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# AUDITORY EXOSTOSES, INFRACRANIAL SKELETO-MUSCULAR CHANGES AND MARITIME ACTIVITIES IN CLASSICAL PERIOD THASOS ISLAND

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## ABSTRACT

Acquired external ear exostoses are an auditory disorder presumably associated with prolonged or repeated exposure to cold aquatic activities. At the ancient necropolis of Thasos, Greece, a low prevalence of auditory exostoses has been documented in one adult male out of an initially larger number of individuals from the ancient necropolis of Thasos, although the city-state was renowned in antiquity for the strength and dependency on its fleet and its seafaring activities in the Aegean and the Black Sea as supported by historical and archaeological records. In addition to auditory exostoses, this individual showed distinct similarities of infracranial axial and appendicular skeletal changes of skeleto-muscular robustness, trauma, and degenerative manifestations to a select sample of 16 males out of 57 individuals interred in proximal contextual associations near the shoreline which may comprise a pattern of occupational conditions when juxtaposed to the context of the larger skeletal population studied at Thasos so far. This study also presents comparative ethnographic information relative to occupational changes documented among a surviving group of wooden boat craftsmen on Thasos, comprising nine male individuals of diverse age-subgroups and intra-trade specializations. It is proposed that the low incidence of external auditory exostoses from ancient Thasos may not necessarily reflect issues of preservation or population sample, but rather the specificity of activities within the domain of specific maritime occupations.

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**KEYWORDS:** Auditory (Ear) Exostoses, Ancient Thasos, Sea Ferrying, Occupational Specialization

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## INTRODUCTION

Thasos, the most northern of the Aegean Islands was colonized in the 7<sup>th</sup> century B.C. by the people of the Cycladic island of Paros (Herodotus *Historia* B:44, ΣT: 46, 47; Thucydides A: 100, Δ:104) for its important strategic position for trade with the Thracian mainland and for its lumber, marble, gold, silver, copper, and iron resources. The new founded city-state of Thasos kept in close relationship with Paros (its Mother city) throughout antiquity, and soon after its foundation Thasos continued to establish strongholds and colonies in the mainland (Herodotus *Historia* ΣT: 46, Z:108; Thucydides *Historia* Δ:105, 107) as also narrated by the ancient poet Archilochus who fought in arms in the region for the establishment of Thasos and its colonies (Agelarakis and Zafeiropoulou, 2006; Zafeiropoulou and Agelarakis, 2005). Thasos became rich and powerful dominating trade routes in the Aegean Archipelago and the Eastern Mediterranean, its coinage found in Syria and Egypt, and its amphorae for the trade of its famous wine (Athenaeus, *The Deipnosophists*, VIII: 364d, 431a, 432c; XI:478d; XIII: 579e, 641f; Salviat, 1986) through the Aegean to the Black Sea. The dominance and nautical power of Thasos, renowned for its strength and ability, is recorded by historian Herodotus describing the Greco-Persian Wars and later by Thucydides recounting the operations during the Peloponnesian War (Herodotus *Historia* ΣT: 46; Plutarch, *Lives* Kimon 14:2; Thucydides *Historia*, A:101, H:64).

In carrying out anthropological archaeology research at the ancient necropolis of Thasos under the auspices of the Hellenic Archaeological Service, it was possible to perform physical and forensic anthropological analyses and a paleopathologic study on 57 human skeletons, a population sample of the ancient city of Thasos dating to the Classical and Hellenistic periods (5<sup>th</sup>-3<sup>rd</sup> c. B.C.) interred at the proximity of the ancient shoreline at the Western outskirts of the ancient city (lot *Myroni*). The objectives of this study, part of a larger ongoing archaeo-anthropological endeavor to unearth aspects of ancient Thasos, aimed to better decipher and elucidate features of the human ecologic, socio-

political, ideational, and organizational abilities in ancient Thasos. A particular focus geared, where pertinent, on specific archaeological anthropology domains such as the retrieval of skeletal evidence reflecting on craft specialization (occupational conditions and kinetics) as a component of the larger realm of study of the economic approaches and output in ancient Thasos.

One of the inquiries into the archaeo-anthropological record pertained to the prevalence of external auditory exostoses, an acquired *in vivo* disorder often associated with repeated exposure of the ear to cold water environments, specifically below 19° C (Agelarakis and Serpanos, 2002; Fowler and Osmun, 1942; Kennedy, 1986). Auditory exostoses are multiple, benign bony growths extending from the osseous portion of the external auditory meatus, typically occurring bilaterally (Graham, 1979; Kemink and Graham, 1982; Tran et al., 1996). Due to the link with cold water stress, the growths often occur in individuals involved in cold aquatic activities such as diving, swimming, or surfing (Karegeannes, 1995; Kroon et al., 2002).

