BRONZE AGE SHIPWRECK SNAILS FROM TURKEY: FIRST DIRECT EVIDENCE FOR OVERSEA CARRIAGE OF LAND SNAILS IN ANTIQUITY

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ABSTRACT

Thirty-six shells of terrestrial gastropods were discovered in underwater archaeological excavations of a Late Bronze Age (3,300 years BP) shipwreck at Uluburun, southern Turkey. Four shells were not related to the wreck and belonged to local species from the nearby coast. The other 32 specimens were accidentally transported with the merchant ship, which had sunk when sailing in a counterclockwise route from the Syro-Palestinian coast via Cyprus to the Aegean and then to Egypt. The Near Eastern endemic *Xerocrassa langloisiana* and the common eastern Mediterranean synanthrope *Xeropicta krynickii* were found in amphoras originally containing terebinth resin, destined for Egypt. The combined ranges of the two species and the morphological record point to a narrow area near the Dead Sea, more than 50 km distant from the Mediterranean coast, as the harvesting locality of the resin. A second group of land snails, partly determined as *Xp. krynickii*, must have been on board the vessel under different circumstances, attached to spiny bushes used to cushion the heavy freight and to prevent the planks from being damaged. The finds provide direct evidence that land snails have been carried on ships for more than 3,000 years, and underline assumptions that human-based oversea dispersal of anthropochorous species in the Mediterranean has occurred since antiquity. The results also show how much can be done if we possess a detailed faunistic knowledge of species distributions and shell morphology.

INTRODUCTION

Many species of Mediteranean land snails are believed to have been dispersed oversea by humans in antiquity, for example to the Greek islands (Mylonas, 1984; Welter-Schultes, 1998a). The distributional patterns derived from the faunistic record lead to the hypothesis that these species were dispersed on ancient ships – an assumption for which direct evidence has never been provided. This is a report on the first systematic search for land snails in underwater excavations of an ancient shipwreck.

The remains of a Late Bronze Age merchant vessel which sank 3,300 years ago at Uluburun, southern Turkey (Fig. 1), were entirely excavated between 1984 and 1995 (Pulak & Frey, 1985; Bass, 1986, 1987; Pulak, 1988; Bass *et al*., 1989; Pulak, 1997). The major part of its extraordinarily precious cargo consisted of 11,000 kg of copper and tin ingots, to be used as raw material for bronze manufacturing, 1,000 kg of terebinth resin stored in Canaanite jars, and several large storage jars with pottery (Figs 2, 3). The cargo originated from many different regions, ranging from subtropical Africa and the Near East to northern Europe (Bass, 1987; Pulak, 1997). Important parts of the cargo, particularly the 10,000 kg of copper ingots loaded in Cyprus, suggest that the Uluburun ship was about to travel from the Near East to the Aegean, but that the final destination was Egypt (Pulak, 1997). The precise origin of many cargo components, such as the tin ingots and the resin, has previously been unknown.

It is believed that Bronze Age merchant ships such as the one at Uluburun plied the eastern Mediterranean in a counterclockwise circular route: Palestine-Syria-Cyprus-Aegean-Libya-Egypt-Palestine (Bass, 1987). Loading and unloading is expected to have occurred at many stations during the journey. The ships sailed relatively close to the coast. At Uluburun the vessel must have been surprised by a heavy storm that damaged the ship so seriously that it sank shortly after. Many personal items and valuable artifacts excavated from the bottom of the sea indicate that the crew cannot have had much time to leave the ship.

The wreck was discovered in 1982 by a local sponge diver in 44–52 m depth and at a distance of 60 m from the coast, a rocky promontory 8.5 km SE of Kaş, Vilayet Antalya (Fig. 4). It took eleven years and nearly 23,000 dives to recover completely the remains of the ship and its valuable cargo. The artefacts have been deposited in the Bodrum Museum of Underwater Archaeology, Turkey, where they have been documented and studied since then.

The number of known ancient shipwrecks in the Mediterranean is considerable (Parker, 1992), but land snails have never been found in nautical archaeological excavations before. Although insects, plant remains and other organic remains have been discovered in scientific excavations of ancient shipwrecks (Karklins, 1991; Haldane, 1991, 1992), shells of land snails remain absent from these inventories. For the non-specialist, land snails are generally difficult to distinguish from those of marine origin. This is the more so if gastropod shells are juvenile or semiadult. The Institute of Nautical Archaeology's (INA) excavation of the Uluburun shipwreck was the first underwater excavation to systematically screen for land snails. It was directed by C. Pulak, who recognized the potential value of land snails for the archaeological record. In contrast to most marine gastropods, many Mediterranean land snail species display restricted local ranges and gradients in their shell morphology, making it possible to determine their origins.

Distributional patterns of many species suggest that they must have been artificially dispersed in the antiquity. The zonitid *Zonites algirus* (Linnæus, 1758) must have been carried overseas

