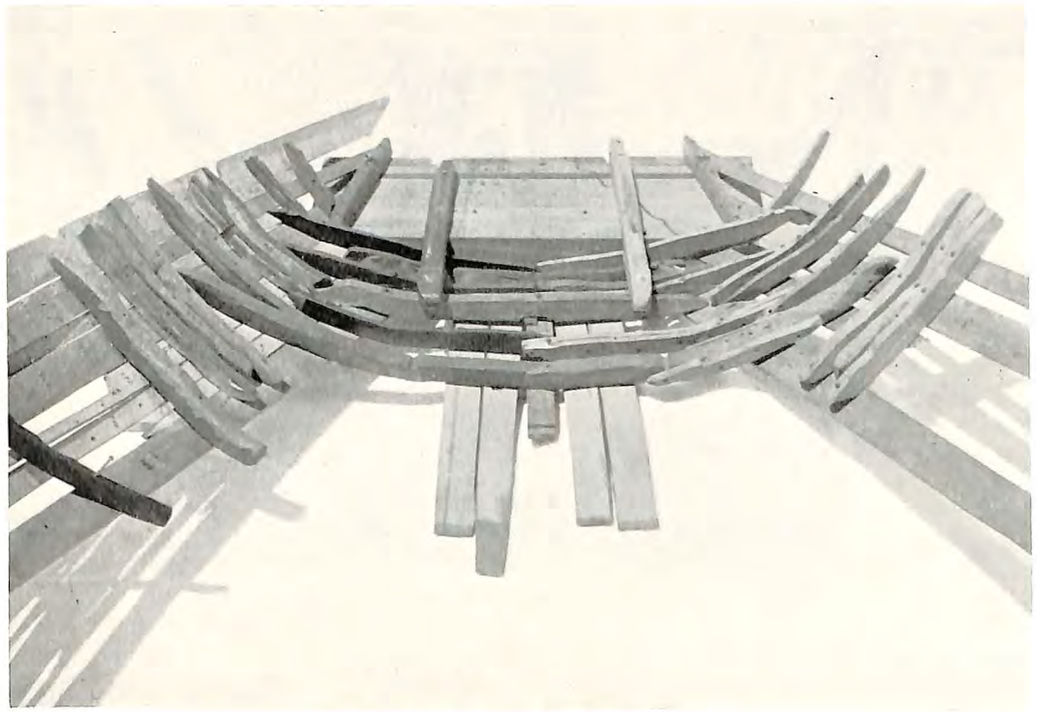

Figure 10. Model photo from above.

sufficiently in size and shape and patterned grouping, so that one could say with confidence what job the fastenings had done.

Large throughbolts fastened wales to frames. Smaller nails held frames to hull planking, or inner stringers to frames. At various decisive points along the hull, some of which we do not understand, big throughbolts were used again: extra strength was needed, and we must try to understand why. (See Fig. 9.)

A model (scale 1:10) was made, sufficiently complete to give us its undisputed shape (Figs 10 and 11). We then measured the model itself, and 'took off' its lines, using the conventional shipbuilder's methods. (Note: the model is incomplete only in that we have not carved out the inner stringers and put them on. There were two sizeable ones and a number of light stringers. Section drawings of them were scarcely helpful at all, as they are very long and much flattened by the weight of years and mud. Their nail holes are, however, very clear, and were used as a constant and in some cases a decisive check in placing frames and floors to planking in the model.)

Interested readers probably know about ships' lines. If not, there are many places to learn the simple geometric processes involved (Chapelle, 1935, 1949, both give excellent explanations).

As far as we know, no one has yet applied the conventions of paper naval architecture to an ancient wreck. Neither have we much help from graphic or philological sources at this period, as the 7th century AD, give or take a little, was not a time when enough people had enough money for enough city and house decorations, including ship representations on walls, vases, floors, or whatever, for any to survive through the accidents of history to instruct us about what to see in the Pantano wreck.

Lacking any such basis and taking lines directly from the model, we tried to draw as much of the ship as seemed correct.

Briefly, the point of the conventional

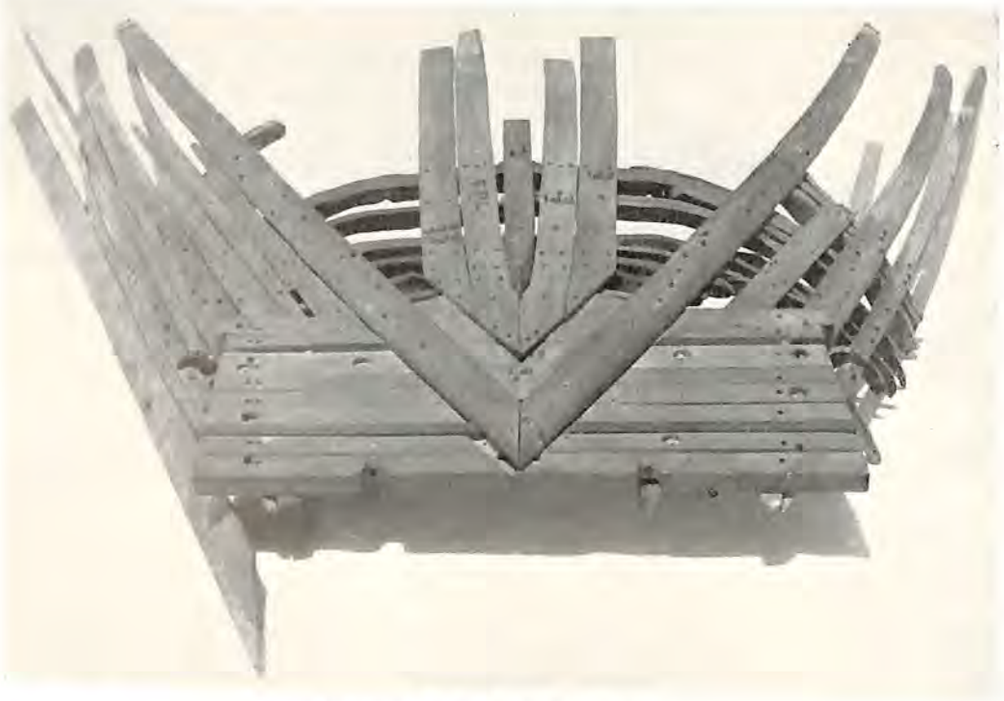

Figure 11. Model photo from below.

Figure 12. Moulds laid out on a scrieve board, at George Mavrikos' yard in Syros. Battens make it possible for the designer to obtain fair lines to 1:1 scale, which then can be transferred to shapes of frames. This invention made the use of tenons unnecessary.

drawing of ships' lines, whether to build a ship or to record the shape of an existing hull, is that a ship must be constructed with a system of fair curves, curves that can be drawn by the builder or re-constructor by a batten, stiff or flexible, in a mould loft or on the drawing board, through a series of points. (See Fig. 12.)

The points are derived, that is, noted, ticked off, in three principal sets of lines which inform us of the shape of a ship. If in the drawing of any of these lines there is a hitch, a nick, a crookedness, that means a crookedness or gouge occurs in the side of the ship; our lines are wrong; we must find the error.

One set of lines is the waterlines, which appear on the drawing as if one took each layer of a ship-shaped sandwich, horizontal from midships to the outer hull, and traced it on paper. These appear on the reconstruction drawing as WL 1, WL 2, etc. (Fig. 16).

The second is the diagonals, lines drawn at useful intervals from the midships line (on the section drawing) at a downwards angle to the outer hull, more or less at a 45 degree angle to the hull planking. This shows the angle at which water flows past the hull (D1, D2, etc. on the drawing.) We have found the diagonals the most useful correction for relationship of the ship's section drawing to the shape of the hull as a whole. If the diagonals, drawn on plan, are not fair, the ship has got a gouge in it somewhere, and it won't sail. The diagonals are particularly useful in dealing with the hull of a wreck.

The third group of lines is the buttock lines. If a knife is sliced through the ship from top to bottom, fore to aft, first near the midships line and then at intervals proceeding outwards to the sides of the hull, and this slice of ship were then traced onto paper, that would be the buttock lines. We have made a number of experimental drawings with these, and have decided to reproduce

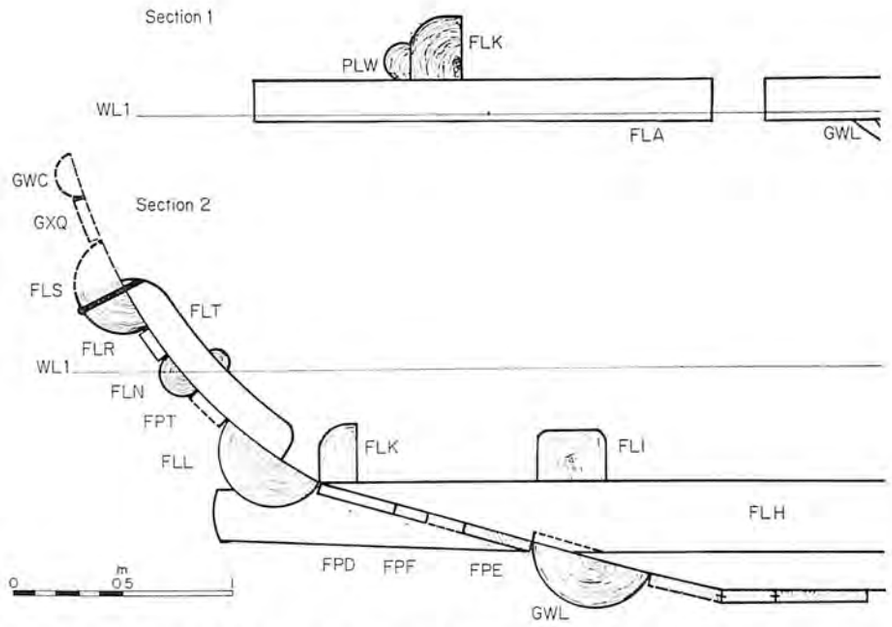

Figure 13. Sections 1 and 2. These show the after- and forwardmost sections of the platform which supported, one assumes from earlier or contemporary vase and mosaic illustrations, some kind of sterncastle or deck house. The nearest parallel we could find among modern sources was, of all things, similar construction in Chinese junks.

Howard Chapelle looked at the photographs several years ago and said it looked to him more like the bow of the ship than like the stern. We refer to it as the stern because the stempost was found (and burnt) by local workmen 30 m or so forward of the platform.

Two massive timbers were bolted to the platform, one of them extending down over the aftermost frames, most carefully cut to fit them. Another timber, shown in the plan, Fig. 4, and photograph, a much twisted and only slightly cut part of a tree, looks as if it had been wrenched out of somewhere else and tossed onto the platform deck, but was in fact nailed to FLI.

We have, with an effort at restraint, refrained from rebuilding a deck house in the reconstruction drawing, but chances are it looked something like the stern of the ship shown in Casson (1971:154).

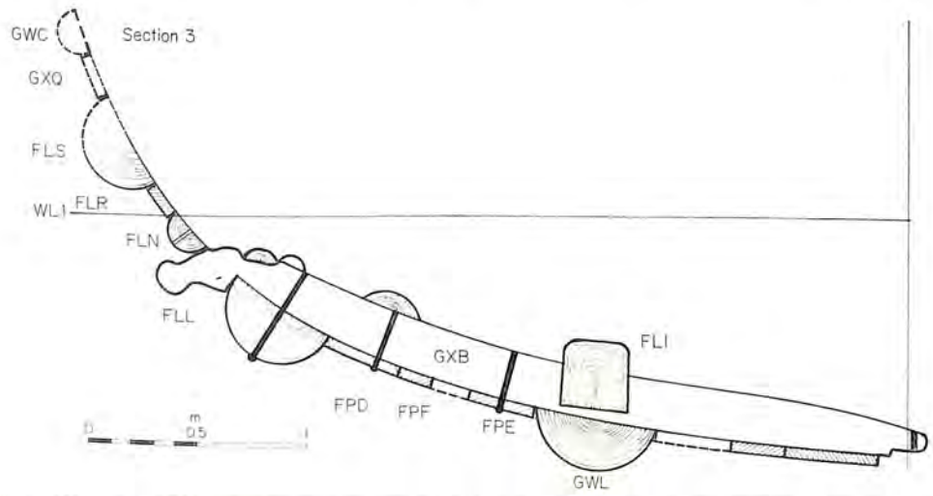

Figure 13. Section 3. Here, obviously, the interesting feature is frame GXB, which passes through the side of the ship, the planking being cut away to permit it to pass through. This has been seen before in works of art (see Fig. 19), but never before, as far as we know, in actuality. GXB is most beautifully cut to sit in the slot made for it in the hull planking (see Fig. 14).