Readings of the surface sea temperature at the northern Aegean Mount Athos station (oceanographic and hydrological station in the Northern Aegean Archipelago in close proximity to Thasos Island) range between 16° to 25°C, varying with seasonality, but reach temperatures below 19°C in the fall to spring months (Nittis and Perivoliotis, 2002). At Thasos during the winter and early spring seasons sea water temperatures plunge to approximately 13°C, whereas strong currents in the immediate northern vicinity of the locus of the ancient city-state keep the seawater in relatively cool temperatures at or just below 18° C even during the late spring to early summer months<sup>1</sup>. Given the Thasian dependability on the strength of its significant naval forces<sup>2</sup> and commercial fleet, the separate military and commercial harbors and adjoining dockyards<sup>3</sup> based on which the very existence and prosperity of the city-state depended, it was speculated that a high prevalence of auditory exostoses would be found among this ancient population sample which was unearthed from the vicinity

of the shoreline. The spatial allocation of the funerary activity area could have indicated a closer an *intra vitam* relation of the interments with a maritime environment. Such a hypothesis was proposed considering a lack of prevalence of auditory exostoses among additional population samples from the ancient necropolis of Thasos of earlier, coeval, and later time periods studied thus far, the contextual provenances of which were further distanced from the shoreline (Agelarakis, 2002; 2000; Koukouli-Chrysantaki et al., 1997). Such manifestations were also lacking among the antedating Thracian native peoples that were settled in altitudinal endoplains during the Late Bronze to Early Iron Age periods in southwestern Thasos (Agelarakis, 1999).

It should be noted that population studies investigating the prevalence of auditory exostoses in maritime ancient Greek populations are as of yet incomplete; hence comparable data from the region of the Aegean Archipelago during Classical antiquity are not available. Therefore, and in conducting an interdisciplinary and diachronic anthropologic approach, an ethnographic study was undertaken aiming to better understand the occupational conditions and changes which could be documented among a surviving group of wooden boat craftsmen on the island of Thasos at Prinós harbor, comprising (in 2006) nine male individuals of diverse age subgroups<sup>4</sup> with distinct intra-trade specializations. In carrying out their dedicated-specialized activities in hauling and repairing wooden boats they use mostly traditional techniques, tool kits and materials, and hence have the tendency to expose their bodies to similar circumstances and analogous conditions of stress to those of antiquity<sup>5</sup> (Kommatas, 1999; Sterionov, 1999).

## METHODS

An archaeo-anthropological examination was conducted on a collection of 57 homini (human individuals), preserved either in dry or cremated form, recovered from 39 grave contexts<sup>6</sup> in Thasos (Limenas- lot *Myroni*). Of the 39 grave contexts (from now on burial contexts), 29 (74.36%) burial contexts yielded 29 (50.88% out

of 57 homini) single interments, while the remaining 10 burial contexts (25.64%) yielded multiple interments that represented 28 (49.12%) homini. In addition to the overall physical anthropologic inspectional and mensurational analyses, part of the study protocol for assessing demographic data (i.e. age and sex subgroup dynamics), this investigation focused on skeletal anatomy and variability as well as the expression of paleopathologic manifestations through macroscopic evaluations aiming to also identify where pertinent the presence of external auditory exostoses. In performing this investigation no discriminatory means were applied against any biological sex and/or age subgroup. Factors imposed by preservation and taphonomic impacts as well as the burial custom of cremation contributed to sample limitations. Hence, all individuals that preserved external *meatus acusticus* skeletal loci in both dry and cremated form were considered for this investigation.