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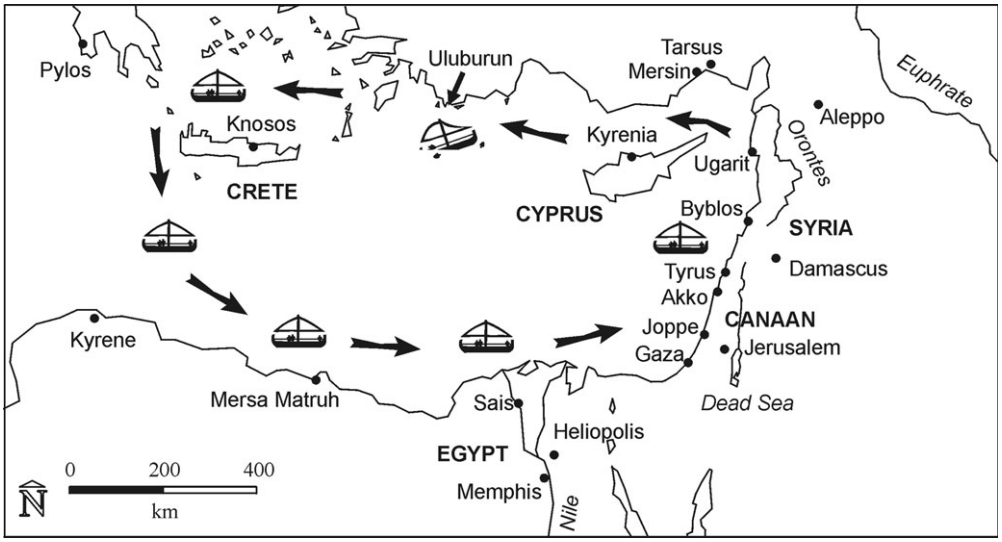

Figure 1. The eastern Mediterranean at 3,300 years BP in the Late Bronze Age. Arrows indicate the possible route of the Uluburun ship. It is believed that merchants plied the sea in a counterclockwise route between the highly developed Syro-Palestinian coast, Cyprus, the Aegean and Egypt.

from Greece to southern France, Italy and to Bergama (Pergamon) in present-day Turkey (Riedel, 1995). Among the land snails that were artificially brought to Greece are the zonitid *Oxychilus camelinus* (Bourguignat, 1852), the hygromiids *Xerotricha conspurcata* (Draparnaud, 1801), *Xeropicta krynickii* (Krynicki, 1833), *Xeromunda durieui* (Pfeiffer, 1848), *Trochoidea pyramidata* (Draparnaud, 1805) and *Cochlicella acuta* (Müller, 1774), and the helicids *Theba pisana* (Müller, 1774), *Helix aperta* Born, 1778 and *Helix aspersa* Müller, 1774 (see Hudec, 1973; Gittenberger & Ripken, 1987; Falkner, 1990; Hausdorf, 1990; Riedel, 1992; Welter-Schultes, 1998a). While there is ample evidence that living snails must have been transported, accidental carriage of empty shells probably occurred even more frequently.

With few exceptions, the wooden parts of a ship disintegrate quickly after such a disaster. When discovered, an ancient shipwreck site is recognized by the remains of the cargo. If land snails are found, it will be difficult to establish that they have derived from the ship's inventory. They also could have reached the site coincidentally on another occasion. The probability of such an intrusive element is enhanced if the species live on the nearby coast, from where they could have been blown or dropped by birds into the sea.

For determining which specimens could have lived in the adjacent coastal area, detailed faunistic knowledge of the species' ranges is a prerequisite. Unfortunately, many regions of Turkey and the Near East remain poorly known in terms of land snail species distributions. The present study suffered from insufficient data on the malacological faunas of Jordan, Syria, the Lebanon and southern Turkey. In these regions, local faunistic surveys and studies on local shell variation have not been published; detailed faunistic data only become available when new species and subspecies are described. Combined with the continuously decreasing number of specialists, the lack of published knowledge in this field is likely to prove a serious problem for future research.

MATERIAL AND METHODS

The material found at the wreck site was lifted by the INA staff between 1984 and 1995, its exact position documented and removed sediments sieved. Material from airlift spoils used to remove sediment was also sieved, although without accurate records. The contents of most amphoras were studied later. The excavated land snail shells were numbered in order of appearance. The age of the remains was detemined by the dendrochronological method. This was possible because fragments of presumably fresh-cut firewood or dunnage were excavated. The analysis suggests a date of 1306 BC, or some time shortly thereafter, for the sinking of the ship.

The species composition of the land snails discovered made it necessary to discount possible specimens that could not have been on board the ship when it sailed and which must have settled at the wrecksite coincidentally and by other means. Apart from some scattered records of zonitids (Riedel, 1982, 1985, 1995), *Albinaria* clausiliids (Nordsieck, 1993) and *Isaurica* helicids (Subai, 1994), partly based on 100–150 year old collection material, nearly nothing was known of the land-snail fauna of the region extending 30 km from Kaş to Demre, where the Uluburun promontory and the shipwreck site were located. To verify the exact species ranges in the Uluburun area, I collected land snails at 64 localities in a one-week survey in 1998, explicitely designed for this purpose, in the region between Kaş and Demre (Neubert, Örstan & Welter-Schultes, 2000).

RESULTS

The excavations yielded 36 land snails (Fig. 5, Table 1). They were discovered at 14 different locations at the wreck site (Figs 2, 3). Specimen 2 was sieved from an airlift spoil and its original location was not recorded. The other snails were well documented. They were either found loose as single shells at the wreck site (1, 13, 18), loose and in close proximity to other shells (clusters 3–12, 15–17, 19–22, 23–25, 26–27), as single shells in amphoras (14, 34, 35, 36) or as a group of shells in an amphora (cluster 28–33).

Thirty-five shells belonged to Hygromiidae (determined by B. Hausdorf) and one to Zonitidae. Twelve shells were determined to species level [1, 2, 18 = *Metafruticicola* species of Megisti *sensu* Welter-Schultes, 2001; 13 = *Zonites caricus* (Roth, 1839); 10, 14, 16, 17, 24, 27 = *Xeropicta krynickii*; 28, 35 = *Xerocrassa langloisiana* (Bourguignat, 1853)]. The rest were juvenile or semiadult shells and belonged to xerophilous hygromiid species (Table 1).

