



Uluburun shipwreck stowaway house mouse: molar shape analysis and indirect clues about the vessel's last journey

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ABSTRACT

Human translocation by stowaway transport is the widely accepted vector of the current worldwide distribution of commensal rodents but its historical process has never been directly evidenced. The anecdotal find of the small murine (mice and rats) mandible among the wealthy cargo of the Uluburun shipwreck provide us with an unexpected opportunity to directly evidence the species associated with this stowaway and provide indirect clues regarding the ship's route. Taxonomic identification and geographic sourcing has been performed using outline molar shape analysis by Elliptic Fourier Transform comparing the Uluburun mouse molar phenotype with extant populations from eastern Mediterranean sibling species. Results showed that the mandible belonged to the house mouse (*Mus musculus domesticus*) with significant phenotypic similarities with extant Syrian house mouse populations. These results provide the earliest direct evidence for stowaway transports highlighting the historical process of the house mouse invasion of the Mediterranean. Using modern behavioural comparisons, combined with archaeological and historical sources, it has been argued that the servicing port of Ugarit (Minet el Beida) was a likely step on the vessel's last journey.

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1. Introduction

Human translocation of rodents has been evidenced in the Near Oceania as far as the Late Pleistocene (Flannery, 1995; White, 2000, 2004), demonstrating an early role of human agency over the distribution of mammalian species. The most ubiquitous of the commensal rodents is the house mouse and the widely accepted cause of its worldwide distribution is its stowaway transport within infested grain and foodstuffs cargo (Auffray et al., 1990a; Boursot et al., 1996; Navajas y Navarro and Britton-Davidian, 1989; Pocock et al., 2005), although the data to support this assertion are sparse (Suzuki, 1980; Baker, 1994). The historical process of its biological invasion in the Mediterranean is now well documented thanks to the diachronic mapping of zooarchaeological occurrences showing an invasive mechanism intimately linked with the evolution of maritime trade and exchange (Cucchi and Vigne, 2006; Cucchi et al., 2005). Its first human translocation happened as a by-product of the Neolithic colonization of Cyprus (Cucchi et al., 2002), evidencing indirectly a deep-sea Neolithic navigation covering 10,000 years (Cucchi, 2005; Vigne and Cucchi, 2005). Bronze Age maritime trade linking eastern Mediterranean cities and empires was then

the main vector of its spread in the eastern Mediterranean. Finally, its adaptation to the western Mediterranean commensal niche had been successful only once the migrant flow of mice by passive transport was impelled by the commercial and demographic maritime expansions of the last millennium BC (Cucchi et al., 2005).

Although this historical process relies on the assumption that stowaway transport was the dispersal vector in Mediterranean, no direct archaeological evidence was available to support it. The only direct archaeological evidence of stowaway transport is the skull of a brown rat (*Rattus norvegicus*) found in the shipwreck of an XVIIIth century French galleon that sank off the Corsican shores. This discovery could directly highlight the association between the brown rat invasion and the history of modern navigation (Vigne, 1995).

Systematic sieving of sediments from the Late Bronze Age Uluburun shipwreck produced a single small murine (mice) mandible of a little more than 1 cm. This seemingly incidental find among the vast royal cargo of this impressive vessel provides us with a unique opportunity to examine the role of stowaway transports in the biological invasion of commensal rodents in light of Mediterranean Bronze Age trading networks.

2D geometric morphometric analysis of the *in situ* first lower molar from the mandible is utilized to identify the species involved in stowaway transport and localise a potential geographical source relying on intraspecific geographical variation of molar phenotype.

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If this mandible can be connected to the vessel's final journey, this anecdotal find will provide direct evidence for the role of the Late Bronze Age maritime trade as a significant factor in the history of the dispersal of the house mouse in Europe, contributing to the global consensus for human activity as a vector for the dispersal of commensal murines, among the most threatening invasive species for biological diversity and human health (Lowe et al., 2000). In addition, if the geographical print on the molar can be inferred from its phenotype, the results could provide a significant contribution to the questions regarding the route followed by the ship before its sinking.