Figure 14. Section 3, GXB. Frame cut to fit over the deckline wale.

none, as what happened to the wales right aft is a matter of conjecture, and we have conjectured enough in the reconstruction without confusing the drawing with spurious buttock lines.

We worked from the model with a series of sections (Figs 13 and 15), taken at points indicated on the drawings, which were as far as we could tell the relevant ones, where the shape of the ship changed and where construction was singular and indisputable. (The exception is section 6, which is speculative in part; we took the foremost frame, and faired the curve in relation to section 5, Fig. 15.)

Working from the sections, we then drew the profile with bulwarks, waterlines, the reported length of ship and height of stempost, and the known position of cuts in frames and floors for the keel. At the same time, checking back and forth between the three drawings (section, profile, and plan), we drew the deck plan, with bulwarks and waterlines drawn out as if seen from above. (Waterlines are in this case a draftsman's convention of convenience, arbitrary reference lines drawn horizontally across the profile, transferred as curves to the plan.)

Here discrepancies occurred. There were indeed gouges and zigzags in our ship. Going back to the original data, that is to the excavation book with its plan of planking with all the nail holes after the frames were removed, and to the drawings of the many individual frames and other timbers, we checked out the sections to find possibilities of error. Altering the sections slightly, one here, another there, the diagonals eventually came fair, that is to say, the ship became possible. She could float.

Checking her out with fair curves, tightening her nail holes, she began to look somewhat less like a saucer and more like a teacup. We tried hard to stand up the sides so that she looked like our idea of a ship, but she will not stand up any more than we have drawn her.

Having returned to the excavation book, we then checked the new sections with the model, which indeed had been done with great care as to connecting nail hole to nail hole. Everything seemed all right, so far.

Then, out of curiosity, we discarded all the original data and drew sections from the plan, diagonals, and profile. This was a lengthy adventure, and the last. This is the final drawing reproduced (Fig. 16). Sections drawn, we checked for a last time back to the model and the excavation log, and found nothing wrong, that is, nothing contradicting the set of lines.

About a third of the ship exists. We know, from Garifalo and other workers who saw much of the remainder of the ship before it was burnt, the approximate length of the ship. Because a ship is necessarily built with fair curves, we think our reconstruction must be safe through, and a bit past, the midships section.

The reconstruction

This was more difficult than we had expected. Working out the drawing was complicated but possible. What the drawing of the wreck told us, however, was exactly that—what the *wreck* looked like. What we wanted to know was what the *ship* had been like, and the 1:10 model was constructed (Figs 10 and 11).

We knew where frames and floors had been fastened. We had sections of the four which remained intact and many of the shorter ones higher in the ship, and could of course assume that the missing port side had been for practical purposes identical to the starboard. The keel was missing, but cuts in both frames and floors showed where it had been. Fastenings of the long interior stringers gave us an

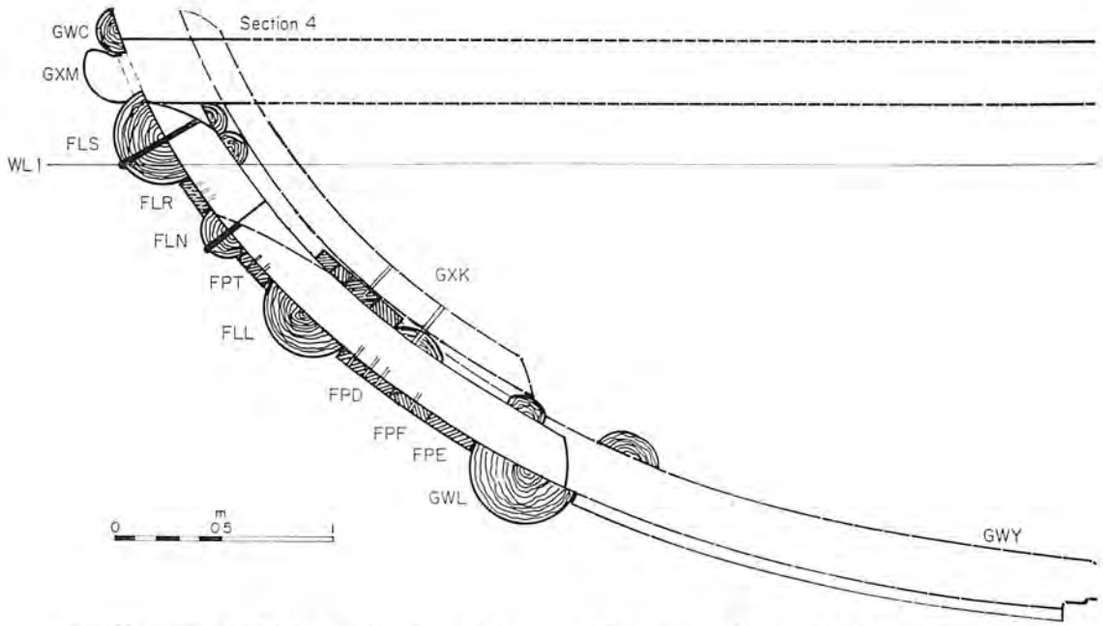

Figure 15. Section 4. This is a section along the lowest and forwardmost frame, which is, like the others, cut away on its lower end in order to fit onto the keel. Here also we have another through beam, this time probably a deck beam, see the dotted line. This is the last point at which we are perfectly positive of the shape of the ship.

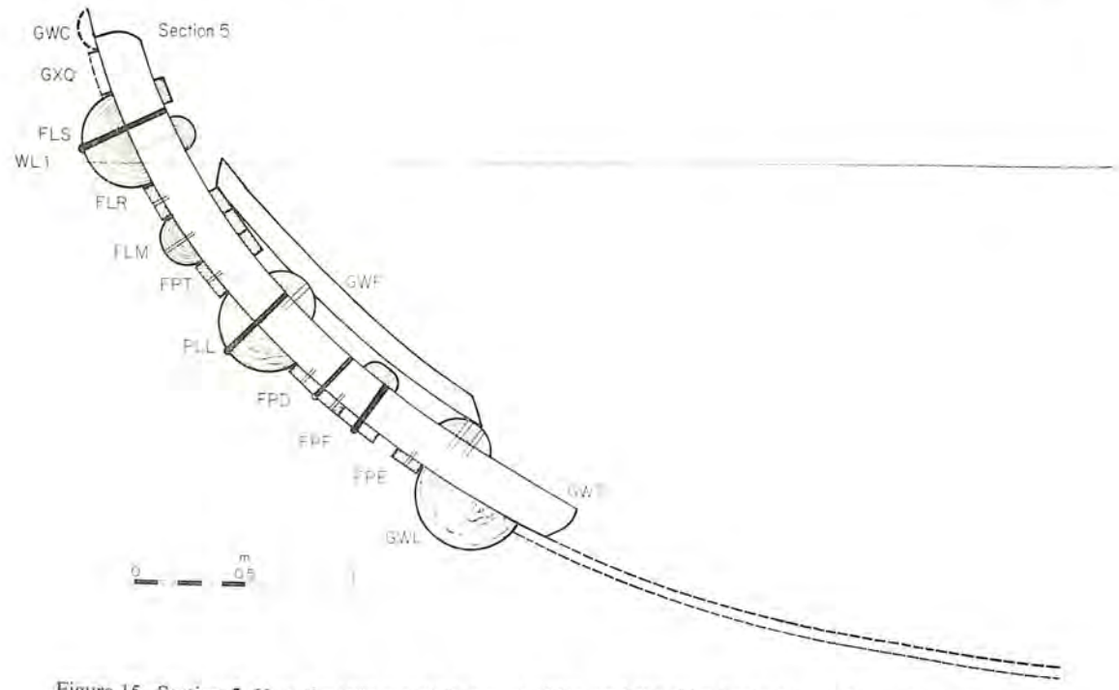

Figure 15. Section 5. Here the ship certainly grows wider, and the sides begin to stand up a little, though not much, as it is so close to section 4. The turn of the bilge, that is, the line of the bottom of the ship to the point where the planking joins the keel, might be very slightly different, but can't be very far wrong, as we are sure about section 4.

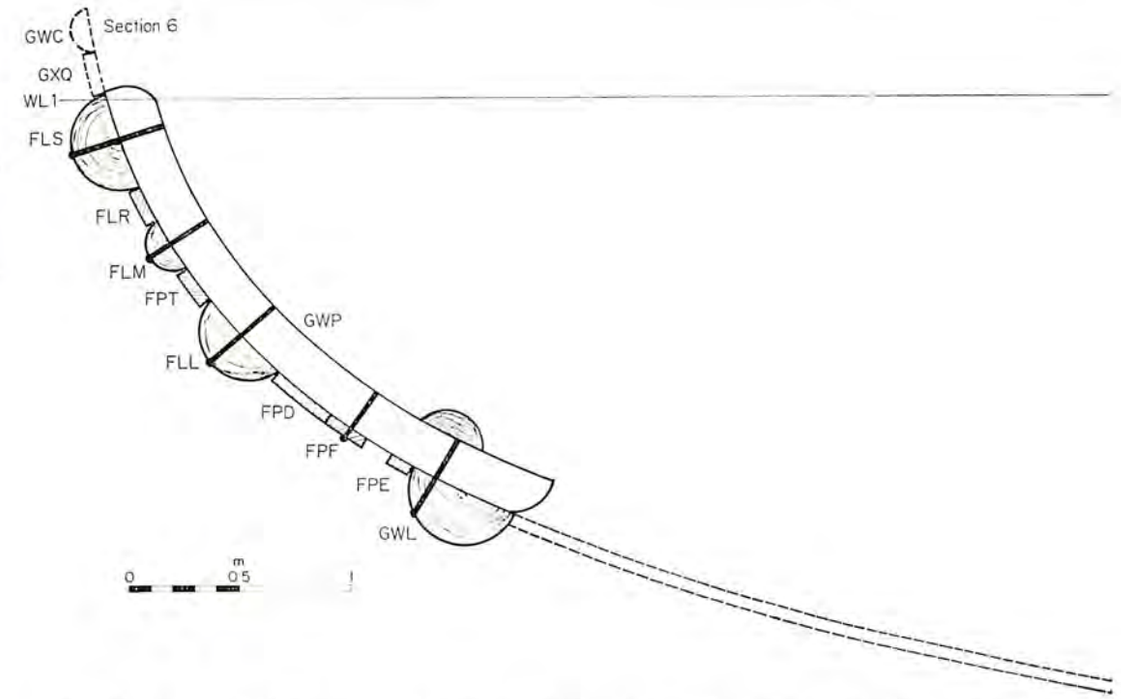

Figure 15. Section 6. We experimented with various different curves along the frame GWP, again hoping the ship would stand up. Here we have finished a fair curve against the centre line, skeg or keel, as it may be. Assuming there was a skeg, and we don't see how the ship could have functioned otherwise, we must have finished with the skeg and got on to a proper keel somewhere near section 6, in which case the section would have a much more attractive curve down to a keel seated considerably lower than the lowest point on section 6.

Still, what we have drawn is what is there, down to below wale GWL. The wreck was considerably spread out by this point, the forwardmost large sound frame presumably in its original position.

The distance between sections 5 and 6 is just short of 2·5 m. A certain amount of change in the sectional shape of the ship can have occurred here. In any case, we know the shape of a definite portion of the side of the ship along frame GWP. Below wale GWL is conservative, and not altogether confident, speculation.

additional check on the shape of the hull below the waterline. Each time we made an error of arithmetic or carpentry, the nail holes were able to set us right again.

We soon found that honesty was not only the best but the only practical policy. Whenever we stretched points in order to make likely looking pieces fit, we found that our mistake compounded itself. The first model had to be discarded completely, and we only managed a satisfactory reconstruction with the second after taking it apart and reassembling it several times.