Based on the findings of the 1998 Kaş-Demre survey, the *Zonites* and *Metafruticicola* shells were demonstrated to have derived from the Uluburun promontory (Welter-Schultes, 2001). In particular, the *Z. caricus* shell must have come from

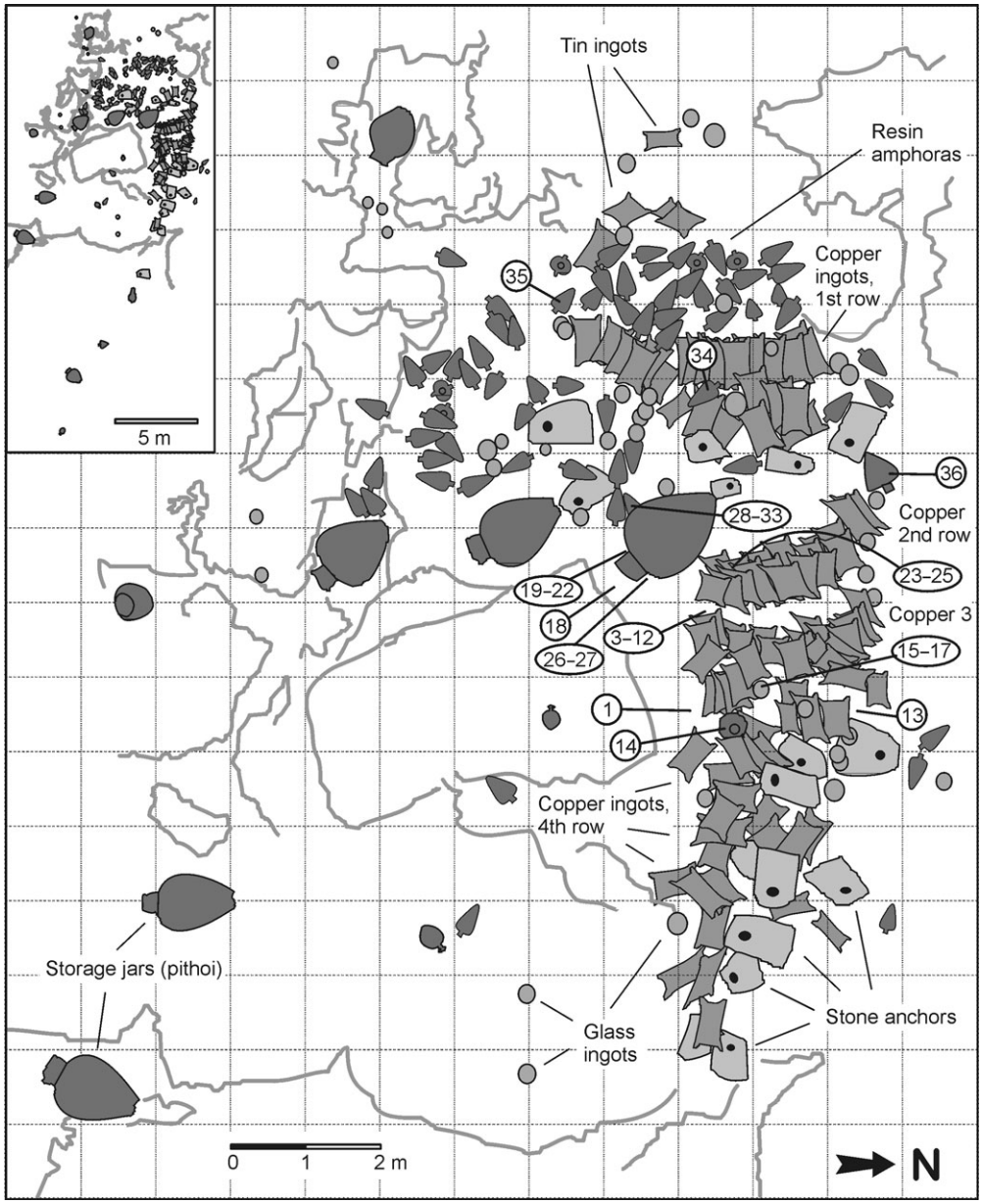

Figure 2. Excavation plan of the Uluburun shipwreck site (simplified after Pulak, 1997). Top is upslope (44 m depth, stern of the ship), bottom downslope (52 m depth, bow of the ship). Land snail locations are indicated (except specimen 2 which was sieved from airlift spoil). Insert map shows total extension of the excavation (the lowest artefacts were scattered down to 61 m). The site consists of sandy zones where the majority of the wreck settled, and rocky outcrops which yielded less artefacts. The structure in the centre is a large boulder.

a locality 0.8–1.2 km north of the shipwreck site, a result obtained by statistical evaluation of several shell characters displaying gradual variations over the species' range. The morphological analysis allowed the additional conclusion that *Z. caricus* is a polytypic species comprising populations of the synonym *Zonites beydaglariensis* Riedel. The *Metafruticicola* is a still unnamed (R. Bank, revision in preparation) endemic species of the region between the island of Megisti, Kaş, and approximately Kekova island (Fig. 4). A description of this species was given by Welter-Schultes (2001). It is by far the most common snail of the Uluburun cape region, followed by *Z. caricus* and *Albinaria anatolica* (Roth).

Specimens 1, 13 and 18 were found loose as single shells at the wreck site, without any other shells in their close vicinity. Another feature they have in common is that they were found at the margin of the excavation site (Fig. 2). Specimens 1, 2 and 13 were partially encrusted (Fig. 5), suggesting that they were deposited earlier than specimen 18, which was a relatively fresh shell devoid of encrustation. Specimen 18 shows typical tracks of a predator at the body whorl, presumably a bird.