2. Description of the shipwreck

The Uluburun shipwreck is a Late Bronze Age vessel discovered in the Mediterranean Sea lying on a rocky side between 44 and 52 m depth, (Fig. 1) just off the south coast of Turkey near the city of Kaş in the province of Antalya (Bass et al., 1989; Pulak, 1997; Cleary and Meister, 1999). The shipwreck was excavated during 11 campaigns by the Institute of Nautical Archaeology (INA; Bodrum, Turkey) between 1984 and 1994. Other Bronze Age shipwrecks such as the Dokos wreck, (third millennium BC) in the Saronic gulf, and the Cape Gelidonya wreck, (1200 BC), off the Turkish coast (Bass, 1967, 1973), have also been excavated but the Uluburun wreck is significant in that it is the oldest one to be excavated using modern underwater archaeological techniques. Dendrochronology has dated the stored firewood to a tree felled 1316–1305 BCE (Kuniholm et al., 1996) which is contemporary with finds from the wreck such as the Mycenaean ware (LHIIIA: 2 type) however, these dates are now considered to be insecure due to the poor preservation of the two samples used (Manning et al., 2001).

The vessel itself was 15 m in length and provided a carrying capacity of 20 tonnes. Its vast cargo has yielded a unique picture of the richness and diversity of eastern Mediterranean maritime trade at the end of the Bronze Age with items sourced from at least nine different cultures (Canaanite, Mycenaean, Egyptian, Cypriot, Nubian, Baltic, Northern Balkan, Babylonian, Assyrian, Kassite...) (Pulak, 1998). The main cargo appears to have consisted of metal ingots comprising 10 tonnes of copper ingots, in typical oxhide shape, and 40 tin ingots. The ship also carried some exotic raw materials such as ebony, amber, ostrich eggs used as containers, elephant ivory and hippopotamus teeth. Manufactured goods included Mycenaean and Cypriot pottery stored in Canaanite storage jars, tools, fishing equipment, weapons, stone artefacts, gold and silver jewellery and

a unique gold scarab bearing the name of the Egyptian queen Nefertiti. The wealth of the cargo indicates strongly the use of the ship as a Royal vessel, rather than that of a private merchant, though still seemingly within the structure of Late Bronze Age international exchange. Evidence from the Amarna letter and the iconography of the Kenamun tombs (Thebes), describes Syrian crews discharging their cargo (Davies and Faulkner, 1947) and indeed the Uluburun cargo probably represents a royal shipment like those exchanged between the Syro-palestinian coast, Egypt and Alashia (Cyprus) with destinations further into the Aegean also suggested (Pulak, 1998; Bachhuber, 2006).

The ship's point of departure is still debated as having a Cypriot or Syro-palestinian coastal origin or alternatively coming from both these areas, however, current opinion based on Lead isotope characteristics (Stos-Gale et al., 1997) suggests that the vessel was outbound from Cyprus with copper ingots quarried from its own mines. Its final destination, according to the vast wealth of the cargo, which may have included offerings to Egyptian Pharaohs, being the Nile River one of the main trading centres of the time. The nationality of the ship itself is nevertheless still questionable (Pulak, 1998).

3. Materials and methods

The right mandible ($L = 1.4$ cm, $l = 0.5$ cm) was recovered by wet sieving loose sand and sediment and fragments of encrustation originating from the vicinity of the fourth row of copper ingots (Fig. 2) and is well-preserved partly due to corrosion from the copper ingots evidenced by the greenish encrustation on the mandible (Fig. 3A and B). The third molar (m3) was missing and the



Fig. 1. Location of the shipwreck and of the main palaces and Empires from Near East and Eastern Mediterranean during Late Bronze Age (second millennium BC).