Our policy during the excavation had been to record and measure everything, and especial care had been taken to locate with all accuracy such things as nail and bolt holes. All the wood was soft on the surface, and much of it in extremely delicate condition; we intended to move it, as we did, to a storage tank where fresh water would prevent its further disintegration, but we knew that the best and, always assuming the possibility of accident in transport, perhaps only opportunity of accurate recording lay in measurements taken while the wreck was intact as a whole. (There were, as it developed, scarcely any accidents as timbers were moved, except for the occasional break we made ourselves to preserve two halves of a single

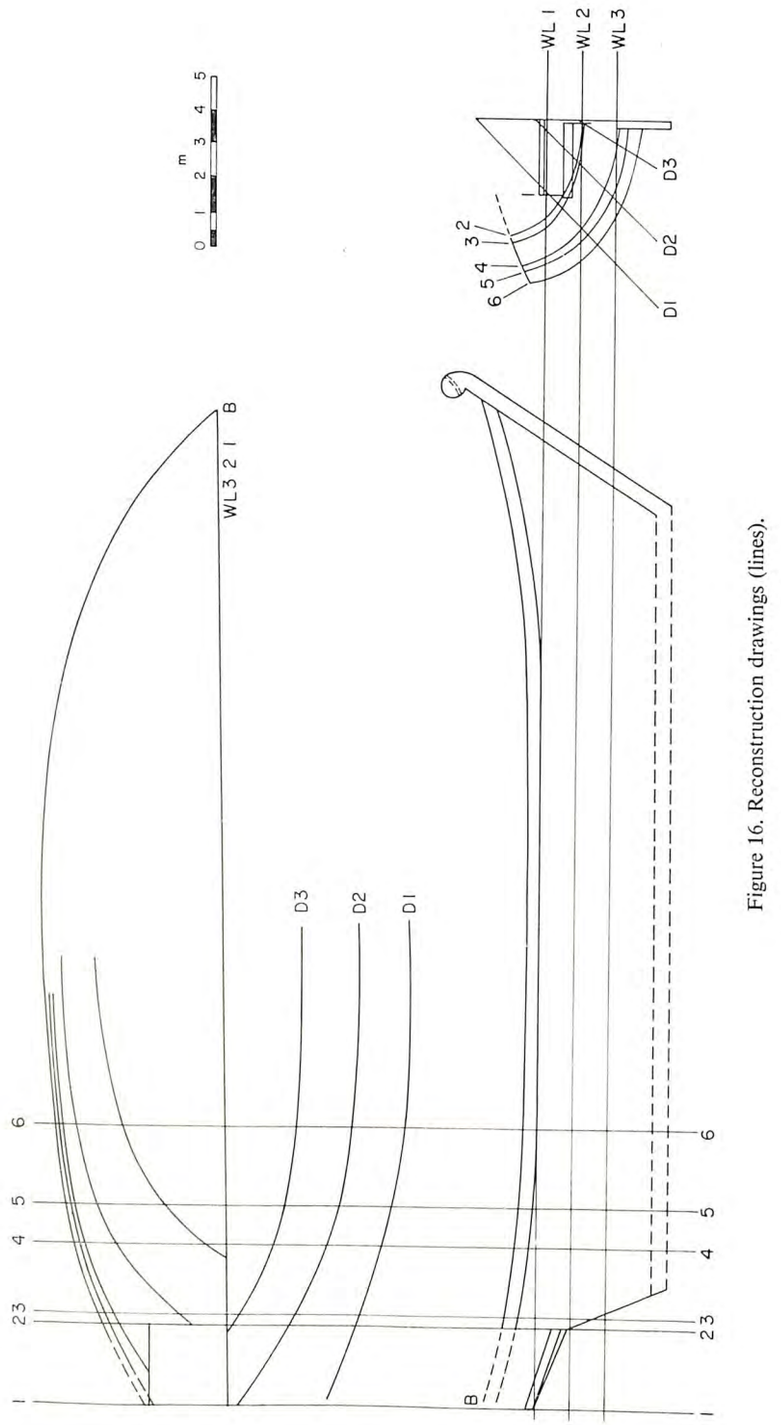

Figure 16. Reconstruction drawings (lines).

fragile timber. The little horsedrawn crane itself broke, however, under the weight of one of the great wales on the last day of excavation.)

Although we made thousands of measurements, our conclusion was that we should have made more. An obvious answer to the problems inevitably created by hand-measurements in such vast quantity might be photogrammetry, which would solve the measurement problem.

The model (Figs 10 and 11), as partially completed, shows the ship to about the centre line. We have discussed the calculations and shipwright formulas involved in laying out modern traditional vessels elsewhere (Throckmorton, 1964, 1972). It is obviously impossible to say with exactness to which formula the Pantano ship was built. However, the Yassi Ada ship of the early 7th century has been reconstructed by Van Doorninck and his associates without any particular reference to modern formulas, and certainly fits, as do other wrecks, within what a study of modern traditional Mediterranean types shows are standard length on keel/maxi-

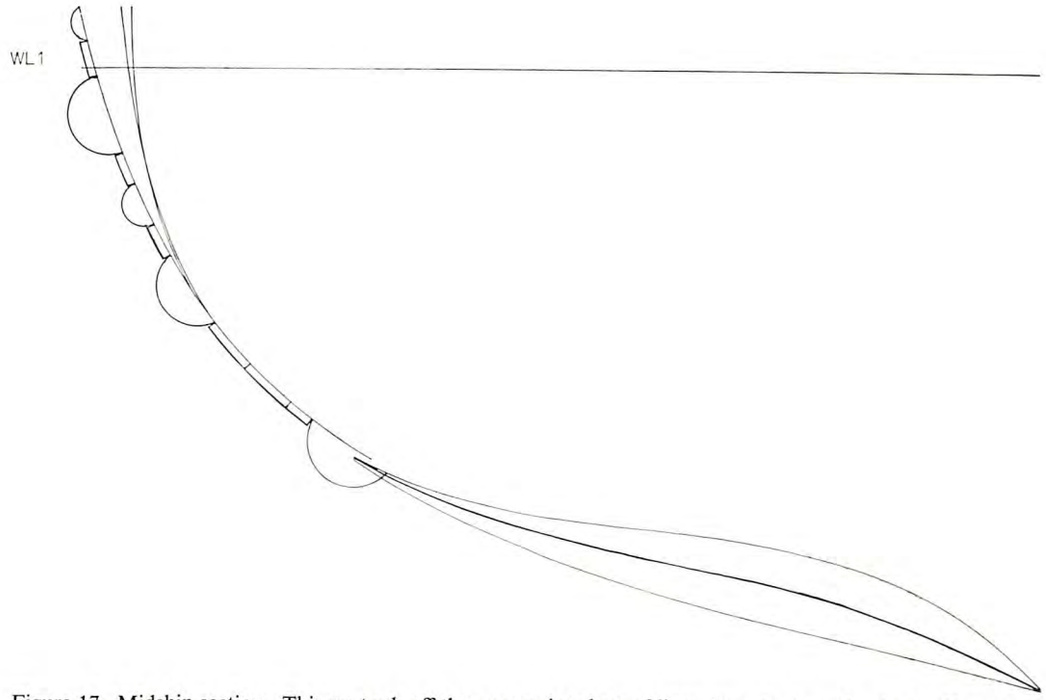

Figure 17. Midship section. This we took off the conventional set of lines, in order to make the profile reconstruction drawing. Taken off the lines as they are, the section is as presented. The line of bulwarks is, however, speculative, and would look better if narrowed a bit, as in the inner single lines on the section drawing.

Always using a stiff batten for a fair curve, it is possible to narrow the bulwarks amidships, and even to shrink the beam at waterline 1. Waterline 2 is so tight a curve, needing to be drawn with a more flexible batten than bulwarks and waterline 1, that one cannot fool around with it at all, or so we judge.

Thus the drawing shows the extreme inner and outer angles at which the midships section might have been built, always assuming that the reported length of the ship is more or less correct. This seems likely on general principles, as a heavy traditional sailing ship's beam is very often about a third of the length overall.

Still it must be remembered that this section is purely speculative, based indeed on the fair curves of the lines, and that we do not know precisely where the keel was in relation to the planking at this point.

mum beam ratios. Aegean cargo carriers, ancient and modern, are all approximately a third as wide as they are long, or narrower, and there is no evidence that this ratio in this type of cargo carrier has ever much exceeded 4 to 1.

We are convinced of the accuracy of the model as a reconstruction of the after end of the ship before it fell out of shape. If the model is accurate, as it must be, then the curves the wales naturally take must lead us to somewhere near the midships section (Fig. 17). The width here comes to about 10·60 m as reconstructed, which is not to say that this is necessarily exact. The width could vary a little, but not, we think, very much.

The account of Salvatore Garifalo of Pachino, who was the mechanic in charge of the pump which kept the ditch dry for the bulldozer when the wreck was found, should be considered. Garifalo describes how the bulldozer struck wood, and has a clear memory of what must have been the stem post being ripped clear by the bulldozer. Garifalo's recollections, the pieces left scattered afterwards, and the excavation itself illustrate that what was originally *in situ* was the stem and stern of the ship, and the starboard side down to the waterline wale.

The width of the ditch, and Garifalo's clear recollection of the location of the stempost in relation to it, indicate that the overall length of the ship on deck without projections was about 30 m. This estimate fits the projection from the model very nicely. We have therefore made our tentative reconstruction of the ship as follows:

LOA 30·30 m
LOD 29·45 m
Length of keel 23·20 m

Minimum possible draft light, 1·50 m; maximum draft loaded, 3·50 m; gross tonnage between 400 and 500; seagoing cargo capacity over 300.

It will be seen from our reconstruction drawing (Fig. 16) that the lines as shown must be reasonably accurate from the stern to section 6, and that by logical deduction they must continue, at least above the waterline, to the assumed midships section. This section is obviously crucial to the reconstruction. (Note that we have included several alternatives.) If it is incorrect the rake of the stempost must move out, i.e. forward, rather than aft.

It will be seen from the line drawing that section 6 cannot be narrower than drawn and keep its fair curve. (See note on section 6, Fig. 15.) We would not wish to claim that our conclusions about the size and shape of the Pantano wreck are other than well worked out assumptions.

We feel that we have much to learn about such reconstructions but that if we wait to publish this material until we are absolutely sure of the complete accuracy of our assumptions, it may never be published.

The missing bow and side

Returning to Garifalo, we include the notes of our several conversations with him, that the reader may draw his own conclusions. He seemed a good example of the best sort of Sicilian workman—tough, cheerful, very willing to help if it meant no trouble to him. He was nearly illiterate and had never been out of Sicily, but impressed me as an intelligent, observant, and capable person.

After describing how the bulldozer had struck the wood, he described what I believe must have been the stempost, and then made a sketch with no prompting from me. The accompanying drawing is taken directly from Garifalo's sketch in my notebook (Fig. 18). He says that the wood was pine. I believe that the hole was for the forestay of the artemon.

Garifalo's most startling discovery was a plaque with Greek letters and a horse's head above the letters, about 1·20 m long, attached to what must, from his description, have been a wale. I asked him if he knew Greek. He replied that he knew nothing about Greek, but that he remembered some of the letters. He described the plaque as being 'metallic and banana coloured'. Could this have been gilt? He said it burned when it was put in the fire.