## RESULTS

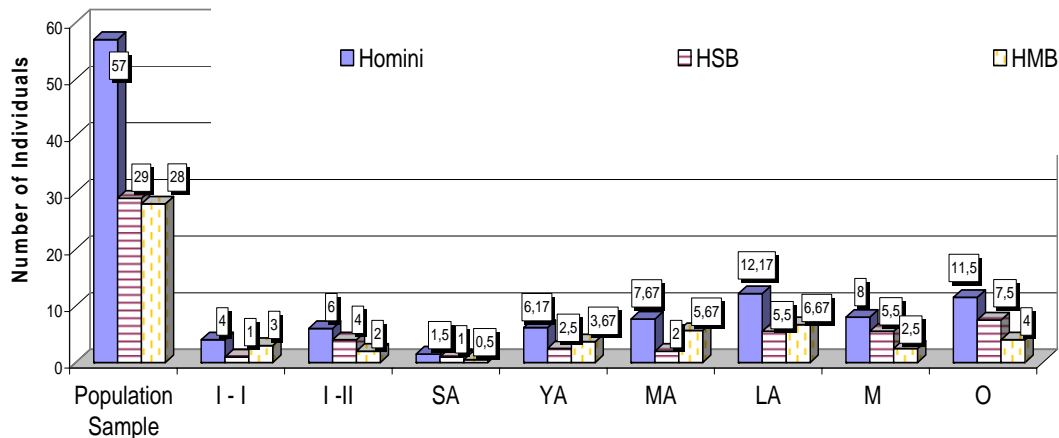
### *On exostoses*

Among the population sample of 57 homini, 47 (82.46%) were recovered with adequate preservation of cranio-infracranial skeletal surfaces enabling the conduct of physical anthropologic and paleopathologic analyses. The remaining 10 (17.54%) individuals, mainly based on taphonomic conditions, did not preserve adequate skeletal surfaces for performing paleopathological examinations. Regarding basic demographic profile dynamics the biological sex assessment of the 57 homini revealed that 25 (43.86%) were male<sup>7</sup>, 23 (40.35%) were female<sup>8</sup>, whereas 9 (15.79%) were of indeterminate biological sex. An abridged age distribution of the population sample is presented in Figure 1.

Forty three of the 47 individuals (91.49%) revealed observable paleopathologic manifestations whereas 4 (8.51%) were lacking macroscopically observable paleopathologic changes. In evaluating the population sample subgroup of 43 homini which revealed paleopathologic manifestations,<sup>9</sup> it was assessed that 35 (81.40% out of the 43) individuals were affected by

symptomatic manifestations of multiple pathologies<sup>10</sup>. Though there were considerably less homini with adequate skeletal preservation and observed pathologic manifestations among the burial contexts that yielded multiple interments as compared to the subgroup that yielded single interments, it appears neverthe-

less that the prevalence of certain pathologic changes observed appear in similar proportionalities among both subgroups; specifically as it pertains to those pathologic changes which have scored on the paleopathologic profile distribution curve the highest, and the lowest prevalence.



Category	Age Definition	# Homini / Interments
I-I = Infancy I	Birth to 6 years	4 (7.02%) / 1 single, 3 multiple
I-II = Infancy II	> 6 to 12 years	6 (10.52%) / 4 single, 2 multiple
SA = Subadults	> 12 to 18 years	1.5 (2.63%) / 1 single, 0.5 multiple
YA = Young Adults	> 18 to 25 years	6.17 (10.83%) / 2.5 single, 3.67 multiple
MA = Middle Adults	> 25 to 35 years	7.67 (13.46%) / 2 single, 5.67 multiple
LA = Late Adults	> 35 to 45 years	12.17 (13.46%) / 5.5 single, 6.67 multiple
M = Maturus	> 45 to 55 years	8 (14.03%) / 5.5 single, 2.5 multiple
O = Older (Senilis)	> 55 to older	11.5 (20.17%) / 7.5 single, 4 multiple

Population Sample = 57 homini recovered from 39 burial contexts; single (29) and multiple interments (28)

HSB = Homini Single Burial

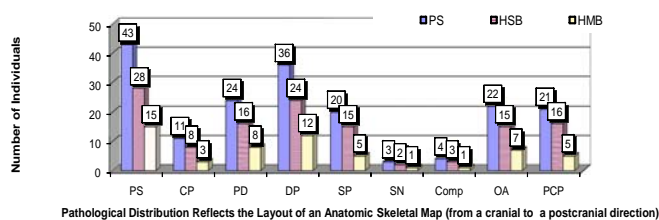
HMG = Homini Multiple Burial

**Figure 1. Age distribution among 57 homini comprising the population sample.**

To illustrate, pathologies of jaws and teeth predominated in both subgroups, whereas vertebral occupational/degenerative and/or traumatic impacts due to load bearing stress (vertebral compression, and Schmorl's nodes) showed the least incidence of sustained impact. Of note is that the predominance of dental pathologies and periodontal disease was closely followed within the overall population sample<sup>11</sup> by osteoarthropathies, postcranial-appendicular pathologies and spondyloarthropathies, while

cranial pathologies showed a relatively low occurrence superseding only the rather rare incidence of vertebral impacts (Figure 2).

In evaluating the prevalence of fracture-trauma manifestations recorded among both subgroups of single and multiple interments, it appears that more than one third of individuals with adequate skeletal preservation (nearly equally distributed among each of the two subgroups) had sustained observable fracture-trauma impacts, none of which was *perimortem*.