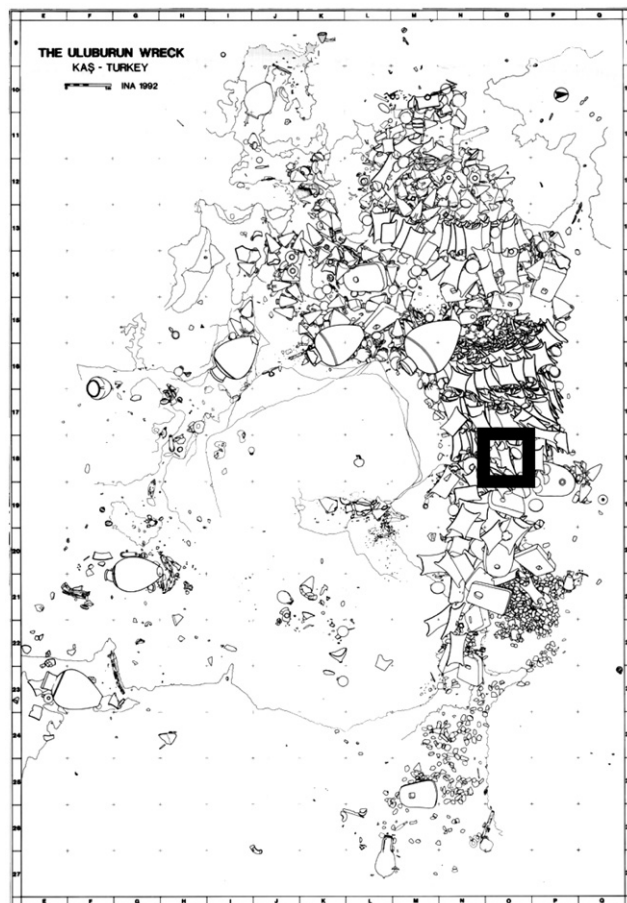


Fig. 2. Planimetric record of the Uluburun shipwreck (courtesy INA 1992). The square meter (O18) highlighted show that the mandible has been collected from the fourth row of copper oxide ingots.

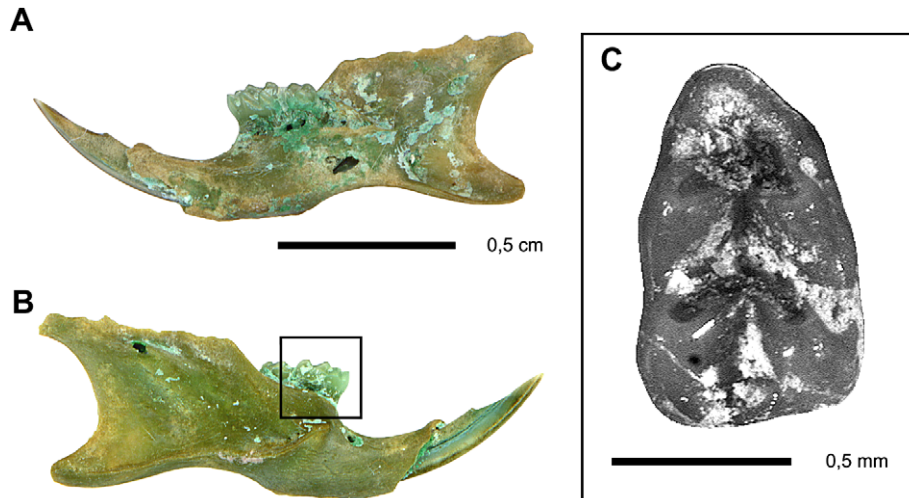


Fig. 3. Buccal (A) and labial (B) sides of the right mandible. (C) Occlusal view of the first lower molar.

coronoid process was broken. According to molar tooth wear (Lidicker, 1966), the mandible comes from a young individual (circa 3–6 months old) (Fig. 3C). Preliminary macroscopic observation of the first lower molar (m1) allowed its positive taxonomic identification as *Mus* sp. (mice). However, morphoscopic examination alone could not provide its determination to species level due to the genus *Mus* comprising several sibling species (Bonhomme et al., 1983). Therefore the m1 morphology of the Uluburun mouse has been compared with genotyped specimens using molar shape analysis. This technic has already demonstrated its suitability for interspecific and intraspecific distinction within the *Mus* genus (Cucchi et al., 2002, 2006; Cucchi, 2005; Michaux et al., 2007; Macholan, 2006; Macholan et al., 2008). The genotyped reference set (Table 1, Fig. 4) includes the three *Mus* species of the eastern Mediterranean considered as prime candidates for taxonomic identification of the Uluburun mouse. The data set include the Macedonian mouse (*Mus macedonicus*), which is represented by two sub-species with parapatric geographic range (Orth et al., 2002), the Cyprus mouse (*Mus cypriacus*) a recently discovered endemic species (Cucchi et al., 2006) and the house mouse (*Mus musculus domesticus*) the only species which has developed a commensal relationship with humans. *Mus macedonicus macedonicus* occurs in Syria, Turkey and Greece whereas *Mus macedonicus spretoides* has been discovered only in Israel (Auffray et al., 1990b). Feral house mice do live in sympatry (i.e. share the same habitat) with other mice such as *M. macedonicus* in the eastern Mediterranean (Auffray et al., 1990b; Orsini et al., 1983) or the endemic *M. cypriacus* in Cyprus, but remain the only *Mus* species in Crete and Egypt.