For at least 10 km around the Uluburun promontory no xerophilous hygromiid species were found (Neubert *et al.*, 2000). At 30 km distance to the east, *Xp. krynickii* was found at Demre, where this synanthrope was restricted to some sites within the area of the modern city (Fig. 4). Several other artificially dispersed xerophilous hygromiids with quite similar juvenile shells were also found at Demre: *Trochoidea pyramidata*, *Monacha syriaca* (Ehrenberg, 1831) and *Cernuella virgata* (Da Costa, 1778). None of these species was found anywhere else in the region. No similar species lives near Kaş.

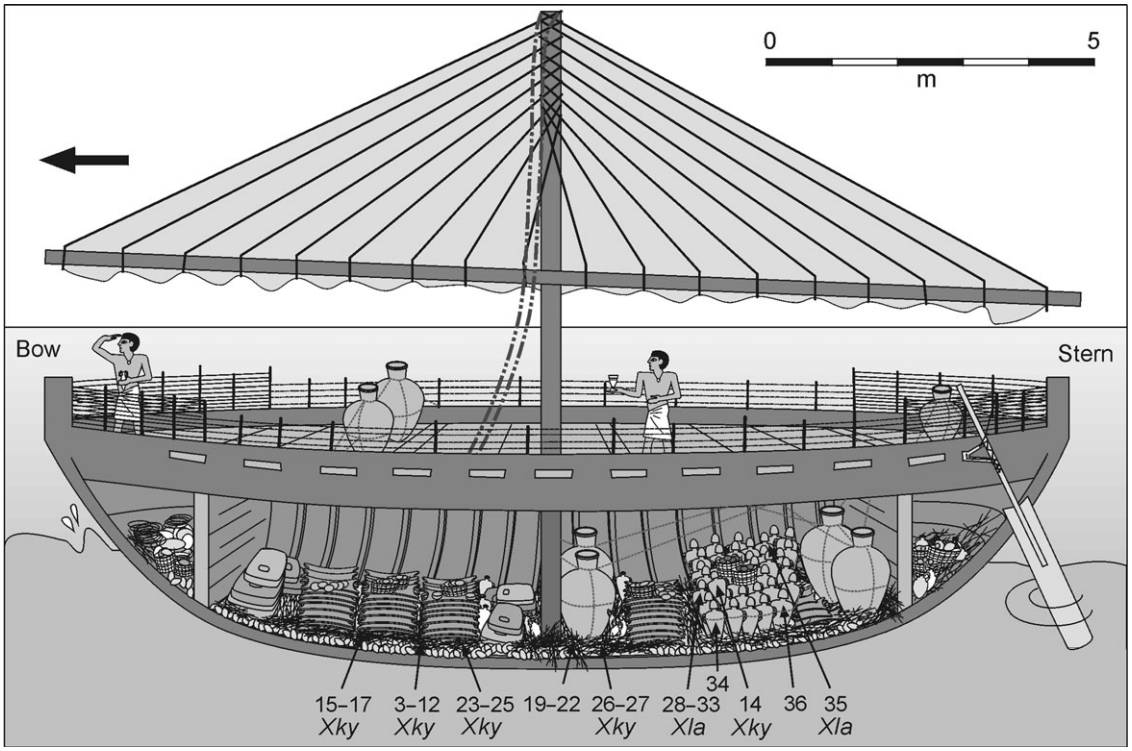

Figure 3. Simplified reconstruction of the Uluburun ship showing loaded goods and approximate locations of land snails during transit. Cargo compounds from bow to stern: technical utilities, stone anchors, 4th, 3rd and 2nd row of copper ingots, stone anchors, storage jars (pithoi), pilgrim flasks, first row of copper ingots, Canaanite amphoras with terebinth resin, tin ingots, storage jars (pithoi), various valuable merchandise. Xky – *Xeropicta krynickii*, Xla – *Xerocrassa langloisiana*.

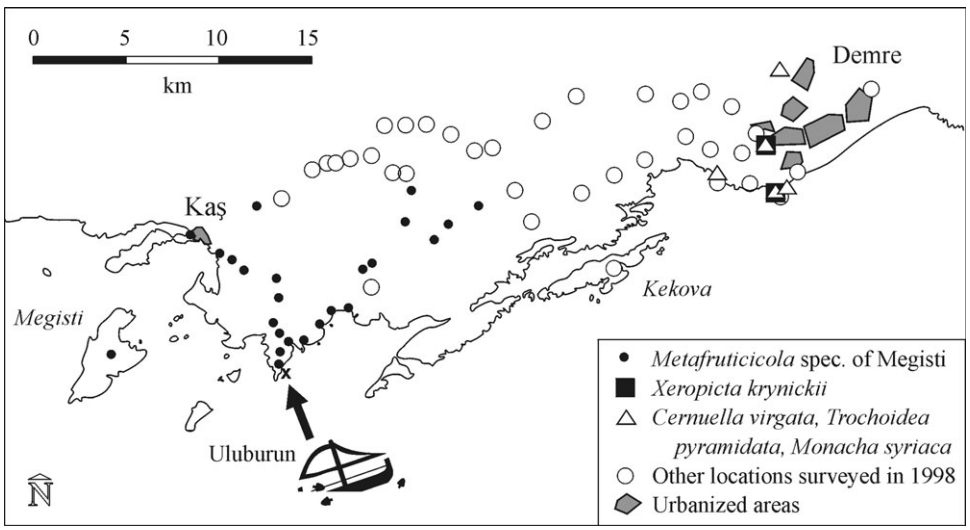

Figure 4. Vicinity of the Uluburun shipwreck site in southern Turkey with ranges of selected land snails and sampling sites of the 1998 survey.