Pathology	# Homini / Interments
CP = Cranial Pathology	11 (25.58%) / 8 single, 3 multiple
PD = Periodontal Disease	24 (55.81%) / 16 single, 8 multiple
DP = Dental Pathology	36 (83.72%) / 24 single, 12 multiple
SD = Spondyloarthropathy	20 (46.51%) / 15 single, 5 multiple
SN = Schmorl's Nodes	3 ( 6.98%) / 2 single, 1 multiple
Comp = Vertebral Compression	4 ( 9.30%) / 3 single, 1 multiple
OA = Osteoarthopathy	22 (51.16%) / 15 single, 7 multiple
PCP = Postcranial Pathologies	21 (48.84%) / 16 single, 5 multiple

Population Sample (PS) = 43 individuals with adequate skeletal preservation and observed pathologies: 28 single, 15 multiple interments  
 HSB = Homini Single Burial

**Figure 2. Distribution of observed paleopathologic manifestations among 43 homini recovered as single and multiple interments.**

In examining this population sample for the manifestations of auditory exostoses, only one case, a bilateral expression, was identified in a male individual (Homo # 22) within the age subgroup of *Older/Senilis*, around 55 to 60 years of age at the time of death (Agelarakis et al., 2007). There were no female individuals identified with ear exostoses, possibly as a result of life conditions pertaining to cultural expectations/labor diversity issues between biological sex subgroups<sup>12</sup>. Therefore, it was decided to compare the skeleto-anatomic morphology and adaptations, as well as the paleopathologic manifestations of the individual which expressed the bilateral exostoses to the rest of a subgroup of 16 individuals that were assessed as of male biological sex<sup>13</sup>, all of which had retained their temporal bones. An endeavor was put forward to identify potential differences, variants or similarities in skeletal morphologic anatomy and/or paleopathology among the individuals involved.

***Skeletal morphologic anatomy and paleopathology of individual (Homo #22) identified with exostoses***

The temporal bones of individual (Homo # 22) showed bilateral manifestations of ear exostoses positioned at juxtaposing supero-posterior to infero-anterior loci at the external ear canals in reference to the Frankfurt horizontal plane (Figure 3).

Bilaterally the supero-posterior exostoses were nearly twice in size to their infero-anterior counterparts. The exostoses, although allowing lateral open passages toward the tympanic membrane had grown to full occlusion *intra vitam*<sup>14</sup>, indicative of cumulative osteoblastic responses to prolonged exposure and irritation to external stimuli/causative agents.

X-ray radiography of the mastoid cells revealed absence of mastoid pathologic changes.

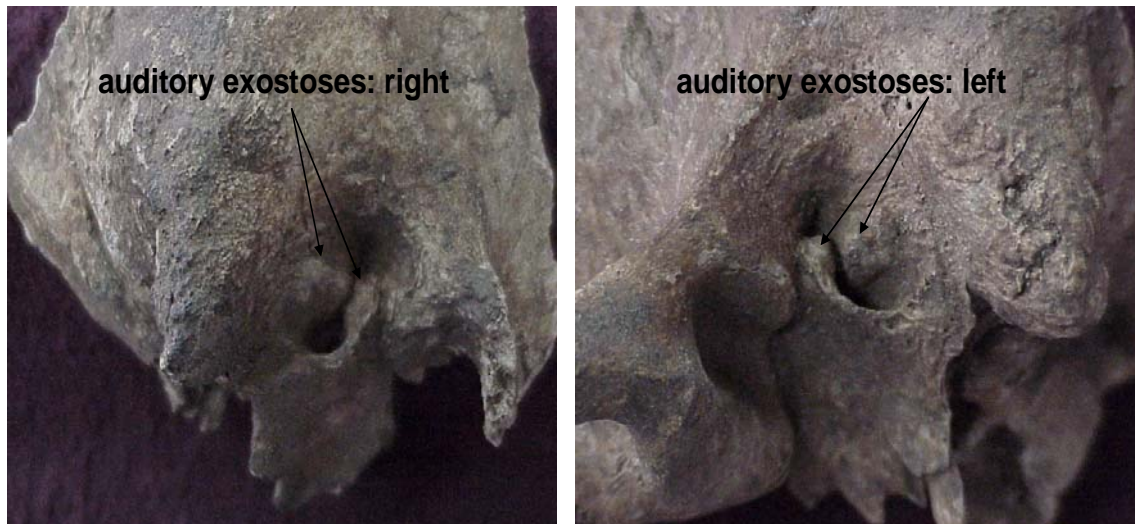


Figure 3. Temporal bone fragments revealing auditory exostoses in Individual #22.

Additionally, advanced osteoarthropathic changes in the form of pitting were observed on both temporo-mandibular joints<sup>15</sup>. Dental pathologic manifestations on anterior dentitions included linear enamel hypoplasias, indicative of early life systemic stress with incidences at 1.0 and 1.3 years of life, respectively. A significant “sigmoid” curve of Spee was accentuated in a distal direction by conditions of well healed *ante mortem* loss of posterior teeth. This was coupled by advanced periodontal disease and significant incisal and occlusal wear of dental surfaces mostly showing continuous islets of tertiary dentin mainly due to masticatory functions relative to dietary intake and conducive to aging processes.