It should be noted that the modern data set of house mouse populations doesn't include samples from coastal Anatolia or Egypt, two potential sources of stowaway transport, however, historical sources allow these locations to be ruled out as useful for this study. Starting with the Anatolian coast, there is no historical or archaeological sources for a port or harbour on the maritime route of the

Bronze Age Mediterranean trade. Antiphellus, the oldest Anatolian harbour situated under the modern city of Kas (Fig. 1), was founded only during the VIth century BC becoming an important trading port during the IVth century BC, exporting timbers from Lycia. Egypt, as previously stated, it is more likely to have been the final destination of the vessel rather than a stop on its route.

3.1. Molar shape analysis

The most efficient way to describe the morphological variation of murine molars is to quantify the 2D projection of its occlusal view, providing information regarding the relative position, and the swelling of the cusps (Renaud et al., 1999), which are an important factor on the genetic identity of the taxon. The external outline of the murine molar does not vary with the wear on the attrition surface which prevents morphological parameters being defined depending on the age of the specimen (Renaud, 2005).

The external outline of each m1 is acquired using 64 equally spaced points semi-automatically sampled using an optical image analyser (Optimas 6.2). To obtain the shape descriptors of the external outline of the first lower molar (m1) occlusal surface (Fig. 3C), an Elliptic Fourier Transform (EFT) was performed (Kuhl and Giardina, 1982; Rohlf and Archie, 1984; Ferson et al., 1985). This method is based on a separate Fourier decomposition of the incremental changes of the x- and y- coordinates as a function of the cumulative length along the outline provided for both the periodic functions, an infinite sum of trigonometric functions with decreasing length waves called harmonics (Ha). Each Ha corresponds to four coefficients: A_n and B_n for x, and C_n and D_n for y, defining an ellipse in the xy-plane. The first harmonic, describing the best



Fig. 4. Location of the samples from the different mice species studied. Circles = *Mus musculus domesticus*, squares = *Mus macedonicus* sp. and the star = *Mus cypriacus*.

Table 1
Samples size (number of specimens) of modern populations of mice species from the Eastern Mediterranean area

Species	Crete	Cyprus	Greece	Israel	Syria	Turkey	Total
<i>M. macedonicus macedonicus</i>			5		6	10	21
<i>M. macedonicus spretoides</i>				10			10
<i>M. musculus domesticus</i>	19	17	22	23	21		102
<i>M. cypriacus</i>		13					13
							146

fitting ellipse of the original outline is used to perform the size, orientation and starting point standardizations necessary to allow the shape comparisons between all outlines. The coefficients of the first harmonic corresponding to residuals after standardization have not been included in subsequent statistical analyses (Crampton, 1995). Shape changes are visually depicted by reconstructed outlines. An outline can be reconstructed from any set of Fourier coefficients following the inverse Fourier method. “Mean outlines”, reconstructed on the averaged Fourier coefficients per taxon, were used to visualise shape differences between the groups.

Digitizing and acquisition of the outlines coordinates have been performed using an image analyser (Optimas v.6.2 by Imasys). Fourier Transformation have been performed using NTSYS-pc 2.11[©] 2002 by Applied Biostatistics, Inc.

3.2. Statistical analysis

The size of the m1 was estimated using the area of the ellipse of the first harmonic and the difference between the Uluburun mouse and Eastern Mediterranean species was tested using analysis of variance (ANOVA) with pairwise mean comparisons assessed with Tukey post hoc test.