Ten shells were found in five Canaanite amphoras originally containing terebinth resin. In four jars only one single shell was found, while one amphora yielded six land snails. Seven shells were unidentifiable juveniles, but specimen 14 belonged to *Xp. krynickii*, and 28 and 35 to the Near Eastern endemic *Xc. langloisiana langloisiana*. This subspecies is morphologically different from the parapatrically distributed *Xc. langloisiana improbata* (Mousson, 1861), which occurs to the north of the range of *Xc. l. langloisiana* (Fig. 6). Some resin was still adhering to specimens 14 and 35. Specimens 29 and 30 were very small and found inside shell 28, which was identified as *Xc. langloisiana*. The other *Xc. langloisiana* shell was found in a different amphora, the *Xp. krynickii* specimen 14 in a partly broken resin jar. Two other amphoras yielded one tiny juvenile shell each. The distribution of the cargo at the wrecksite suggests that most amphoras were stored near the stern (Fig. 3).

The five *Xp. krynickii* specimens that were found loose at the wrecksite came from four different locations. They were all found in close proximity to other shells possibly (in one case definitely) belonging to the same species. Their locations at the

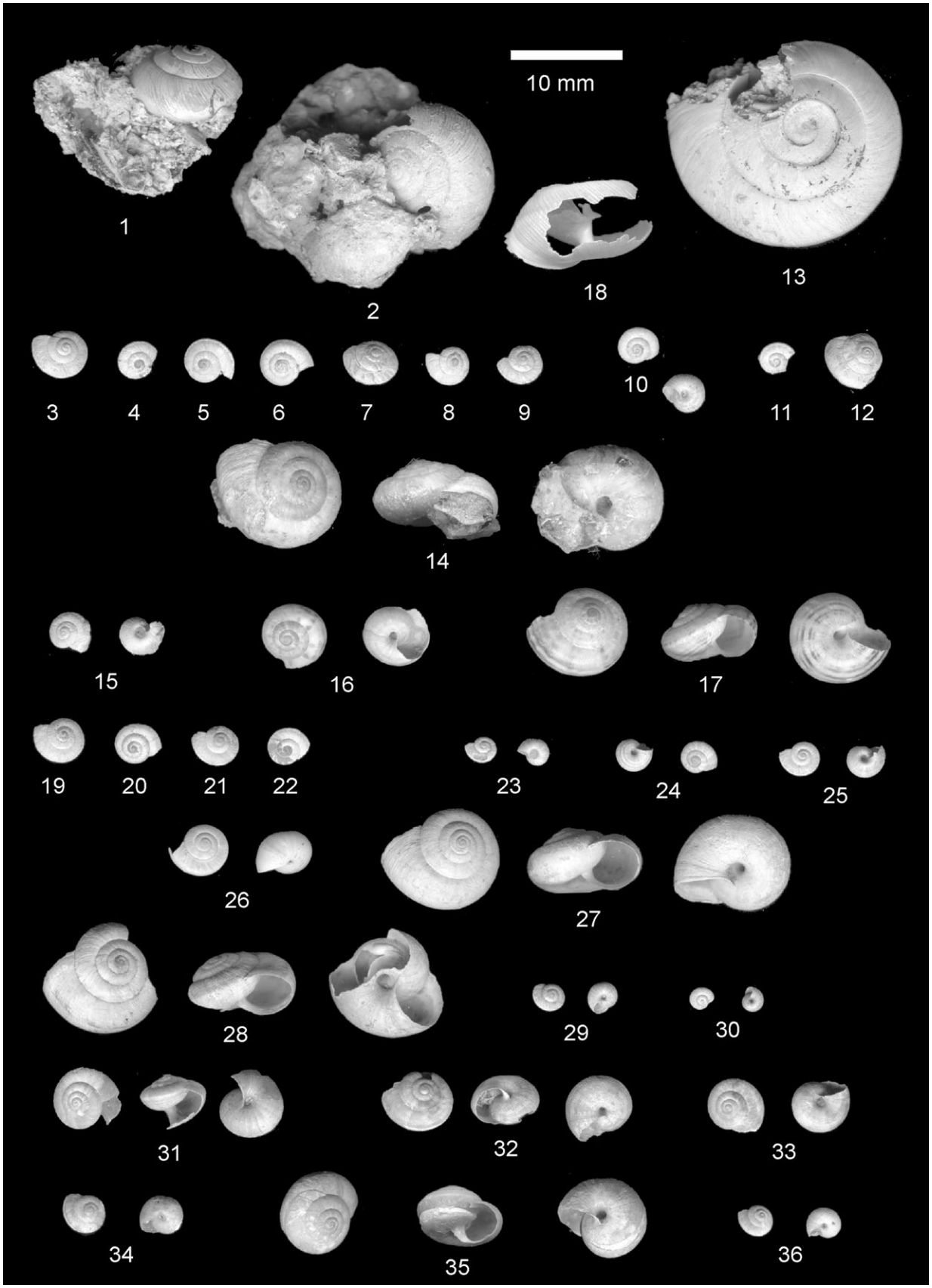

Figure 5. Shells of land snails excavated from the Uluburun shipwreck. 1, 2, 18, *Metafruticicola* species of Megisti; 13, *Zonites caricus*; 10, 14, 16, 17, 24, 27, *Xeropicta krynickii*; 28, 35, *Xerocrassa langloisiana*. The other shells were juvenile or semiadult and belonged to xerophilous hygromiid species. Clusters are arranged in rows.

Table 1. Land snails discovered in the Uluburun shipwreck.