Infra cranial axial pathologies were observed in the form of spondyloarthropathic changes affecting the majority of the vertebrae caused by degenerative processes as well as by compression impacts due to habitual/occupational conditions sustained by excessive load bearing conditions on axially oriented (non-benign) trajectory areas of stress (Figure 4). This included a sacralization process of the 5<sup>th</sup> lumbar with discernible *intra vitam* tendencies of lateral upper body dexto-rotatory/flexion of the spine, under compression tension indicative of load-bearing stress as also substantiated by emphasized enthesophytic growths manifested on the iliac plates and crests, specifically in the areas of attachment of abdominal ventro-lateral and dorsal muscular systems in synergistic antagonistic

kinetic relations to perform physically demanding actions and tasks of everyday life.

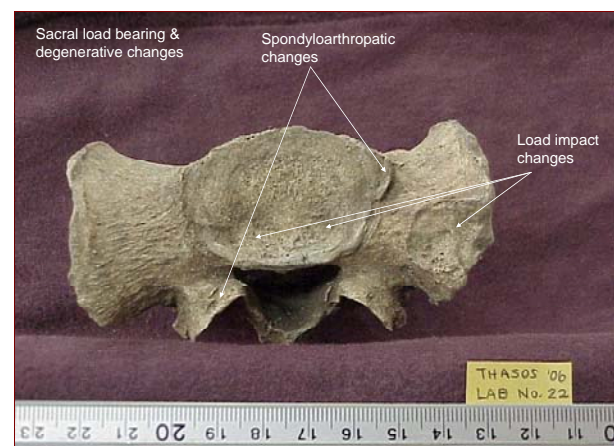


Figure 4. Lumbaro-sacral spondyloarthropathic and compression impacts in Individual #22.

The appendicular skeleton showed upper extremities of very emphasized skeletal robustness with accentuated muscular imprints at loci of origin and insertion in both upper arm bones although with greater emphasis on the right side (congruent with the dexto-rotatory preferential conditions in the flexion of the spine as explained above) in relation to the claviculo-scalular domains, also clearly traced to relevant loci at the occipital nuchal areas. Further, the scapulo-claviculo-humeral bones in relation to the forearms and extending to the bones of the hands with a greater emphasis of the right side showed a primary emphasis in the flexion and extension movements of the upper extremities in relation to medially oriented adduction proc-

esses of the extended by abduction upper extremities, while combining sino/dexto-rotatory movements of the carpal areas (in pronation and supination) with hand metacarpal and phalanges manifestations indicative of very strong hand grip. Paleopathologic changes of osteoarthritic degenerative nature were observed among the upper extremities in combination with the mesial epiphyseal areas of the clavicles, whereas such changes were more prevalent among the lower extremities especially affecting with a nearly equal distribution both proximal and distal ends of the femorae.

Furthermore, the lower extremities showed emphasized skeletal robustness and muscular imprints reflective of diaphyseal strength, and indicative of endurance and stamina during strenuous physical activities with significant muscular loci of origin and insertion (and by extension traceable at relevant loci of the innominate bones) pertinent to locomotory behavior in non precipitous substrates. Specific skeletal markers of habitual and/or occupational stress (Agelarakis, 1996) indicated the flexion of the knee joints in squatting bodily postures combined with a hyper-flexion and extension of the femurs at the hip joints.

This was a robustly built, physically very active individual *in vivo*. The manifestations of skeletal morphologic anatomy and bone plasticity as well as the paleopathological conditions observed were not necessarily atypical to the *intra vitam* circumstances and conditions of life reconstructed of the select skeletal sample of 16 male individuals of the same site, considering the parameter of age-relative degenerative changes, and in fact even of the larger coeval anthropologic collections from ancient Thasos studied to date (Agelarakis, 1997; 2001; 2002). Exceptions were the auditory exostoses as observed in Individual #22 combined with a qualitative, non metric in nature, gradient of differences observed mainly in the dexto-rotatory flexion/abduction-adduction kinetics of the spine and upper body along with the emphasis and specificity of upper extremity motions and activities as explained above. The latter conditions had been observed in some comparable form among other coeval Thasians who were however lacking any auditory exostoses and

were locomoting on precipitous substrates (i.e. for economic output and production such as in herding, lumbering, stone quarrying, etc.) in contrast with the circumstances of locomotory behavior of Individual #22 (Agelarakis, 1997; 2001; 2002).