He tried, without me, to draw the letters he remembered:

ΣXC

I then made some experimental combinations of Greek letters in the notebook, attempting to work in such a way that he would not be influenced. It was obvious that

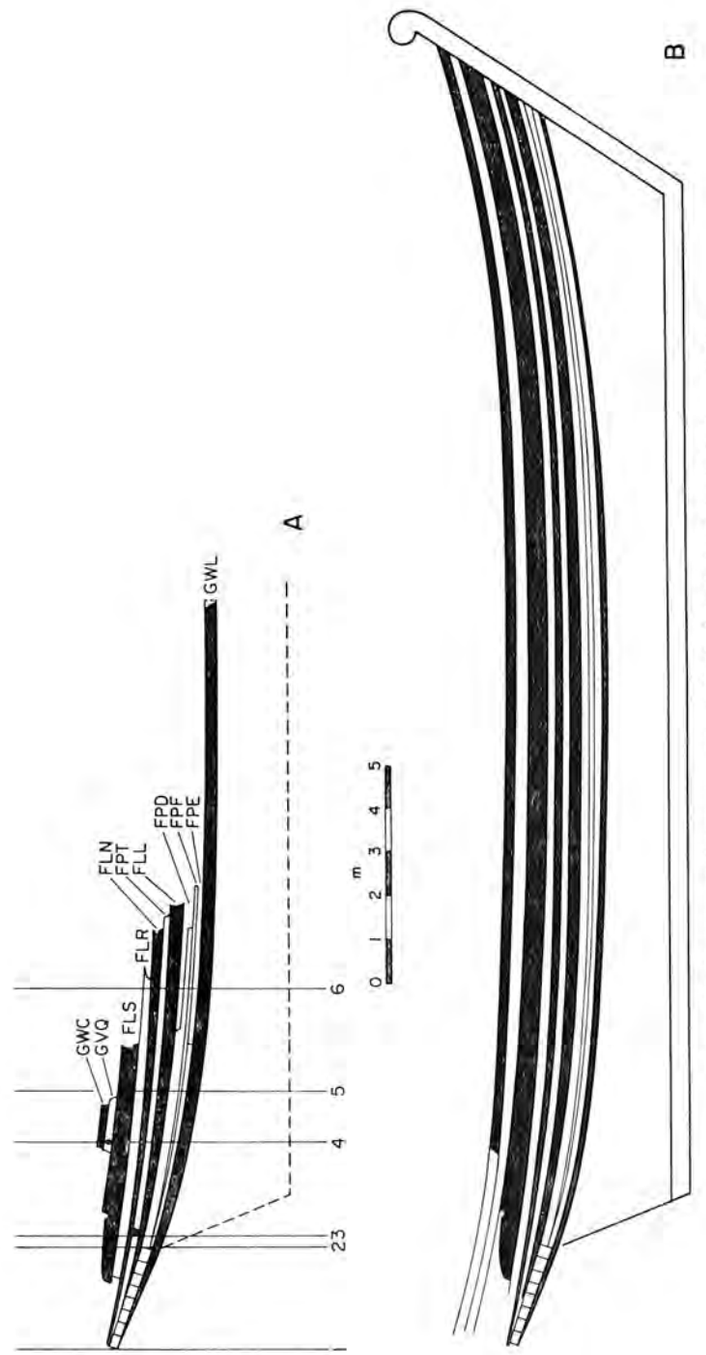

Figure 18. Reconstruction incorporating Garifalo's sketch of missing bow section.

at some point in the conversation I began influencing him, though I tried hard not to do so. In any case, I tried to get him to remember the sequence of letters by taking a page for each letter, and writing it in the left hand margin, thus:

Σ ϕ X
Σ ϕ X
Σ ϕ X
Σ ϕ X

I then asked him if he remembered the sequence. He went to the page I had filled with thetas, apologized for not remembering the theta, and wrote ϕΣHCU saying that what he had remembered as an X was actually an H. There were, he said, five or six letters, he was sure of that. He had another go and this time got ΣUϕH. He then experimented with ⍾ ⍾ and recognized ⍈, immediately when I wrote it for him.

It may or may not be useful to attempt to reconstruct Garifalo's memories of the name-plate he burned in the ditch. It is in any case an amusing pastime, and I have shown my notes to several scholars whose competence in Greek is undoubted. Dr Peter Green favours

ΣA⍈ϕΩ
ΣA⍈Φō,
⍈ΣA⍈Φō,
ΨA⍈Φō, etc.

[ΣAHΦΩ
ΣAΠΦO
ΠΣAΠΦO
ΨAΠΦO, etc. *Ed.*]

However, with enough manœuvring, he and I also produced

⍈HΓACOC
⍈HΓAΣOΣ.

Dr Frank Walton favours

ΘHCEYC.

As my knowledge of Greek leaves much to be desired, I propose no opinion, except that I am truly convinced that the mysterious piece of banana coloured wood was the ship's gilt nameplate, that it indeed had a small horse's head above the letters, that there were about six Greek letters and that there is little question about the Σ and the C. For the other letters, ϕΘH⍈ and Ω are all likely candidates.

It is possible of course that Garifalo wasn't speaking the truth, but as he was perfectly honest in his other dealings with us, as other information of his which could be checked was reliable, and as he is intelligent and observant, although uneducated, it seems more logical to believe him than not.

One fact will affect eventual interpretation of Garifalo's information: inscriptions on Roman lead anchor stocks (there is a large collection at Syracuse and in the Palermo museum) seem to be the names of ships and of gods. They are often misspelled.

Small finds

The ditchdiggers found a 'porcelain pot which shattered into small pieces'. There were several sherds of late Roman pottery under frames, which we thought were *in situ*. None of them was large enough to draw, and the colour of the clay had been affected by the corrosion of the nearby iron. They were all of combed ware amphoras similar to the globe amphoras of Yassi Ada. Several experts have seen these sherds and agree that they are typical late Roman-early Byzantine fragments and are not datable with more accuracy. They do fit the C-14 dates which indicated (kn-129) AD 500 ± 120.

Dating

The best possible evidence for dating is the construction, which seems to be in the same tradition as the early 7th century Yassi Ada ship. Although later evidence might well prove me wrong, I would date the loss of the ship to sometime after AD 500, with the remote possibility that the ship could have been lost just before the Arab invasion of Sicily. The best 'guess' is, I think, perhaps AD 600–650, which fits the sherds, the construction, the C-14 date, and the historical data.

Conclusions

Most Roman and late Roman ships appear to have been double ended, and the Pantano wreck is the first ship excavated which has a transom stern. It seems likely that the heavy beams which sat on the waterline wale and extended aft from it were designed to support a large after cabin, like the 3rd century AD

example shown in Casson (1972: pl. 154), (Fig. 19).

The Pantano ship probably came from the east, as cypress and pistachio wood are more typical of Aegean construction than of Italian. For instance, *Archangel*, the sailing perama that we used at Torre Sgarrata (excavation of a Roman shipwreck) was built of cypress on mulberry wood frames. It seems likely that she was manned by Greeks, as she certainly had a Greek name. She was a large ship, with shallow draft for her size. She was undoubtedly seaworthy, but not so efficient to windward as other types of late Roman ships, like the Yassi Ada ship or the Mahdia ship, which had steeper floors.

Carpentry work is definitely transitional, a step between the beautifully built, copper-fastened, full tenon ships of the empire, and the 'frame first' carvel built caulked ships of medieval and modern times. The pistachio wood tenons are vestigial. Like those in the Yassi Ada wreck, they are set in large mortices quite far apart (at the Pantano, at intervals of about 1 m), and they are not held in by treenails. This must be because they functioned only as a convenience to the carpenter in setting up the immersed part of the hull by the 'shell first' method.

Figure 19. Roman mosaic from Mostra Augustea showing what the Pantano ship's stern might have looked like. Photo: Alinari. Courtesy of Prof. Casson.

This technique has been well described by Van Doorninck and me (Bass, 1972). The only student who has objected to this theory is Lucien Basch (1972). Some of his conclusions may well be correct, although my own experience with wrecks and modern yards leads me to disagree that Classical and early Byzantine vessels were other than shell first constructions.

Here at the Pantano it seemed clear that the immersed part of the hull was built shell first. The shell planks which survived, i.e. those under GWL, were tenoned. As these tenons were loose, in largish slots, at generous intervals, their only function must have been to hold the shell together as it was set up and faired.

Once the shell was set up and faired, the frames, floors and futtocks were installed, and were bolted in place. Once the structure was strong enough to hold it, the waterline wale, GWL, was worked into place and bolted through onto the frames. Building from GWL up must have proceeded in a logical sequence. The most logical, perhaps, would have been to install the uppermost wale GWC next, and plank work towards the middle. In section 3 we get an idea of how this was done. After waterline wale GWL was in place, the carpenter slotted transom timber FLH to take on planks FPD FPF FPE and their lost companions. It may be that wale FLL was installed before frame GXB (Figs 13 and 14), as GXB seems cut to fit FLL rather than the other way around. In any case, small wale FLN was then installed on top of GXB serving to lock GXB in place. We presume that a number of frames along FLL were through frames like GXB, and locked in place by FLN.

The lowermost wales came together in a fair shape under the transom. These must have been above the waterline, when the ship was in harbour, but often immersed when the ship was running. As the transom was at an angle of perhaps 30° from the waterline,

following seas would have caused the stern to rise.

The massive transom would have formed a very strong support for the steering oars. The ship cannot have had a rudder, as there is no place for a rudder post.

The most interesting aspect of the ship's construction is the use of through beams like GXM (Figs 20 to 22), and frames like GXB, which passed across the wales, at what must have been fairly frequent intervals (although we only found two, and evidence of a third, because so little of the ship remained). The whole structure of the ship formed something like a box girder, which gave the ship great longitudinal strength. This concept of a ship as box girder does not seem to have been thought of again until Brunel built the *Great Western* in the early 19th century.

This system of wales, although it died out in the west, has survived in the Orient. Worcester studied a Foochow pole junk just before World War I, and it seems to have had remarkable similarities with the Pantano ship. She was 150 ft (45 m) long by 30 ft (9·0 m) wide, considerably longer than the Pantano ship but about the same width. Worcester wrote (1947) that

> 'Longitudinal strength is provided by three enormous hardwood wales which, lying close together and following the curve of the bilge throughout, also serve as bilge keels, as they are placed so low on the hull that, except at bow and stern, they are at or below the water line, according to whether the junk is light or loaded. Three lighter wales or strakes are situated at and above deck level at varying intervals . . .'

This sounds very like the Pantano ship, with her three heavy and two light wales along each side and her big skeg, which seems to resemble the skegs on Chinese junks.

The manner in which the Pantano ship seems to have broken up also illustrates the faults inherent in such a structure. The ship broke longitudinally at the waterline wale.

Figure 20. Beam GXM *in situ*. Its inner end has been cut off in antiquity. The timber above the beam was a wale, which perhaps ran along the side at deck level.

Figure 21. Beam GXM from the inner end. Note supporting timbers put in on top of inner stringers and lining of hold. These riders were bolted through a lower wale at an angle to the frames. On the left next to the hose, note another pair of riders, probably for a beam now missing.

The men who originally found the wreck say that they saw the whole starboard side, including the stempost, but are certain that nothing existed below the waterline wale.

Figure 22. Beam GXM after removal. Slot in side fits filler planks. See Fig. 20.

This means that the ship, probably heavily laden, might have struck on a bar off the beach trying to make the existing harbour, and broke in two. The bottom, cargo, and port side probably stayed on the bar. The starboard side broke off in one piece and washed ashore, to be covered up by sand and lie intact for us to study, 1300 or so years later.

Problems

This excavation, in a remote part of Sicily, poses several very serious problems.

The wood, after having been removed from the site, was put into Francesco Spatola's irrigation tank, where it could soak in fresh water until we could remove it for preservation.

Optimistically, we imagined that we would find funds for removal of the wood to permanent storage tanks where it would be intensively studied. The excavation had in any case to be made, or the ship would have been altogether lost during the construction of the drainage ditch. (There was a possible third alternative, that of the site having been marked by the Italian Archaeological Service as an archaeological site, stopping the reclamation project by Mr Spatola, and doing nothing to increase the already minimal goodwill between the country people who find archaeologically important objects and the Archaeological Service who must deal with recovery, rewards, and restoration).

Our financial optimism was not justified. We have tried very hard to raise funds for preservation and eventual display, small scale or large, of the Pantano ship, without any success at all. It is very much easier to find money for discovery and excavation than it is for preservation.

We hope this is a preliminary or interim publication, and that further research can be done when the wood is removed from Mr Spatola's irrigation tank. But it does seem quite clear that a wreck excavation of this sort should not, unless it is a case of complete loss of the wreck if not excavated at once, be undertaken without preparation (and funding) of storage and preservation facilities being assured before digging is begun.

There are many questions about the ship as we have reconstructed her. Yet, having resolved to follow the normal rules of ship construction drawings, we feel that free reconstructions are not in order. (See notes on the individual drawings.) We would be delighted if a professional naval architect would look at the original data and work over the lines.

Acknowledgements

We are indebted to literally dozens of people for help with the reconstruction. Amongst the many are Howard Chapelle, Curator Emeritus of the ship section of the United States National Museum, shipwright and builder in the grand tradition; John Sangarinos of Perama, in Greece, shipyard owner and master shipwright; Lt.-Cdr. James Griffin, RN Ret., Professor of Engineering of Gibraltar Technical College, who spent many evenings helping Joan Throckmorton work out the first set of lines from the model; Prof. Lionel Casson, for his editorial advice and interest; Michael Valtinos who spent many hours working on the model with Peter Throckmorton; Helena Wylde Swiny, who did the original measurements and drawings with Joan; and Joe Reinhard, who leapt the barriers of the Sicilian language to do much of the original triangulation survey.