As the primary objective of this study was to identify the specific status of the Uluburun's mouse, a multiple group form of discriminant analysis of the shape variables called Canonical variate analysis (CVA) was utilized. EFT compute a very large amount of shape variables (i.e. 256 coefficients in our case) (64 harmonics $\times$ 4 coefficients) and CVA requires more specimens than the sum of the number of groups and measurements per specimen. Therefore a dimensionality reduction based on Principal Component Analysis (PCA) (Sheets et al., 2006) was performed. The scores of the Principal Components that optimize the rate of correct assignments obtained through cross-validation (Jackknife) were used rather than the coefficients set.

Differences between mice groups (species, geographic localities) were assessed using Multivariate Analysis of Variance (MANOVA; test considered: Wilks' Lambda). Mahalanobis distances (D^2) were computed inside the canonical molar shape space for the group (species, geographic locality) assignment of the Uluburun mouse. The posterior probabilities for group membership associated to these distances will allow to decide which specific status and geographical area can be allocated to the Uluburun mouse. Allocations with posterior probabilities below 0.75 will be rejected.

Statistical analyses were performed using Systat v.11 Systat Software Inc. (SSI) and NTsys-PC v.2.1[©] 2002 by Applied Biostatistics, Inc.

4. Results

4.1. Taxonomic attribution

Molar shape differences are highly significant between the three extant mice species (Wilks' Lambda = 0.1108, $ddl1 = 2$, $ddl2 = 143$, $P < 0.0001$). The classification matrices (Table 2) indicates that 97% of the specimens are correctly classified; using the cross-validation (Jackknife) the assignment drops to 89% confirming the robustness of the comparative model. The canonical scores plot (Fig. 5) clearly shows that the Uluburun mouse falls within the *M. musculus domesticus* molar shape variation range. This graphical classification is confirmed by the D^2 with a 1.0 probability associated with the assignment to the *M. musculus domesticus* group. Its molar size falls within the variation range of house mouse populations from both mainland and island regions (Fig. 6), with no significant differences (Table 3). Therefore, the mandible found in the Uluburun shipwreck can be unambiguously identified as a house mouse (*M. musculus domesticus*).

Table 2

Correct assignment of genotyped specimens by resubstitution and cross-validation (Jackknife)

	<i>Mus cypriacus</i>	<i>M. musculus domesticus</i>	<i>M. macedonicus</i> sp.	% Correct
Classification matrix				
<i>Mus cypriacus</i>	12	0	1	92
<i>M. musculus domesticus</i>	3	99	0	97
<i>M. macedonicus</i> sp.	1	0	30	97
Total	16	99	31	97
Jackknife classification matrix				
<i>Mus cypriacus</i>	9	1	3	69
<i>M. musculus domesticus</i>	6	94	2	92
<i>M. macedonicus</i> sp.	2	2	27	87
Total	17	97	32	89

4.2. Geographical origin of the house mouse

Extant house mouse populations from the eastern Mediterranean display highly significant molar shape differences (Wilks' Lambda = 0.1481; $ddl1 = 4$; $ddl2 = 114$; $P < 0.0001$) (see Table 1). These populations represent five potential geographical sources for the Uluburun house mouse origin. Nevertheless the classification matrices indicate that only 65% of the specimens are correctly classified (using the Jackknife procedure, this percentage drops to 45%). The highest probability of group membership associated to the D^2 is the sample from Syria ($P = 0.89$) (Table 4). This means that among the phenotypic diversity of house mouse populations in the eastern Mediterranean basin, Uluburun's house mouse is most similar to the modern Syrian morphotype. This suggests that this particular house mouse boarded the ship with cargo from a harbour situated somewhere along the Northern Levantine Coast. However, this specific geographic attribution is somewhat tentative due to the percentage of correctly assigned modern specimens among their geographical group and must be further discussed in light of other archaeological and historical evidence.