No.	Species	Finding circumstances
1	*Metafruticicola* spec. of Megisti	Found loose at wreck margin near bow
2	*Metafruticicola* spec. of Megisti	Airlift spoil
3–12	Hygromiidae (juvenile)	Found loose in organics from sievings under copper ingots
	10: *Xeropicta krynickii* (juvenile)	
13	*Zonites caricus*	Found loose at wreck margin near bow in vicinity of a glass ingot
14	*Xeropicta krynickii*	Found in a broken terebinth jar, some resin still adhering
15–17	Hygromiidae (juvenile)	Found loose in organics from sievings under copper ingots
	16-17 *Xeropicta krynickii* (juvenile)	
18	*Metafruticicola* spec. of Megisti	Found loose at wreck margin near bow
19–22	Hygromiidae (juvenile)	Found loose under a pithos in a krater containing wreck artifacts and organics
23–25	Hygromiidae (juvenile)	Found loose under copper ingots
	24: *Xeropicta krynickii* (juvenile)	
26–27	Hygromiidae (juvenile)	Found loose under a pithos
	27: *Xeropicta krynickii*	
28	*Xerocrassa langloisiana*	In toe conglomerate of an amphora, extensive resin
29–30	Hygromiidae (juvenile)	Found inside snail #28
31–33	Hygromiidae (juvenile)	In toe conglomerate of the same amphora, extensive resin
34	Hygromiidae (juvenile)	Sieved from upper half of an amphora, some resin in jar
35	*Xerocrassa langloisiana*	Sieved from upper half of an amphora, some resin on shell
36	Hygromiidae (juvenile)	Sieved from upper half of a Canaanite jar

wrecksite were relatively close to each other in an area of only 2 m^2 (Fig. 2). The total area that was densely excavated exceeded 70 m^2, but nowhere else were such snails found. The shells were sieved from deposits under the second (cluster 23–25), third (cluster 3–12) and fourth (cluster 15–17) rows of copper ingots, and under a large storage jar (cluster 26–27). Cluster 19–22, in which no species could be identified, was found under the same pithos of cluster 26–27. This means that the specimens must have been on board approximately between the centre and the bow of the ship (Fig. 3). They were largely devoid of any encrustations.

DISCUSSION

Calcareous shells of land snails dropped into 50 m deep sea water will disintegrate relatively quickly. To be conserved, they must be covered by sediment. The present case shows that this indeed can happen when a sinking ship hits the ground and, once covered by a sediment layer, the shells can survive thousands of years. Some specimens of *Xeropicta krynickii* even had their characteristic colour bands preserved, which made it easier to identify them (specimens 16, 17 and 24 in Fig. 5). If snails are covered by sediment much later than the date of deposit, the shell will suffer, the colour disappears, and they can become encrusted. The rate of encrustation depends mostly on where the object is deposited. Shells without encrustations are either fresh or were quickly covered over with sediment after their deposition.

Intrusive elements

There is no doubt that the *Zonites* and *Metafruticicola* shells were intrusive elements (Welter-Schultes, 2001). The coast is steep and rocky and nothing in the archaeological record would substantiate the hypothesis that the ship could have landed in this region and loaded freight, with which the snails could have come on board.

It is interesting to note that the four shells which were not on board the ship were found in different conditions. Specimen 2 from the airlift spoil was taken from a place where no important artifacts from the ship had been expected in the sediment. The other three shells were found loose at margins of the wrecksite, with no other snails in their close vicinity. The results suggest that the shells were blown into the sea from the steep hill of the Uluburun cape, rafted over some distance (1 km southwards is likely for the *Zonites* shell) and finally sank to the bottom. The broken specimen 18 allows the speculation that a bird could have dropped the shell during flight. Since it looks like a fresh shell, it is possible that this event took place in the decade of the excavation.

The amphora snails

The shells that were found in amphoras must definitely have been on board the vessel. The 150 amphoras had an average capacity of 6.7 l. They were stored in the centre of the hold, behind the mast (Fig. 3). Canaanite amphoras were widely distributed in the eastern Mediterranean, but those from the Uluburun wreck are believed to have been made somewhere in present-day Syria (Pulak, 1997). The amphoras contained resin of the common Mediterranean tree *Pistacia atlantica*, a previously underestimated luxury item probably destined for Egypt, where several thousand litres were imported per year at the time (Loret, 1949; Mills & White, 1989; Pulak, 1997). An amphora labelled *sntr* depicted in a tomb of Thebes (Egypt) displaying Canaanite tribute in a royal storeroom suggested a Near Eastern origin of this material (Davies, 1943; Loret, 1949; Pulak, 1997). *Pistacia atlantica* is widespread in Syria and Palestine and occurs as far south as Sinai (Mills & White, 1989).

The amphora that contained the *Xp. krynickii* shell specimen 14 came to rest between the copper ingots of the forth row (Fig. 2). It was partly broken. No other jar landed between the copper ingots of the second, third and fourth rows. The location of this amphora was relatively far from the deposit of most other Canaanite resin jars, so a different origin of that jar could be suspected. But since the jar was filled with terebinth resin, like all the others, its occurrence in the unusual location is probably a coincidence. In the vicinity of the fourth row of copper ingots some other jars were recovered which also had suffered longer trajectories from their original position near the stern.