We want also to thank the many sea people of several nationalities who have taken an interest in the ship and our problems in reconstructing her, not least the unknown (to us) fisherman who, passing by in the street outside where we were building the large and curious model, said in ripe *mankika*, 'Those silly foreigners, they don't know how to build a dinghy!'

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The Battle of Lepanto search and survey mission (Greece), 1971–72

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This search for the site of the Battle of Lepanto started in the summer of 1971, 400 years after the battle, at the request of Prof. Spiridon Marinatos, Director of Antiquities. Preliminary expeditions to the vicinity of the battle site (Bay of Patras, west of Mesolonghi and east of Oxia Island) showed the vastness of the area to be surveyed and the difficulties involved in ultimately pinpointing the wreck site. Five trips were made to the area, four in 1971 (June, July, September and November) and one in 1972 (18 May–17 June) (Fig. 1).

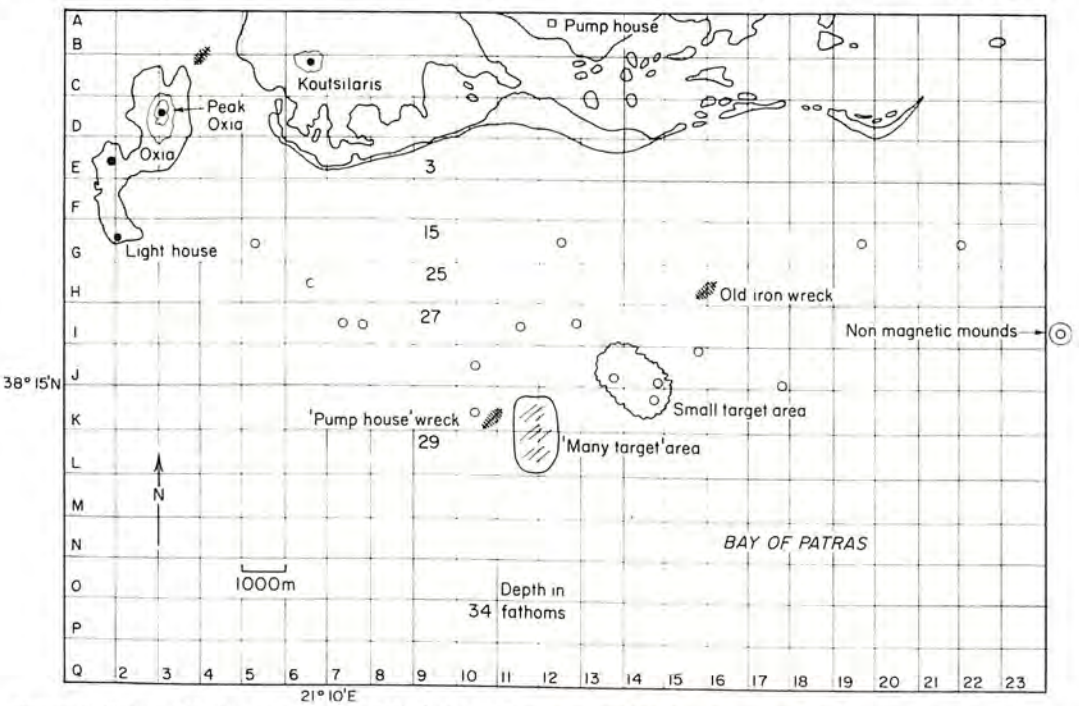

Figure 1. Map of the suspected site of the battle of Lepanto (1571) showing some of the many targets plotted with side-scan sonar. From U.S. Naval Oceanographic Chart 3962.

Figure 2. Chart of 1598 from the Gennadeion Library, Athens.

The battle took place on 7 October 1571, in the Bay of Patras, south of the mouth of the Acheloos river and the Koutsilaris Islands, between the Christian fleet, under the command of Don Juan of Austria, approaching from the west, and the Turkish fleet, led by Ali Pasha, coming from the east. That afternoon saw the greatest defeat, on land or sea, suffered by the Turks up to that time. The battle is well described by Lesure (1972) and Marx (1966).

The exact size of each fleet is uncertain, but the best sources say the Turkish navy had over 300 galleys and 80–90 auxiliary vessels with over 100,000 men; and the Christian fleet had some 300 ships and over 60,000 men.

Soon after the battle had begun, the Turkish right wing began to break, and eventually about 30 ships were driven into shallow water and ran aground. They were later plundered and burned by the Christians. The heaviest fighting took place in the centre, where the Christians lost about 12 galleys. The exact number of ships sunk in the battle is uncertain but it is said the Turks lost about 80 vessels, most of which were burned.

Almost all of the ships that went down were rowed galleys, of a design that had changed very little for over 2000 years[1]. They were long and narrow, usually about 120–160 ft (36–48 m) in length, and 15–20 ft (45–46 m) in width, averaging from 100 to 200 tons. They could carry a limited number (up to five in the bigger galleys) of carriage guns in the bows, and a few pieces of light artillery in the stern-castles. Most of the ships that were destroyed were either burned or shattered from collision. Because they had very little ballast, it would be unrealistic (although by

no means out of the question) to expect these ships to sink to the bottom intact, although it is not impossible that considerable parts of the wooden structures could be found preserved in the mud. Various metal objects, including light artillery, weapons, armour, chains, anchors, grappling hooks, and possibly some treasure, might be expected. The best area in which to look (see below) would be in depths of 150–200 ft (45–60 m), where a muddy bottom would help to preserve those remains not completely covered by the heavy silting from the Acheloos River.

One of the important problems which faced the Lepanto search and survey team was to determine how much the coastline of 1571 differed from that of the present. In view of the fact that the battle took place outside the mouth of Greece's largest river, the Acheloos, notorious for its silting, it would be quite reasonable to suspect considerable change in the geomorphology of the region over a period of 400 years. Thucydides (ii:102) describes clearly the silting of the Acheloos River.

Careful inspection of a series of maps found in the Gennadeion Library of the American School of Classical Studies in Athens dating from 1598 to the present, showed considerable changes in the shape or extent of the land over a 400-year period[2]. Several of these maps are reproduced for this report (Figs 2, 3 and 4). The inaccuracies of 16th to 18th century cartographers can readily be appreciated, and the maps must be examined with considerable reservation. A number of points, however, must be considered more seriously. In most 18th century maps, for example, the island of Oxia is either clearly marked or can be singled out among the clusters of small islands to the east and north of it (often called Curzolari Insulae, as in Figs 2 and 3). The islands which appear on these maps to the east are not shown as islands in any 20th

Figure 3. Chart of 1702 from the Gennadeion Library, Athens.

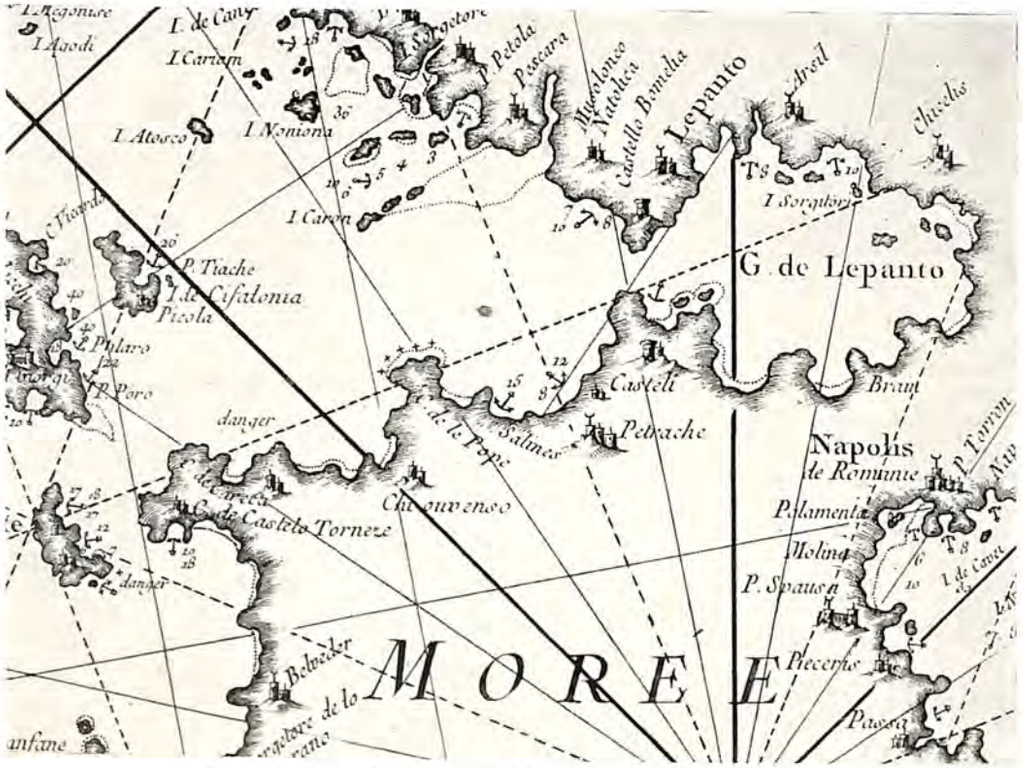

Figure 4. Chart of 1700 from the Gennadeion Library, Athens.

century map (see Fig. 1). They are mountains (Koutsilaris, Scoupas, etc.). Ancient mariners and cartographers could be expected to make sizeable errors in outlining the coastline of an area (especially if it was foreign to them), but islands would appear as islands on their maps. William Prescott (1881, **III**, 884) describes the Christian armada as it approaches the battle site: 'By sunrise they were abreast of the Curzolari, a cluster of huge rocks, or rocky islets, which in the north defends the entrance to the Gulf of Lepanto . . .'[3]. It is also obvious that the position of the mouth of the Acheloos River changed many times. Topographical and geological surveys carried out by engineers from Edok Eter, the company hired by the Greek government to run the giant reclamation project in the area, confirm this and the fact that the shoreline was once much farther north than it is now.

Further evidence for pushing the 1571 coastline back several miles will be shown on Fig. 5, which can be compared with a modern chart of the same region (Fig. 1). What follows is an explanation of Fig. 5:

1. Possible vicinity of the mouth of the Acheloos River in 1571. Core samples taken recently by Edok Eter engineers confirm that there was once sea in this area.

2. Ancient classical city and harbour of Oiniadae. Remains of the ancient harbour, including slips for the ships, can still be seen in the north of the island, now a mountain. The land to the north of it was said to have been swampy in Classical times, and that heavy silting from the Acheloos was occurring even then. (See Bury, 1927, 419).

3. Taxiarkhai. Remains of a Byzantine monastery nestled between the two south-east ridges of Scoupas (now a mountain).

4. Ancient Pleuron. A city famous in Mycenaean times, referred to by Homer (*Iliad*, 14.116., 9.529ff.) as 'Pleuron by the Sea'. Also active down to Hellenistic times.

5. Samples of sea-shells found (May, 1972) in this area, in irrigation trenches dug by Edok Eter.

6. Reconnaissance by hydraulic engineers showed that the mouth of the Acheloos was once here.

7. Old customs house. Probably used in the 19th century for ships coming into the mouth of the Acheloos when it was there.

8. Sonar and magnetometer search in this 'many target' area has shown a cluster of small deposits (could be cannon, cannon balls, etc.) in about 180 ft (55 m) of water. This is the most promising of the sites (see below), and is the prime target for future investigation.

9. Modern town of Aetoliken. Figured in Byzantine times as an important centre of coastal trade.

This map, the result of preliminary, and necessarily incomplete research, does not pretend to be totally accurate. It only intends to show that the coastline of 1571 was considerably north of where it is today. Only further research and careful geological investigation can produce a more accurate map. This was not necessary for the purposes of our search and survey work for the site of the Battle of Lepanto.