## DISCUSSION

The observation of one case of bilateral auditory exostoses in one male individual within the Older/*Senilis* age subgroup (out of an originally larger number of individuals from the ancient necropolis of Thasos of both biological sex subgroups and lastly of a select population sample of 16 male individuals<sup>16</sup> as explained above) was initially perceived as a relatively low prevalence, even when factoring in the inability to retrieve comprehensive data from coeval cremated human skeletal remains. The low prevalence of auditory exostoses seemed to underline an anomaly especially when considering the all-season (although possibly less frequently during the winter months) exposure to sea water, including partial submersion and/or diving that may have been required in order to maintain, repair and/or restore ships (moored or docked), as recorded in ancient historical records<sup>17</sup>. During antiquity through to relatively recent periods including the first three quarters of the 20<sup>th</sup> century in the traditional wood boat crafting in Thasos (and before the wide commercial use of polymers), all exterior water-lodged boat surfaces were made of local pine tree planks exteriorly treated with ephemeral waterproofing media such as resinous lacquers produced by local Thasian resources (Kommatas, 1999), more recently superimposed by heavy duty oil-based paints.

From the earlier years of studying anthropological remains excavated at the ancient necropolis of Thasos (since 1979) and in addressing the inquiry into auditory exostoses, the possibility was considered that the near absence of such manifestations was a parameter co-relevant to a limited population sample retrieved and/or that a specific spatial domain of the necropolis had not yet been discovered. On the latter it was speculated that spatial distribution and allocation of interments within the necropolis could possibly have had a symbolic



meaning and that perhaps a segment of the necropolis in close proximity to the sea would have conceivably yielded individuals with auditory exostoses as they would have been interred at a spatial domain close to the sea shore, linking them posthumously in some ways to their *ante mortem* daily routines.

Clusters of family graves with well defined boundaries have been discovered through archaeological research to be a typical component of the funerary rights at the ancient necropolis of Thasos, and since 2003-2004 a number of such burial clusters have been unearthed next to the sea shore. Interpretations of these latter finds of the archaeological record, and specifically of the burial artifacts through preliminary analysis in addition to the discovery of one case of bilateral auditory exostoses in a severe form of expression among the male individuals of this population sub-segment, could lend support to our spatial allocation hypothesis discussed above.

Yet the prevalence of auditory exostoses observed among the population sample recovered from the necropolis domain adjacent to the sea, which was hypothesized as possibly more relevant to maritime occupational conditions, was considered as strikingly low. In an effort to provide a better understating of the available data in the context of our theorization, a measure of evaluation was acquired by bridging into ethnographic work.

### *Ethnographic examination*

Such an opportunity for participatory observation<sup>18</sup> of the occupational conditions focusing on intergroup dynamics and allocation of subspecialty responsibilities that may have resulted in the prevalence of auditory exostoses were documented since 1986 at Thasos Island among the only surviving group of wooden boat craftsmen. Their cohesive group, comprising nine male individuals of diverse age subgroups<sup>19</sup> and intra-trade specializations, perform their specialized activities in repairing wooden boats (moored or hauled) using traditional methods, techniques and tool kits, and hence expose their bodies to relatively similar circumstances and conditions of stress comparable to those of antiquity. Through participant

observation and interviews among other important realizations, it was determined that only a select intra-group crew of seven individuals may be involved in specialized activities at the Prinós dockyard or around the island either for seasonal or emergency boat repairs while only one crew member is the designated diver to investigate the conditions of the submerged hull area of a vessel.

The greatest prevalence of diving takes place whenever a vessel must be hauled for repairs to the dockyard. The vessel-hauling preparatory activities involve a team of two crew members whom enter the water up to their abdominal area and using their body weight and muscle power in a synergistic/antagonistic concert with each other aim to guide the direction of a narrow, heavyweight wooden non-floating boat slip<sup>20</sup> to be positioned on an intended center line across the length of a much longer and somewhat wider wooden structure which submerged from beneath<sup>21</sup> the domain of the partially moored vessel reaches well out to the shore. This platform will later function as the substrate for the hauling of the laden boat slip. The two crew members aim to bring the boat slip to the proximity of the prow of the partially moored vessel. Often times when the wooden vessel is of a larger size and tonnage it is moored in deeper water and thus the two crew members may ride on the boat slip and by paddling they soon come in close contact with the stem of the approached vessel. At this juncture they release the front set of floats on the boat slip side facing the prow causing it to submerge while the set of floats at the back end of the boat slip (those facing the shore) are manipulated with a predetermined rope slack<sup>22</sup> preparing for a final boat slip positioning.