Resin adhering to snails 35 (*Xc. langloisiana*) and 14 (*Xp. krynickii*) indicates that both species were trapped at the harvesting locality. If (1) the jars were filled at the harvesting localities, which is likely, and (2) the resin came from a single region, then the origin of this part of the cargo should be identical with the overlapping zone inhabited by both molluscs, discounting the range of *Xc. l. improbata* (Fig. 6). If true, then the amphoras

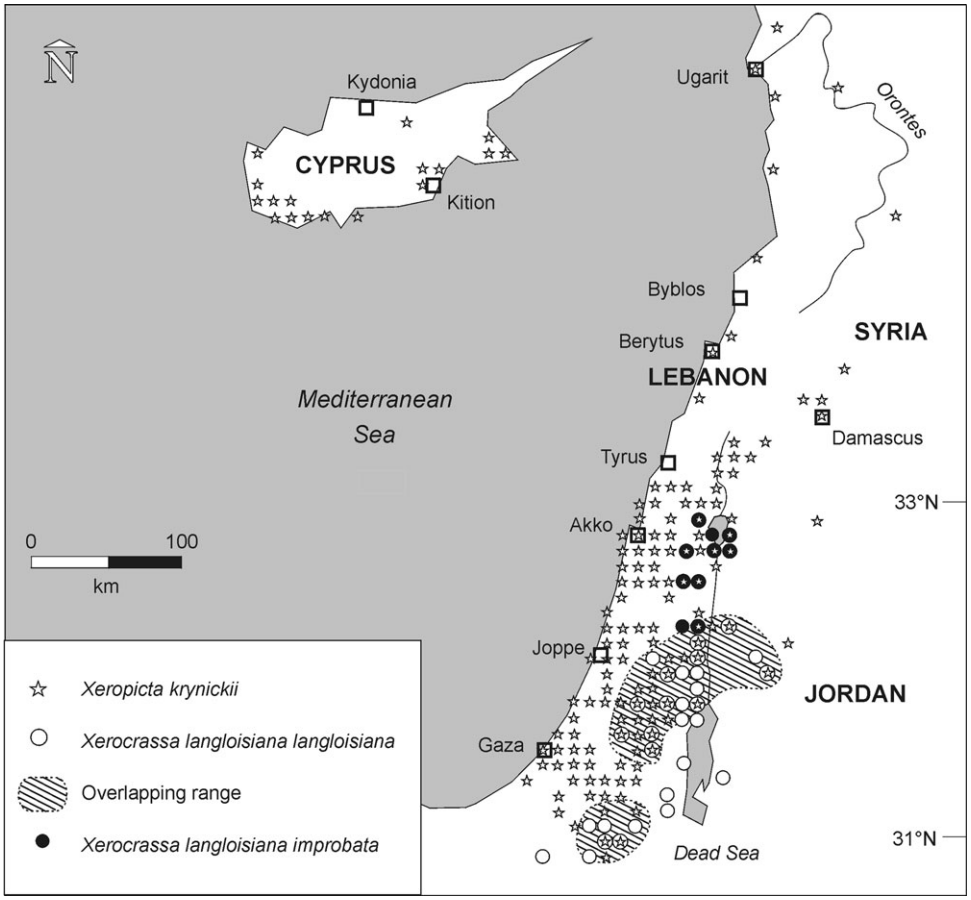

Figure 6. Ranges of *Xeropicta krynickii* and *Xerocrassa langloisiana* in Cyprus and the Near East (after Forcart, 1976; Schütt, 1983; Gittenberger, 1991; Heller, 1993). The zone where *Xc. l. langloisiana* and *Xp. krynickii* occur sympatrically is marked. Faunistic data from Jordan, Syria and the Lebanon are scarce.

were filled in Palestine or Jordan near the Dead Sea. The present-day range of *P. atlantica* overlaps entirely the combined ranges of the two snails. The distance of at least 50 km from the coast suggests that in Canaan the jars were transported considerable distances over land.

A Canaanite origin of the terebinth resin does not bear direct implications for the other cargo compounds, but may indeed help tracing the ship's route. Almost all the items on the ship, cargo or otherwise, could have been taken on at a Cypriot or Syro-Palestinian port, with some goods probably in transshipment, which makes it difficult or impossible to determine the ship's precise point of departure. However, most of the cargo comes from the Syro-Palestinian coast or from Cyprus (Pulak, 1997). The position of the wreck 300 km west of Cyprus *en route* to the Aegean suggests that loading and unloading of such heavy material was not usual, and that trajectories longer than necessary were common. If destined for Egypt, the resin would have left the Dead Sea region to be transported over an impressive distance of 3,000 km via the Aegean to reach the 300-km distant Nile delta.

The snails from under the copper ingots

Of the 22 specimens found loose under pithoi or copper ingots, at least five (10, 16, 17, 24, 27) belonged to *Xp. krynickii*. They were found in close vicinity to the second, third and fourth row of copper ingots, underneath the freight. The copper ingots are assumed to have been loaded in Cyprus. They occupied a large part of the storage space and, at 10,000 kg, were by far the heaviest part of the freight when the ship sank at Uluburun.

Xeropicta krynickii is a common synanthrope in the eastern Mediterranean. Its native range is located between the Black Sea and the Caspian Sea, from Romania and Bulgaria to Azerbaijan and Iran (Damjanov & Likharev, 1975). The species is supposed to have been introduced to the eastern Mediterranean very early in history. At present it is the most common xerophilous hygromiid in the Near East (Falkner, 1990). At the beginning of the 20th century it was introduced to Skopje (Jaeckel, 1954), the westermost station of its present-day range. On the central Aegean islands it is rare (only on Páros and Andíparos), but it is more frequent on the islands of the south Hellenic island arc between Crete and Rhodes. In Gávdos, south of Crete, it is distributed all over the island, locally outnumbering the local native hygromiids (Welter-Schultes, 1998b).

Xeropicta krynickii and some xerophilous hygromiids with similar juvenile shells were found to occur at Demre. But since it is improbable that the shells floated over a 30 km long distance to settle in such numbers at the wrecksite, the 22 xerophilous hygromiid shells found outside amphoras must have been on board the ship. The fact that clusters of shells were found underlines this conclusion – shells dropped into the water will not settle in clusters when hitting the ground at 50 m below sea level. It is also improbable that, when dropped into the sea, such shells will settle in a restricted area of only 2 m^2 of a site exceeding 70 m^2.