Because evidence suggests that the coastline of 1571 could have been as much as six miles north of its present location it was pointless for our survey team to look for the remains of the 30 or so Turkish galleys that were allegedly forced aground by the left flank of the Christian armada and then burned. Although the beach on which they grounded could have been in any of several possible places, one thing that is certain is

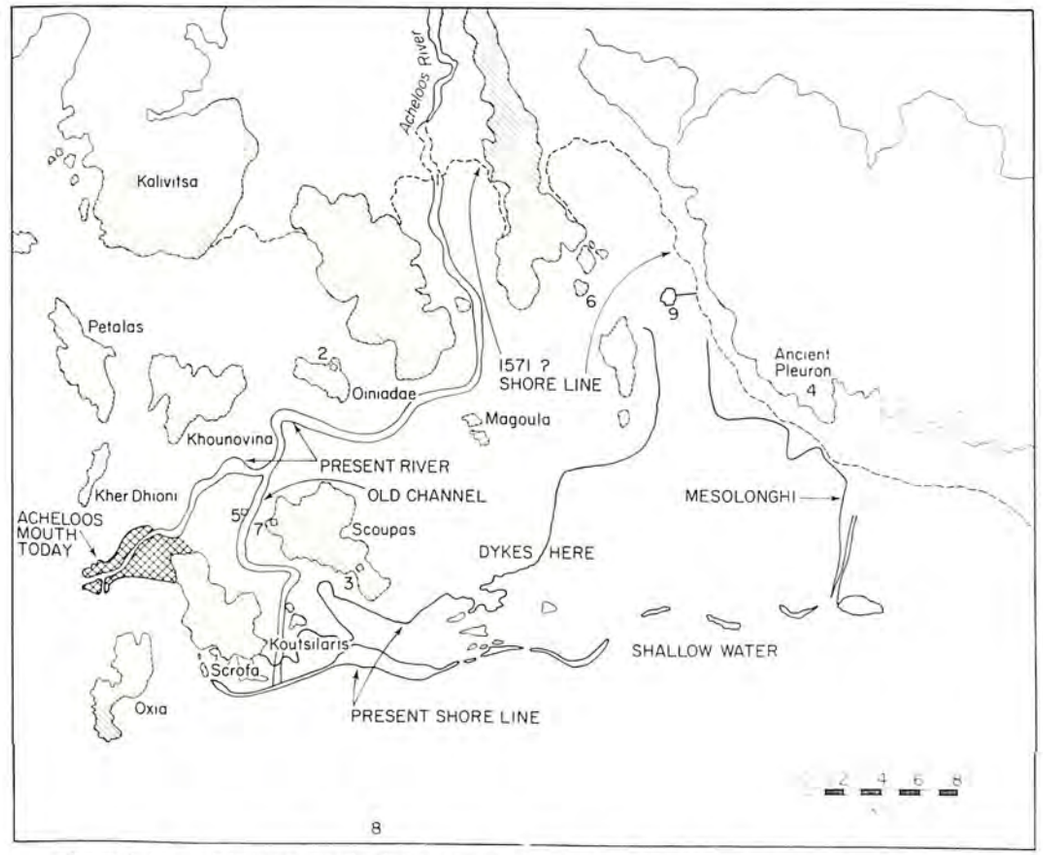

Figure 5. Map of Lepanto battle site with possible coastline of 1571 and present beach shore line.

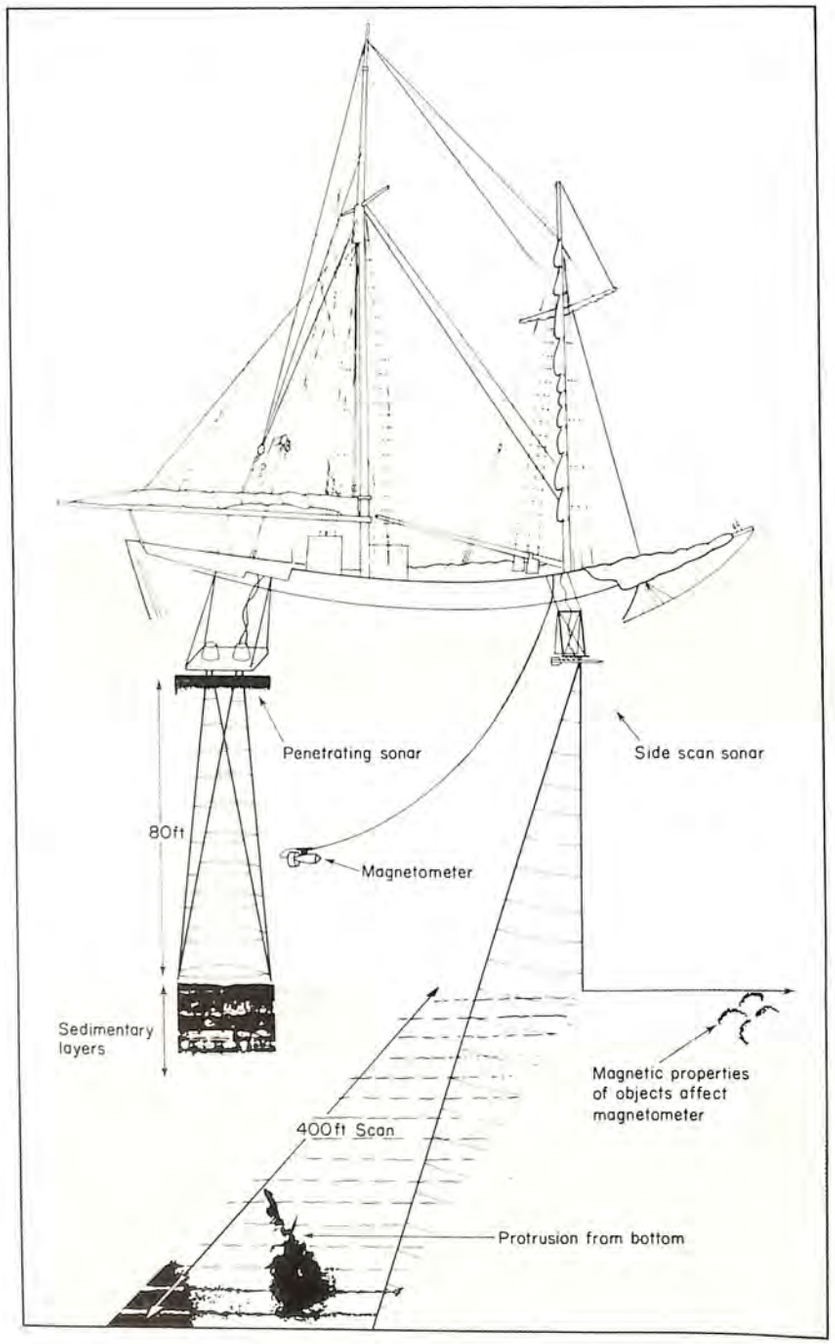

Figure 6. Diagram showing the equipment used on RV *Stormie Seas*.

that it was not on what is now known as the Louri, a strip of sandy beach to the south of Koutsilaris (Fig. 1). This beach, the present southernmost shore of the land mass in question, did not exist in 1571. Our attention thus turned to deeper waters, where the heavy silting from the Acheloos did not have to be dealt with.

Search and survey

An extensive area sprinkled with small targets that could be remnants of wrecks from the Battle of Lepanto has now been identified in the area south-east of Mt. Koutsilaris, in about 180 ft (55 m) of water (Fig. 5, no. 8, Figs 1 and 2). Numerous other modern wrecks and other interesting 'targets' were also located. The latter could be ancient wrecks, as they appear on the sonar pictures as shallow mounds. These mounds, of course, could also be of geological origin. No dives in the suspected area of the battle were made, primarily because of the depth and lack of proper diving facilities.

The survey work was conducted aboard the ship RV *Stormie Seas*, with an EG & G side-scan sonar, an EG & G 5 kHz penetrating pinger with recorder (Model 254), and an ELSEC Proton Magnetometer (Type 592) as the basic search tools. The side-scan sonar covers a 500 ft (150 m) field to the port side only. At 8 knots, the ship's top speed, an area of about one square mile could be explored in about one hour. However, most of the exploration was done at 4 knots in order to get records of better quality. The track of the ship had to be controlled so that nothing was missed and to prevent duplicate coverage of an area. Several methods for navigation were used. These included the use of hand-bearing compasses and the ship's compass coordinated with a pelorus, and were used from the deck of the ship to get position lines which then could be laid out on an enlarged nautical chart. It would have been more accurate to use shore stations with the transits, but haze, lack of sufficient personnel, and the distance from the shore made it impossible to do. A shore party had been sent a week ahead to the area to make a general reconnaissance and verify the exact bearings of the several points of reference (Oxia, Koutsilaris, pump house, etc.) which were to be used for getting the ship's bearings.

The accuracy of the navigation was found not only to be influenced by the reading of the hand compasses, but also by the heading of the ship and the position of the compass on the ship. A few experiments indicated that our position, at the furthest range in the worst case, could be $\pm$ 400 m. This fact should be kept in mind when the charts are to be used to refind the targets, especially the weaker targets that need to be relocated and investigated. This problem is known to exist since it was very difficult to refind several weak targets, in particular, the one due west of the pump house wreck. It is probable that there are other important targets that were missed due to navigational errors or equipment. These will show up when the critical areas are re-surveyed. It would then be most important that the ship's position should be plotted continuously on a chart to ensure complete coverage and all the information would be continually available.

The second acoustic equipment was used to penetrate into the sediments, This used a pulse of about 0·5 ms duration with a basic frequency of 5 kHz. Much interesting information about the geology of the area was recorded and many sub-bottom target features

Figure 7. The magnetometer chart on the ship's deck showing an anomaly picked up by the detector in the water.

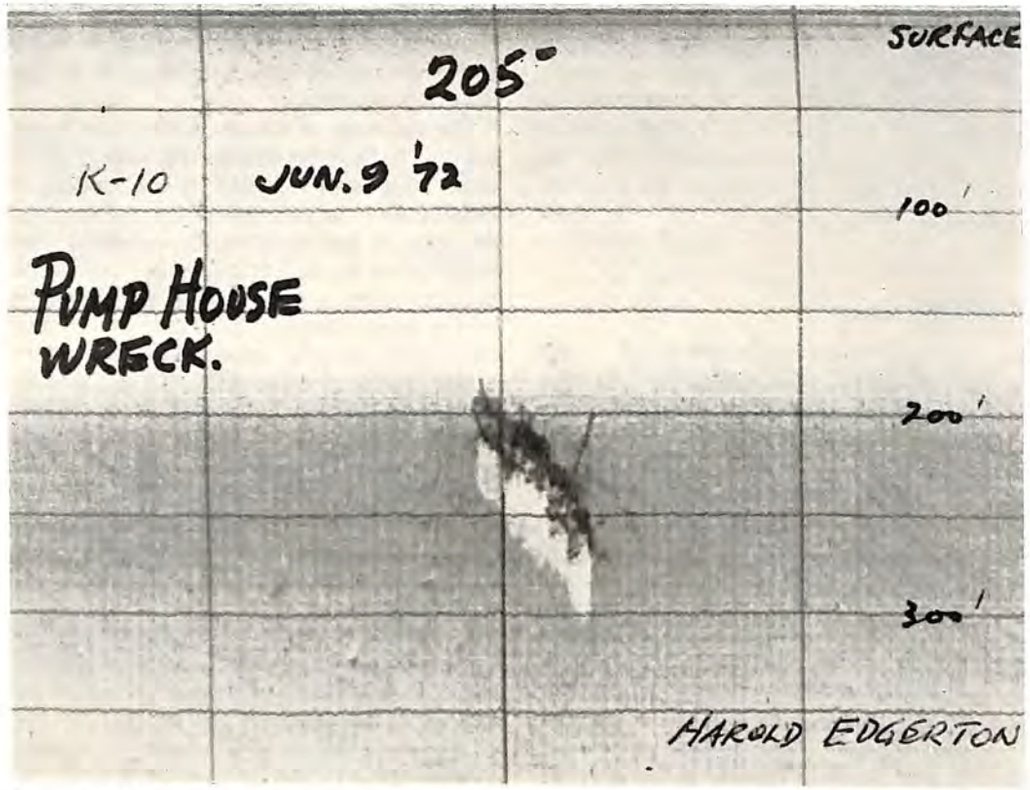

Figure 8. A side-scan sonar record of a modern wreck, directly south of the pump house. This wreck is thought to be a German escort vessel. Holes to the left could be bomb craters.

revealed, though many were too deep in the sediments to excavate at the present time. Not all the targets have been plotted on the chart.

The magnetometer, provided by Dr E. T. Hall of Oxford, England, was used to detect iron. This measurement is important, since many of the targets found by the acoustic equipment are of geological origin and of no interest to the project. The magnetometer makes it possible to reject these.