5. Discussion

5.1. A stowaway house mouse within the Uluburun' cargo

Because shipwrecks are not sealed deposits, they can suffer from later contamination (Parker, 1981). The greenish encrustation on the mandible (Fig. 3A, B) demonstrating the long contact between

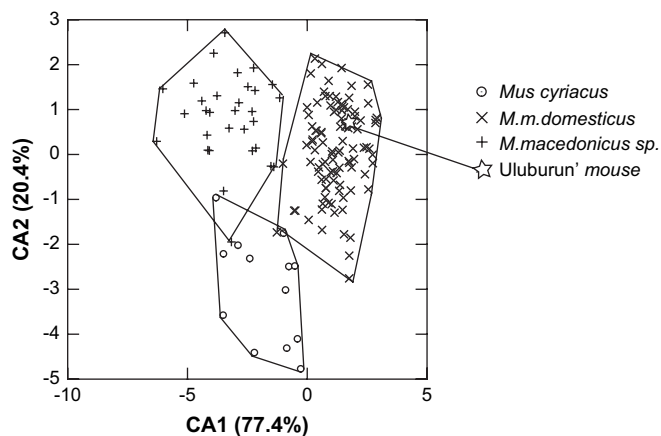


Fig. 5. Biplot of the two first canonical axis (CA) synthesizing the first lower molar shape variation of the three species of reference (*Mus musculus domesticus*, *Mus macedonicus* sp. and *Mus cypriacus*) and of archaeological mouse from the shipwreck.

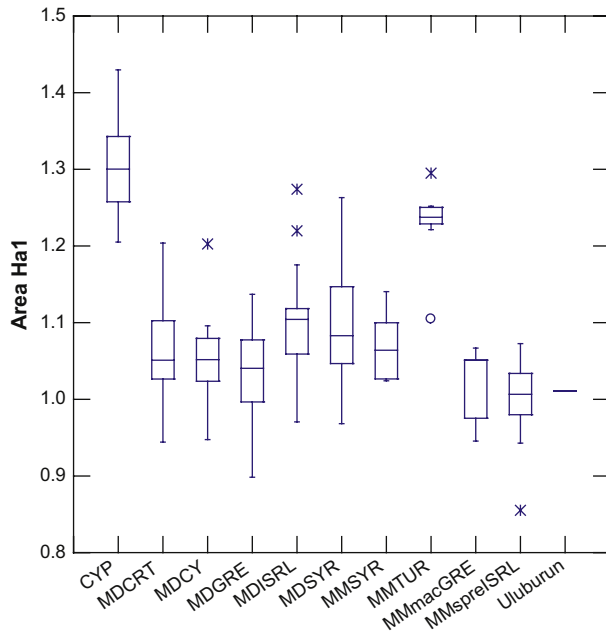


Fig. 6. Boxplot displaying the m1 size (area of the first harmonic (Ha1)) range of eastern Mediterranean mice populations. CYP = *Mus cypriacus*, MDCRT = *M. musculus domesticus* from Crete, MDGRE = *M. musculus domesticus* from Greece, MDSRL = *M. musculus domesticus* from Israel, MDSYR = *M. musculus domesticus* from Syria, MMSYR = *M. macedonicus* from Syria, MMTUR = *M. macedonicus* from Turkey, MMmacGRE = *M. macedonicus macedonicus* from Greece, MMspreISRL = *M. macedonicus spretooides* from Israel.

the mandible and the copper ingots among which it has been found, provides clear evidence that the mandible does not represent an intrusive element and can then be considered as contemporary with the shipwreck. The mandible is therefore the remnant of a house mouse living on board when the ship sank.

The molar of this mandible doesn't present any peculiar morphological characteristic compared to extant house mice whereas allometric increase of the tooth size (macrodontie) and morphological drift are common features for murines (rat and mice) populations adapted to isolated environments like islands (Cucchi et al.,

Table 4

Mahalanobis distances (*D*) and posterior probabilities (*P*) associated between the m1 shape of the Uluburun mouse and the centroid Eastern Mediterranean house mice geographical populations

	<i>M. musculus domesticus</i> Crete		<i>M. musculus domesticus</i> Cyprus		<i>M. musculus domesticus</i> Greece		<i>M. musculus domesticus</i> Israel		<i>M. musculus domesticus</i> Syria	
	<i>D</i>	<i>P</i>	<i>D</i>	<i>P</i>	<i>D</i>	<i>P</i>	<i>D</i>	<i>P</i>	<i>D</i>	<i>P</i>
Uluburun	27.4	0.00	21.8	0.04	25.1	0.01	21.1	0.06	15.6	0.89