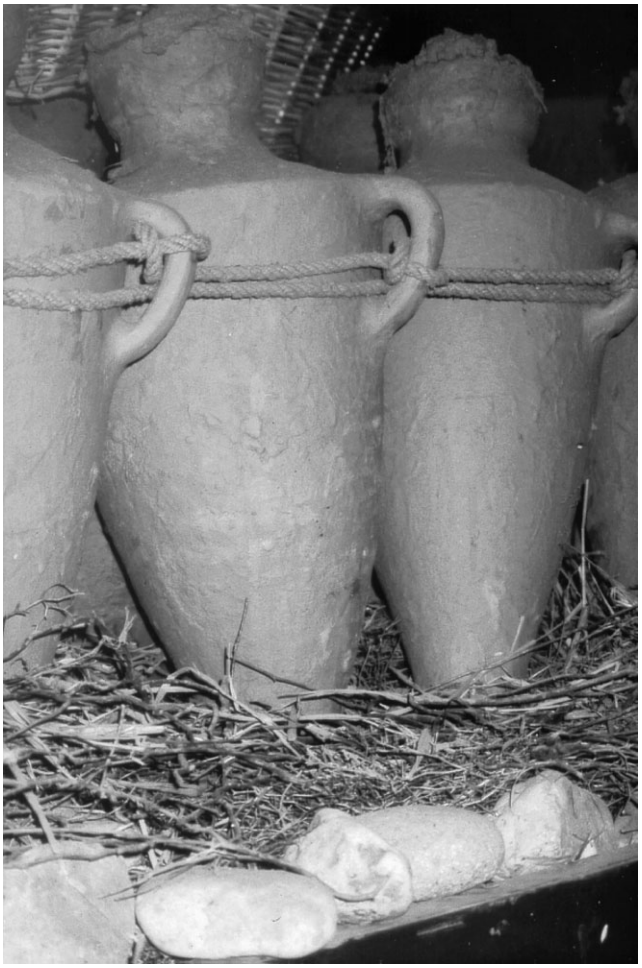

Figure 7. Detail of a transverse section of the cargo compartment of the Uluburun ship as displayed in a life-sized diorama in the Bodrum Museum of Underwater Archaeology, showing the situation near the stern. The lowest layer consists of stones, covered by a layer of spiny shrubs (*Sarcopoterium spinosum*). The resin amphoras were moored with ropes and baskets with lightweight goods were stored above them. Impressions of *S. spinosum* were found on some copper ingots, the land snails were found below these.

Especially when heavy material was transported, the planks of wooden ships needed to be protected. It is quite probable that these snails came on board the ship together with branches of the common Mediterranean spiny shrub thorny burnet (*Sarcopoterium spinosum*), used to cushion the heavy freight and to prevent the planks from being damaged (Fig. 7). Remains of thorny burnet were found attached to some copper ingots (Bass, 1987). In the eastern Mediterranean, living snails in aestivation, notably *Xp. krynickii*, often attach in large numbers to macchia and phrygana bushes, particularly in the hot season (Falkner, 1990; Welter-Schultes, 1998b). This would explain why clusters of snails were found below the copper ingots and under a heavy pithos.

Thus, it seems that these snails must have come on board the ship on a different occasion than the snails discovered in the amphoras, and presumably from a different locality. It is very difficult to judge how long the spiny bushes were on board the vessel and when they were loaded, but a transport of the voluminous spiny bushes from the Dead Sea region to the harbour over a distance exceeding 50 km would not make sense. The bushes must have been harvested near the harbour where they were taken on board. 10,000 kg of copper ingots was an unusually heavy cargo, so it is not excluded that some additional shrubs could have been gathered in Cyprus where the ingots were loaded. The heavy pithoi contained pottery from Cyprus (Pulak, 1997). *Xeropicta krynickii* is reported from various localities in Cyprus, where most populations live attached to the southern and western coast (Gittenberger, 1991) (Fig. 6).

Possible transport of living snails

The snails from the jars are not expected to have survived their journey. Amphoras were often deposited in full sun. But some snails from the spiny bushes could still have been alive on board the Uluburun ship. It must have been such snails that founded new populations at their final destinations, when old packing material was discarded at the final destination. The Uluburun ship is the first ancient shipwreck that has been searched systematically for land snails. It is notable that on this first possible occasion, land snails were discovered among the remains. The results also show us that there were various ways for land snails to get on board an ancient ship. The amphoras and spiny bushes are only two examples. Accidental oversea carriage of clausiliid *Albinaria* snails attached to stones used for construction purposes in antiquity has been suggested on various occasions to explain the occurence of presumably introduced populations at historical sites (Pfeiffer, 1955; Welter-Schultes, 1998a). Cereals and other agricultural products provide further opportunities to carry land snails.

The finds provide the first direct evidence that land snails were carried on ships and by such means dispersed by humans in antiquity. This is consistent with predictions based on faunistic analyses of the Greek islands, suggesting that shipping living land snails cannot have been uncommon in the eastern Mediterranean. While there is ample evidence that living snails must have been transported, accidental transport of empty shells is expected to have occurred even more frequently.

In future shipwreck excavations the potential significance of land snails should be considered, otherwise information on the ship's routes could be lost. Such information, however, can only be provided if we know in detail the species' distributions and geographical patterns of variation in shell morphology. For this study, we were lucky that Heller (1993) had published a detailed land-snail atlas for Israel, and that the species involved came exactly from this region. The range maps published for hygromiids in Cyprus (Gittenberger, 1991) were also very valuable. For Egypt, Jordan, Syria and the Lebanon our basic knowledge is scarce, as for most regions of Turkey and Greece. More basic faunistic work is necessary to evaluate the diversity of land snails in the Mediterranean, and this means more than mere descriptions of new taxa.

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