Pending weather conditions and water currents, this step relays to the passing of heavy ropes (already tied to the front of the now submerged boat slip well under the stem) to four additional crew members allocated in subgroups of two aboard two small row boats, each along one side of the vessel. The latter crew members, with a dynamic rowing toward a directional from the stem area toward the stern of the vessel, aim to maintain the ropes in relative tension while always guided and in constant communication

with the hand signals and body language of the diver (with no other assistive gear than goggles and often a snorkel) who has already been submerged in the water since the initial approach and the partial mooring of the vessel. Synchronously, guided by the diver, the two crew members at the prow increase the rope slack of the floats tied at the boat slip facing the shore until it submerges enough to accommodate a good fitting of the prow and stem area at the indentation on the superior surface of the boat slip. At this juncture the wooden vessel to be hauled, propelled by the aid of its diesel motors slightly jolts itself forward<sup>23</sup>, repeating the motion a few times if positive signals are received by the vessel pilot via hand gestures from the diver, using as liaison the two crew members which in concert also manipulate the slack of the floats tied at the boat slip-end facing the shore. This process continues until the entire length of the boat slip is inserted across the entire length of the keel of the vessel at which time it is further secured from stem to stern. Often times because of water currents and weather conditions the placing of the boat slip under the keel may be more challenging to secure, especially considering constant lateral movements of the vessel to the right or left, therefore requiring repeated submersions of the diver<sup>24</sup>.

Once this stage is complete additional sets of ropes secure the boat slip to the vessel before any attempt to slowly initiate the hauling process (of the laden boat slip resting on the larger wooden substrate platform) to the dockyard<sup>25</sup> aided by heavy duty steel cables (affixed on the boat slip) pulled through a system of pulleys by a dockyard land-locked diesel motor. The diving roughly ceases at that point, the designated diver to assume other responsibilities in the ongoing process. Consequently, the diver usually remains in the water for an approximate duration of 45' to 65'.

Based on such ethnographic observations it was possible to further illuminate aspects of the nature and reasons of the authoritative role, function, and uniqueness of expertise of the designated diver, ultimately responsible for the hauling process of a vessel. Consequently the reasons for the rarity of such a master individual within his crew had become apparent, even with the influx of modern diesel motors and

steel cables. Accordingly it was possible to draw on some analogies regarding the ethnographic data and aspects of the low prevalence of ear exostoses<sup>26</sup> in the Thasian archaeological record elucidating aspects of the rarity of ear exostoses among individuals who may have been involved in maritime activities (as described above) in antiquity.

Given the ample opportunities presented over the years to observe the subsequent stages of wooden vessel repairs hauled at the dockyard it was rendered valuable to further study not only the intra crew dynamics on labor diversity but to also investigate the possibility of traditional ergonomic conditions which in involving specific bodily postures and/or repetitive actions would be able to reflect on skeletal-anatomic adaptations, trauma, and pathologic degenerative manifestations with a particular, though not exclusive, focus on the diver. Such documented conditions could possibly offer some additional, if not independent, lines of infra-cranial evidence to be juxtaposed to the infra-cranial skeletal changes and manifestations observed among Individual # 22, and the rest of the select ancient population subgroup of male individuals<sup>27</sup>.

Plank repair to the vessel is a physically demanding process, as replacement fittings and caulking with natural fiber between planks require of the crew members physical stamina and great manual precision. Caulking is a labor-intensive, load impacting activity that takes place with a traditional double-headed wooden hammer, wooden pegs, and/or metal chisels (Figure 5). It is an activity that may go on for hours based on demand and deadline pressures, affecting significantly the standing/sitting posture of the individuals involved (usually sitting on a very low bench at a squatting position with hip joint in hyper-flexion/extension) with the spine abducted from the mesial line flexed to the right (due to dexterity issues) while the right upper extremity is working in caulking at a rapid repetitive tempo.

This component of the repair work is considered by all members of the craft as the most physically demanding, distributed more broadly among crew members, namely among four experienced individuals (including the

diver) out of the initial crew of nine members. Their upper extremity joints are often swollen; especially the joints of the elbows, carpals, and fingers, as repetitive movements and a steady strong grip are required. The body postures, ventro-dorsal torso physique and muscular mass and tone of the members of the boat crafting crew were more robust<sup>28</sup> and most often differed significantly from those that were involved with other aspects of an aquatically supported economy in the region such as fishing<sup>29</sup>.



**Figure 5. Process of lateral plank caulking of moored vessel**

Such ethnographic understandings fitted well with the physical anthropological / paleo-

pathological skeleto-anatomical observations of the osseous record among male individuals recovered from contextual associations adjacent and/or peripheral to the burial feature of Individual # 22, suggestive of their involvement in similar maritime activities and tasks.

## CONCLUSIONS

Whereas this study is only a component of a larger on-going interdisciplinary project, it is proposed that the archaeo-anthropologic data in conjunction with the ethnographic results may provide evidentiary data regarding the low incidence of external auditory exostoses observed among ancient skeletal remains in Thasos.