It was found that the magnetometer bottle had to be towed close to the bottom to detect the small amounts of iron involved. However, if the bottle touched the bottom, a false signal would be produced which was misleading. It was therefore necessary to exercise great care in interpreting the readings properly. Dr Don Frey, magnetometer operator for the 1972 expedition, prepared a table for a five-gamma signal, which was calculated from an approximate equation furnished by Dr Hall.

If a galley contained 1·5 tons of iron, the magnetometer must be 25 m from it for a minimum signal of five gammas. This calls for

Distance of the magnetometer bottle to the target (m)	Tons of iron in the target
10	0·1
15	0·33
20	0·80
25	1·6
30	2·7
40	6·4
50	12·5
60	21·6
70	34·3
80	51·2
90	72·9
100	100

the magnetometer to be close to the bottom for small target detection, and a distance of 3 m was achieved by allowing the ship to drift. Two runs over the centre of the 'many target' area produced significant signals which Frey interprets to indicate iron in the appropriate amounts. This strengthens the belief that the 'many target' area is part of the Lepanto battle site.

Navigational information on Figs 1 and 9 is sufficient to return to the areas of interest[4], but certainly acoustic devices will be needed again when diving commences. Because of the depth, which seriously limits the working time of a diver, the diving should not proceed until targets have been accurately buoyed. The diver should not be used as a search device since his bottom time is so limited.

Modern developments have made diving at depths of 150–200 ft (45–60 m) a practical possibility. This is the maximum practical diving depth for work with compressed air, and well across the threshold of mixed gas diving. Taken as a mixed gas diving project, the area is not excessively deep, but a serious diving project such as this, both time-consuming and costly, should not be undertaken before a preliminary investigation is launched to determine the exact nature of the contents of the target area. This can be done in any one of several ways: bounce dives with compressed air; use of a small research submarine (such as *Asherah*) with underwater television as an aid to the surface crew; bounce dives with mixed gases. Ideally, it would be best to use the submarine and the underwater TV with divers ready to make bounce dives on a site once it is pinpointed.

Conclusion

The purpose of the Lepanto search and survey project was to conduct a surface reconnaissance to locate the site of the Battle of Lepanto, using acoustic and magnetometer equipment. A map of 'targets' has been produced which showed promise as possible sites of wrecks from the battle. The next step is to go down to the bottom and investigate the cause of the signals.

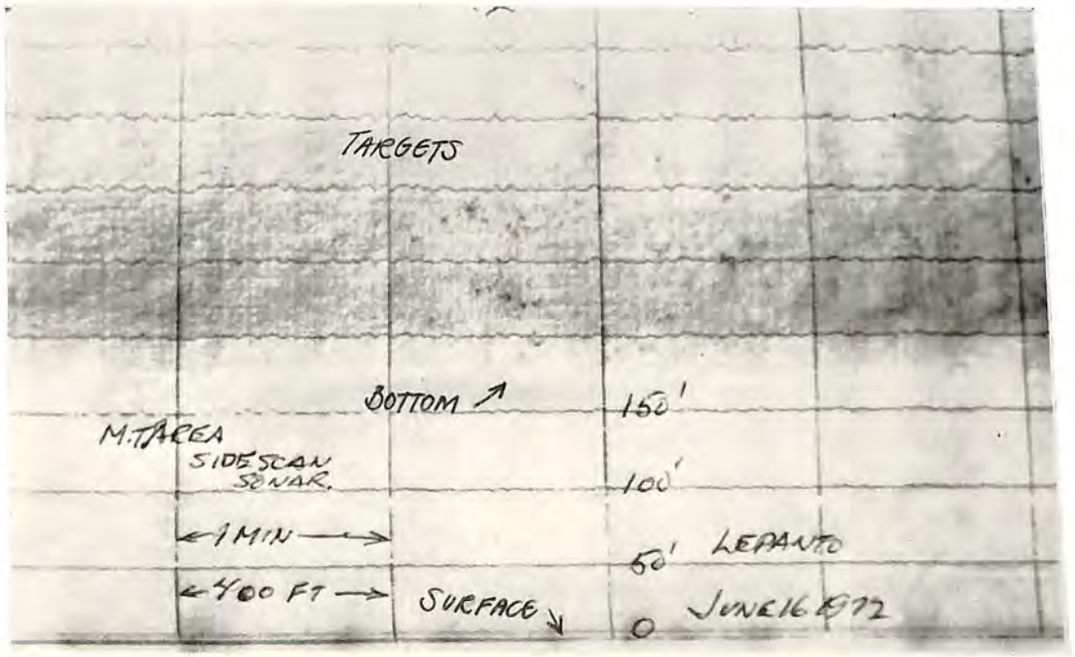

Figure 9. A side-scan sonar record of part of the 'many target' area which could be the site of the Lepanto battle.

Acknowledgements

We acknowledge with appreciation the substantial contributions of Dr Don Frey (magnetometer operator), Fred Feyling (charts and navigation), Derek Whitmore (ship work and navigation), Bob Sadock (sonar operator), Tom Hopkins (geologist and sonar operator), Joan Throckmorton and Pat Whitmore (many ship tasks), Tim Green (sailor), and many others who contributed to the running of the several expeditions. The interest and co-operation of the representatives from the Greek Archaeological Service, Harry Kritsas and John Papapostalou, are appreciated. Also, the support of the Research Committee of the National Geographic Society is gratefully acknowledged.

References

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Lesure, Michel, 1972, *Lepante: la crise de l'empire ottoman*. Paris.
Marx, Robert, 1966, *The Battle of Lepanto, 1571*. Cleveland.
Prescott, William, 1881, *History of the reign of Philip II*. London.

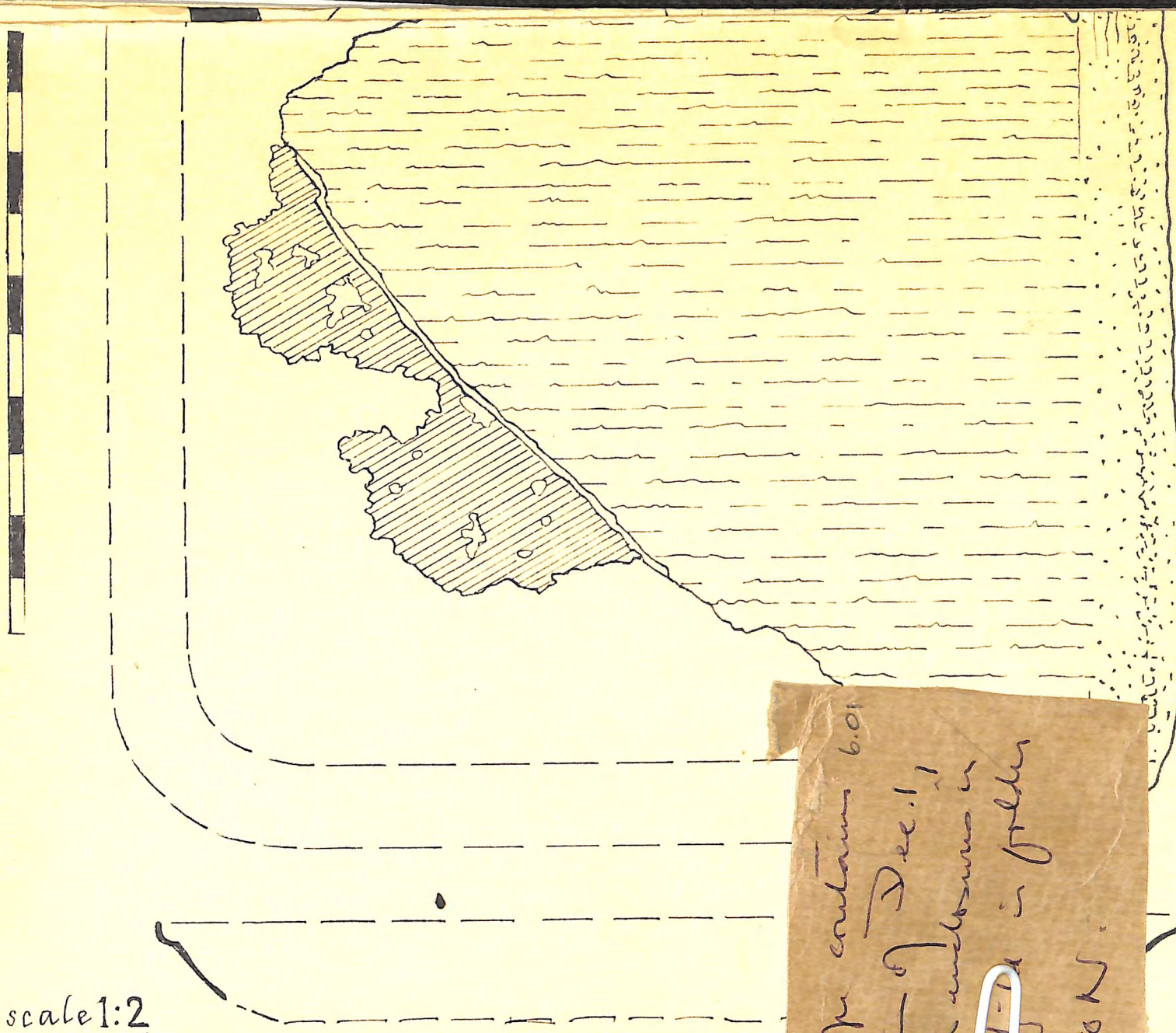
Notes

[1] For a description of the galleys of the period see B. Landström, *The ship*, London, 1961, 127–41. For further details on construction, iron work, etc., see Lane *Venetian ships* and *shipbuilders of the Renaissance*, Baltimore, 1934.

[2] The following is a brief list of maps in the extensive collection of the Gennadeion Library. In each entry the catalogue number is given first. The kind assistance of Mr Francis R. Walton, the librarian, is gratefully acknowledged.
GT 173. 2q. Muenster (a collection, c. 1598–1628). GT 230. *Maps of Greece* (a collection from 1700–19th century). GT 328. *The English Pilot: Pt. III, the Mediterranean Sea*, 1771. GT 225.6. Stieler, *Hand Atlas*, 1831. GT 271.9. Hellert, (a collection), London, 1844. GT 220.1. Kiepert, *Atlas Antique*, 1882.

[3] The 'many target' area (Fig. 5, no. 8). This is right in the area where it was suggested that the heaviest fighting took place, and the indications, many of which are undoubtedly wrecks, may be thought of as the 'dregs' of the battle.

[4] Figure 1 is a chart of the Bay of Patras, showing the modern targets found and navigational information from landmarks. Figure 9 shows the approximate position of numerous targets, some very small and weak, that should be investigated.