2006; Michaux et al., 2002; Orsini and Cheylan, 1988; Pergams and Ashley, 2001; Adler and Levins, 1994) and potentially boats. However, there is currently no known biometric study of house mouse populations living on boats that could confirm that this type of isolation will lead to the same morphological adjustment as the ones found on island populations. Nevertheless, we can hypothesize that the high level of commensalism on a boat leads to increased population density, which is in favour of body size increase and a concomitant macrodontie (Adler and Levins, 1994). The biometric analysis of the brown rat (*R. norvegicus*) skull discovered in the "Ça ira" shipwreck supports this hypothesis. Indeed, this skull presents allometric proportions (a large cranium and jugal teeth row with a reduced rostrum length) interpreted as the morphological adaptation to a life spent in the galleon (Vigne, 1995). Therefore, both the age at death (juvenile) and the lack of morphological drift of the Uluburun house mouse lends strongly in favour of this particular mouse being loaded just prior to the vessels final journey. The house mouse in the Uluburun shipwreck is therefore the oldest direct evidence so far for stowaway transport of a commensal species and clearly illustrates how Bronze Age maritime traffic was a vector of house mouse dispersal.

5.2. Minet el Beida, a port on the last vessel's journey?

The biometric data have yielded evidence of a stowaway house mouse loaded on the vessel prior to the ships sinking. Its tentative Syrian origin can contribute to the debate regarding the route of the vessel before its fateful day. The question concerning the point of departure or the origin of the vessel is impossible to answer using

Table 3

ANOVA & Tukey HSD pairwise comparison probabilities for m1 size (area of occlusal outline)

Source	Sum-of-squares	ddl	Mean-square	F-ratio	P
Groups	1.036	10	0.104	25.491	0.000
Tukey HSD					
<i>M. cypriacus</i>	1.000				
<i>M. musculus domesticus</i> Crete	0.000	1.000			
<i>M. musculus domesticus</i> Cyprus	0.000	1.000	1.000		
<i>M. musculus domesticus</i> Greece	0.000	0.954	0.998	1.000	
<i>M. musculus domesticus</i> Israel	0.000	0.695	0.440	0.023	1.000
<i>M. musculus domesticus</i> Syria	0.000	0.707	0.456	0.028	1.000
<i>M. musculus macedonicus</i> Syria	0.000	1.000	1.000	0.979	0.995
<i>M. musculus macedonicus</i> Turkey	0.131	0.000	0.000	0.000	0.000
<i>M. musculus macedonicus</i> Greece	0.000	0.959	0.992	1.000	0.251
<i>M. musculus spretooides</i> Israël	0.000	0.274	0.528	0.926	0.001
Uluburun' mouse	0.000	1.000	1.000	1.000	0.957
Tukey HSD					
<i>M. musculus domesticus</i> Syria	1.000				
<i>M. macedonicus macedonicus</i> Syria	0.995	1.000			
<i>M. macedonicus macedonicus</i> Turkey	0.000	0.000	1.000		
<i>M. macedonicus macedonicus</i> Greece	0.255	0.961	0.000	1.000	
<i>M. macedonicus spretooides</i> Israël	0.001	0.512	0.000	1.000	1.000
Uluburun' mouse	0.956	0.999	0.042	1.000	1.000

The pairwise significant differences are highlighted in grey.

items from the cargo alone as in the case of the Uluburun vessel, they could have been loaded from Cypriot, Syro-palestinian or Aegean ports.

In general the best evidence for ship's origin comes from the stone anchors stored in the bow of the shipwreck. However, until petrography results refine the geographical source of their limestone (Evrin et al., 2002), the ones of the Uluburun vessel could potentially come from Cyprus, the coasts of Israel or Ugarit (Pulak, 1998). The ship galley wares represent the best potential indicators of the nationality of the boat. Among the artefacts discovered (Pulak, 1998) a saucer-shaped ceramic oil lamp presumably of Syro-palestinian origin displayed charring along their nozzles indicating their use during the journey and therefore leaning in favour of the argument for the Syro-palestinian ethnicity of the ship. Unpublished petrography results of the ship galley wares yield a geographic source around Haifa in Israel for these ceramics, which would refine the ethnicity of the crew as Canaanite (Cemal Pulak, personal communication, August 2005). It is well known that Canaanite merchants who settled along the Syro-Palestinian coast, played a major role in eastern Mediterranean maritime trade during the Late Bronze Age (Sasson, 1966; Linder, 1972; Bass, 1998).