Therefore the low prevalence of manifestations of ear exostoses might not necessarily be due to aspects of burial customs and practices (i.e. cremation) and skeletal preservation issues at large of the population sample recovered so far through archaeological excavations, but mainly of the parameter of task oriented specialization and specificity of dedicated activities within specific occupations.

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## NOTES

1. Seasonal temperature readings recorded by A. Agelarakis between 1975 to 2006
2. Plutarch (*Lives*: Kimon 14:2) indicates that the Thasians lost in a single naval battle to the Athenians 33 triremes
3. As also substantiated by both archaeological finds, and the extant so called "Limanaki" harbor of modern Thasos, which is functioning since antiquity
4. From Late Sub-Adults to the Older/Senilis age subgroups, to use comparable age subgroups as those of the archaeo-anthropologic population sample
5. Seasonal ethnographic observations at Thasos since 1975, then methodically conducted during the 1993, 1996, 1998, 2000, 2002, and 2006 Thasos Archaeo-Anthropology projects by A. Agelarakis
6. The grave contexts were excavated by a team of archaeologists headed by Dr. Stratis Papadopoulos of the Greek Archaeological Service with crew chief archeologist Sofia Stoutsoubei
7. Includes all levels of assessment certainty (i.e. males, probable males, possible males)
8. Same as footnote No. 7 but here addressing females
9. Comprising individuals from the two subgroups of burial contexts that yielded both single and multiple interments
10. Some individuals revealed up to six pathologic manifestations of different causative agents
11. In sequence of prevalence
12. Although our current investigation did not record auditory exostoses among skeletally well preserved female individuals, our approach nevertheless is not deterministic in conclusively precluding the involvement of female individuals in exposure to environments of cold water stress as may be shown in future studies
13. This selective sampling included a late Infancy II individual, age assessed between 10-11 years of age, which revealed an adequate state of skeletal preservation and developmental morphology while retaining temporal bones
14. Also considering the presence of soft tissue at these anatomic loci
15. Better discerned at the left counterparts due to issues of preservation
16. 6.25% prevalence (one case out of 16 individuals)
17. Such stipulated the need for the very frequent hauling of the boats via boat slips to shore in dockyards during both rough weather conditions seasonally and for the more serious water-proofing repairs of the hull (Herodotus *Historia* B:44, ΣT: 46, 47; Plutarch, *Lives* Kimon 14:2; Thucydides A: 100, 101, Δ: 104, H: 64; Lazos, 1996)
18. Initiated in 1975 originally for the study of traditional wood boat craftsmanship at Thasos Island, at the dockyard of Prinos harbor, and since 1966 at the nearby dockyard of the town of Kavala (at Kalafatya).
19. Consisting of one Subadult and a Senilis/Older individual, while the majority of its membership ranged between Young to Late Adulthood
20. This is a significantly sturdy, heavy and complex structure laden with iron and lead weights for purposes of stability and load bearing. It becomes somewhat buoyant by the use of two sets of two significant floats, each set tied in the front and back ends respectively and at isometric positions
21. Submerged with the aid of mooring devices
22. The ropes tying the floats are rigged to the boat slip by a system of pulleys thus providing the ability to move the boat slip from the surface (minimal rope slack) to various depths pending on the type of vessel and its keel
23. Similarly, row boats equipped with a single center mast, as observed by Agelarakis between 1966-1973 at the dock-yard of Kavala harbor, at the shoreline opposite to Thasos island, used the rowing power of 12 rowers (allocated 6 per side) to affix the row boat on a boat slip

24. On several occasions of vessel hauling Agelarakis observed the designated diver in a sequential range of 26-39 diving modes, with a varied tempo of diving intervals, and a duration of full body submergence ranging between 10'' to 45'', averaging per vessel hauling 18' of complete body submergence; a usual depth of diving is at 5 meters and occasionally deeper to about 6-7 meters for arrangements of permanently submerged anchors and ballast weights
25. Additional lateral wooden support beams and/or composites of wooden stock piles fastened between both sides of the hull to the boat slip must be secured gradually during the slow hauling of the vessel to the dockyard
26. Skeletal evidentiary data relative to ear exposure to water activities in relation to diving
27. See "Results" section
28. All else being equal it could not just had been the dietary increase in terrestrial animal protein consumption, which was the only condition they could quote us as different in their lives when compared to the conditions that prevailed earlier than 25 years ago. Undoubtedly, the habit of their traditional work has a significant effect on their body build, and acquired morpho-anatomic plasticity.
29. Given the opportunity to examine older photographs of wooden boat craftsmen it was possible to gather some additional visuals on the enhanced upper body robustness and upper extremity muscularity which was assessed that it was not a recent occurrence, characteristic of the extant group; such an understanding was also supported by the ethnographic observations in the fishing villages of Thasos