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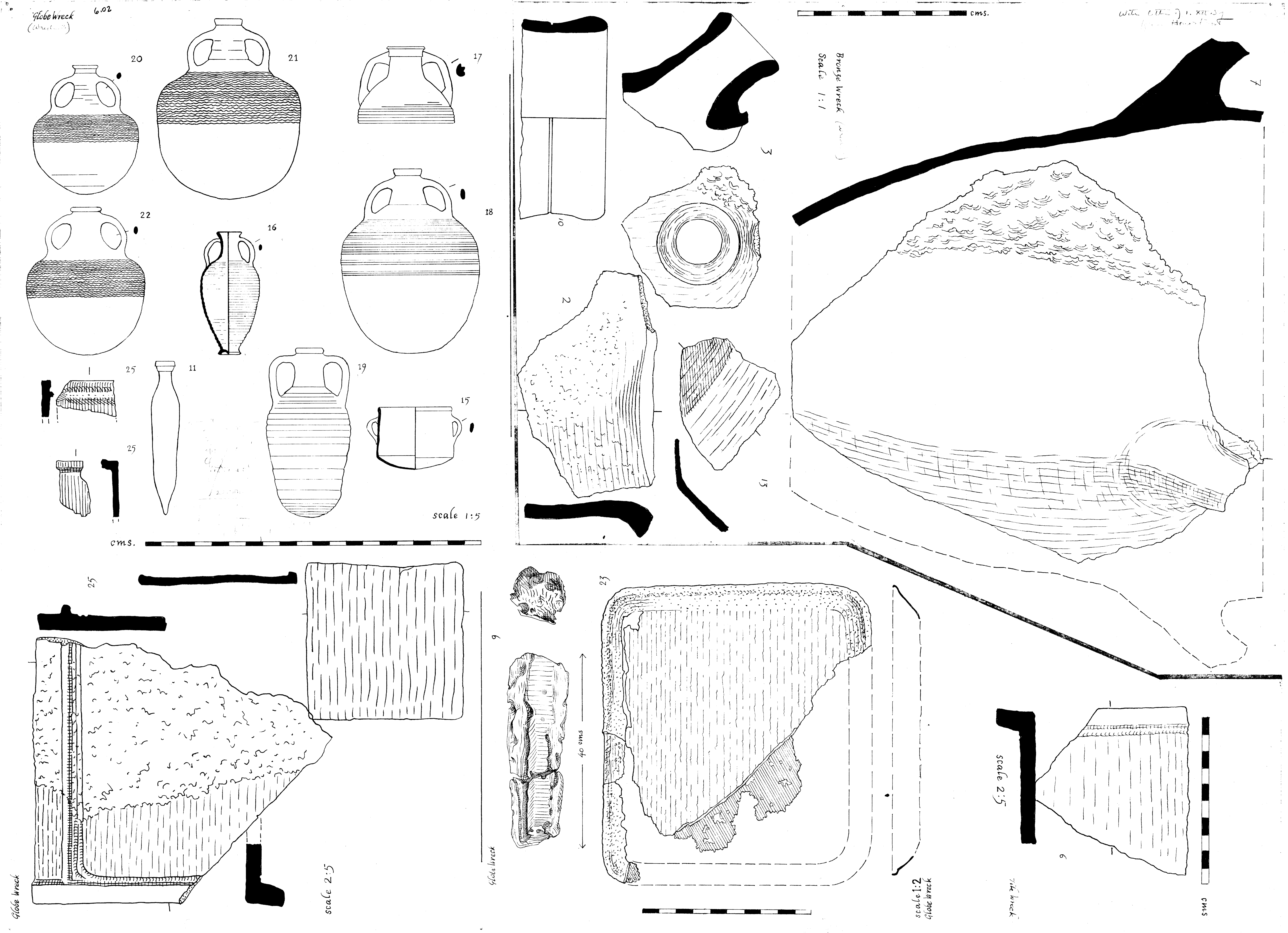

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Photo Mustafa Izmir

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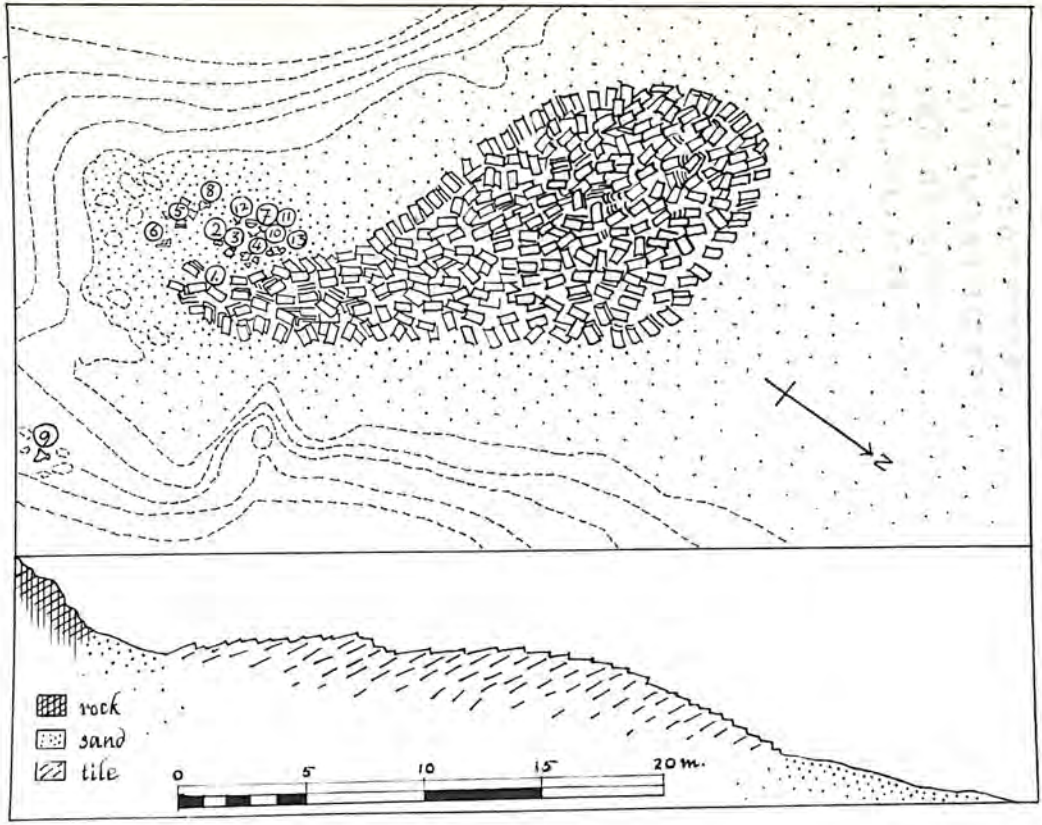
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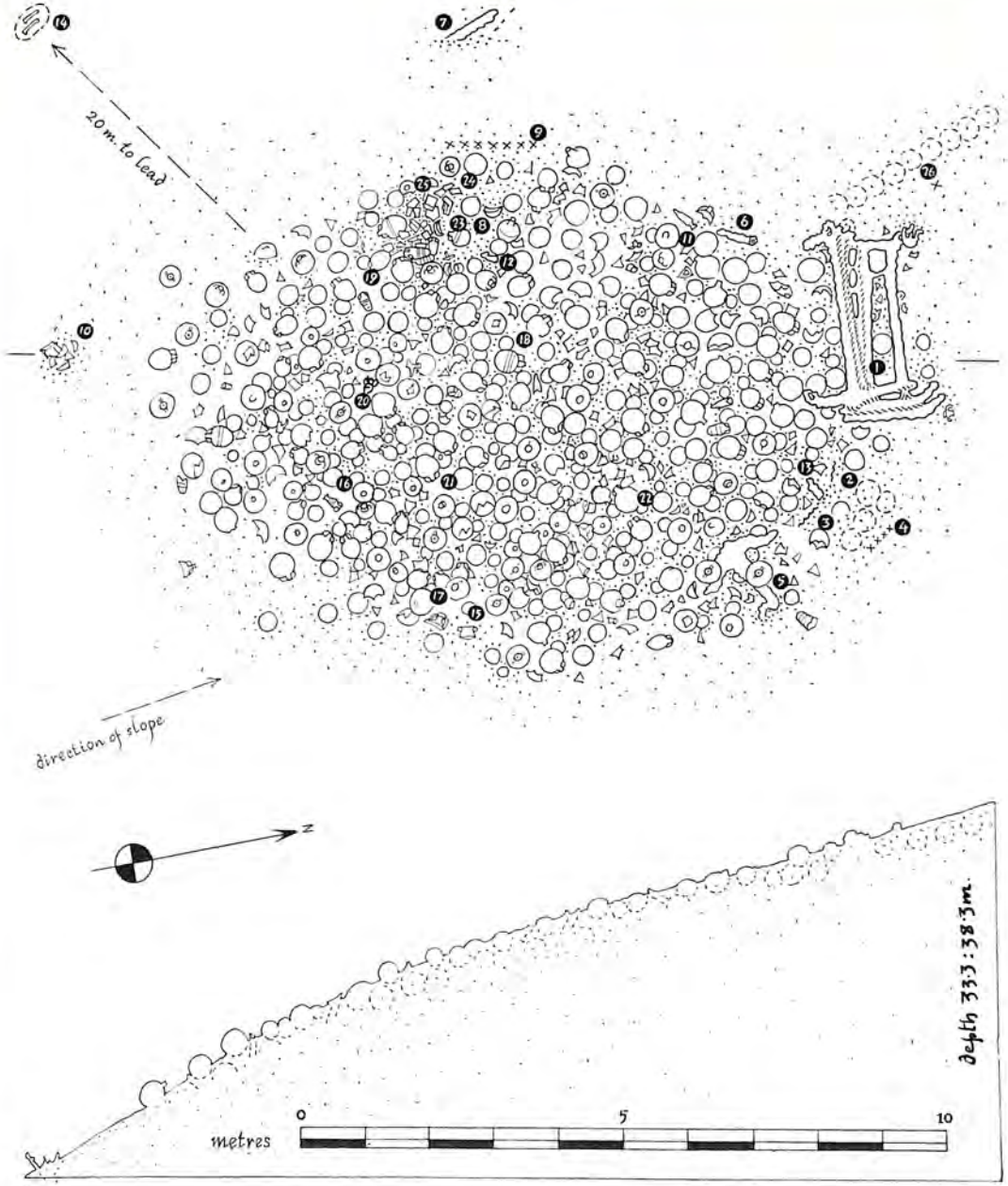
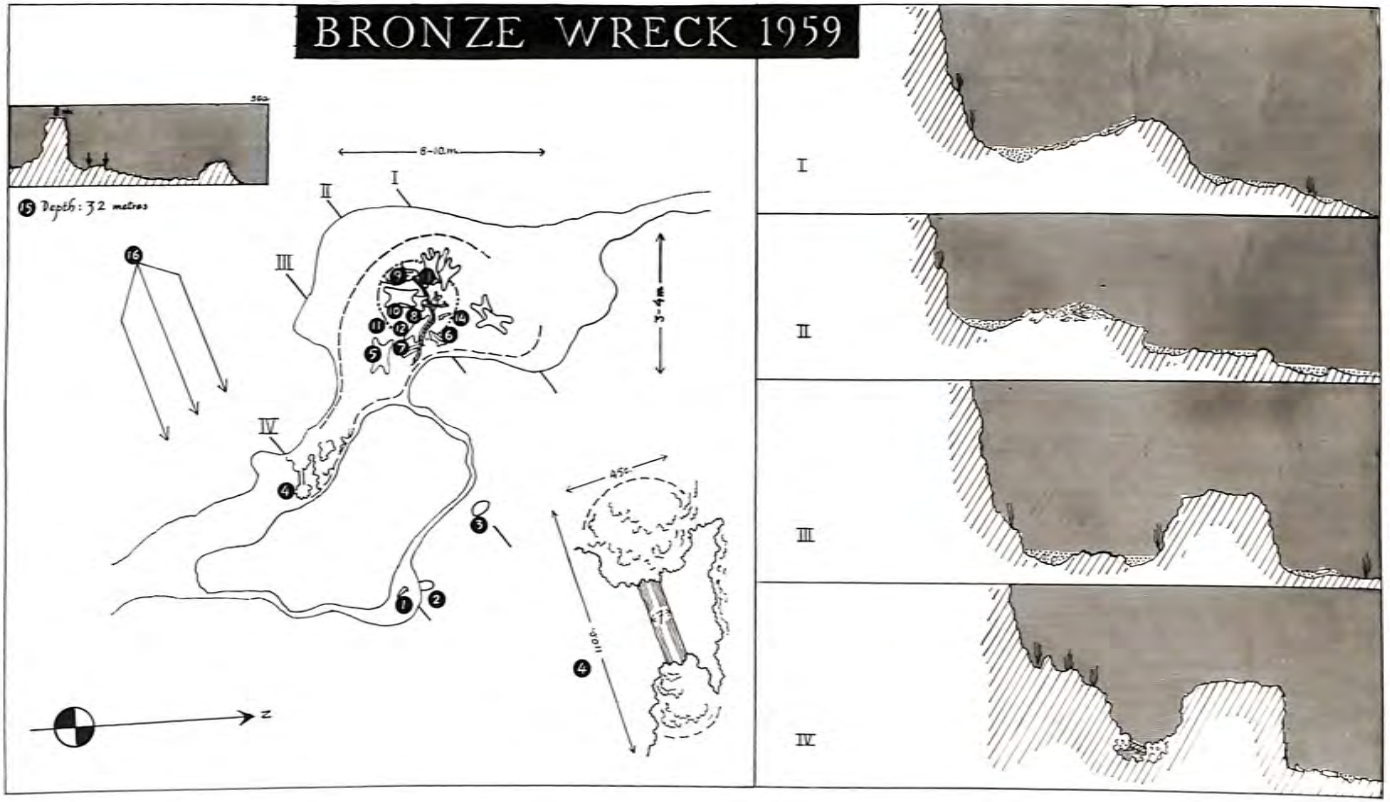


BRONZE WRECK 1959



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