However, the most dramatic direct evidence of a port along the route of the vessel is undoubtedly the geographical source of unwelcome guests like commensal rodents, especially if the specimens are young and newly loaded like the house mouse of Uluburun shipwreck. In contrast to non-cargo pottery or personal items, the geographical origin of a stowaway commensal cannot yield the ethnicity of a ship but it can inform us about the route of the vessel and ports visited.

This can be inferred when combining behavioural, archaeological and historical information.

We know from behavioural ecology that although omnivorous, the house mouse is mostly fond of cereals (Robards and Saunders, 1998) and that the transport of infested grain and hay are the most likely vector for their passive transport (Baker, 1994). The rate of stowaway transports of one mouse per 7 tonnes of grain/hay (Baker, 1994), suggests that huge amount of grain/hay have to be shipped to allow a successful loading of a commensal mice. The presence of a house mouse in the shipwreck would then plead in favour of a grain shipment for trading purposes. Direct evidence of cereal crops among the plants remains only rely on few fragments of charred wheat and Barley, rachis and chaffs (Haldane, 1990, 1993). Furthermore, the possibility of a grain shipment for trading purposes has been considered unlikely since no space was available on the ship for traded cereal crops cargo (Cemal Pulak, personal communication, August 2005). However, the tenuousness of cereal crops evidences shouldn't rule out the hypothesis of a grain shipment for trading purpose if one consider that their storage could have relied on basketry or matting whose fragments have been recovered (Haldane, 1993), rather than on jars. Such containers would not have been able to prevent the cereals from dispersal both during and after sinking. In addition, it cannot be denied that such long distance trade would have necessitated extensive food provisions for the voyage (Pulak, 1998). Hence a large amount of grain is highly probable, even if not for trading purposes, to ensure the needs of both crew and passengers were met.

The city of Ugarit (Ras-Shamra) (Fig. 1) seems to be the most likely Canaanite port that allies with the Late Bronze Age east–west copper and tin maritime trade route where large amount of grains could have been loaded. Situated on the Syrian coast, this city was the largest international emporium between the XIVth and the XIIIth centuries BC, benefiting from its fertile hinterland which produced an abundance of wheat, barley, wine and olive oil (Huot, 2004). It owed its prosperity to its strategic position, its well sheltered port of Minet el Beida and to a valley situated north–east of the city. All these factors converged to ensure control of the trade

routes, which connected Egypt, Mesopotamia, the Hittite Empire, Cyprus and Crete (Huot, 2004). Of relevance to the understanding of the origins of the Uluburun cargo, its strategic position also made Ugarit the main tin port of the Levant (Cierny et al., 2001). According to Carol Bell (oral communication, British Museum, March 2005) the Uluburun ship most likely took on its tin cargo at Ugarit because it was situated at the end of the shortest route between the tin mines of Central Asia (Iran) and the Mediterranean coasts, along the Euphrates River and through the Syrian Desert.

The port of Minet el Beida as the potential home port of the Uluburun ship was already mentioned by Pulak (1998), after the discovery of 80 canaanites amphoras (Schaeffer, 1949) similar to those from Uluburun, as well as a 1000 pieces of mostly Cypriots vessels (Schaeffer, 1939) possibly awaiting export by sea. The biometric identification of a stowaway house mouse with a Syrian phenotype provides further support for the hypothesis considering Minet el Beida as a most likely port on the trading route of the Uluburun vessel.

6. Conclusion

The tiny single mandible of a house mouse discovered among the prestigious and vast Uluburun shipwreck cargo represents the earliest direct evidence for the stowaway transport of commensal rodents. This anecdotal but important discovery has highlighted the role of Bronze Age shipping in the invasive process of house mouse dispersal. By combining biometrical data with ecological, historical and archaeological sources, this study has also been able to pinpoint that a grain shipment from a storehouse infested with mice most probably originated in the servicing port of Ugarit. A seemingly insignificant discovery within a vessel crammed full of exquisite and exotic goods provide a useful piece of evidence for the ships route 3500 years after its final and fateful journey.

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