

On the use of mosses in the building of a XVth century ship in Northern Spain

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(Received 20 February 2008, accepted 11 July 2008)

Abstract – The study of two wooden pieces from the remains of the hull of an XVth century pinnace for iron ore and ironwork transport has yielded fragments of eight different bryophyte species: *Eurhynchium striatum*, *Hylocomium splendens*, *Hypnum cupressiforme* var. *cupressiforme*, *Kindbergia praelonga*, *Neckera complanata*, *Pseudoscleropodium purum*, *Rhytidiadelphus triquetrus* and *Thuidium tamariscinum*.

These remains were revealed at the archaeological site of Urbietta (Urdaibai Biosphere Reserve, Gernika, Vizcaya, Spain) and provide the first evidence of the use of mosses as caulking material for ships in Spain.

Use of mosses / ship building / caulking / Archaeology / Urbietta / Urdaibai Biosphere Reserve / Spain

Resumen – El examen de dos piezas de madera procedentes de los restos arqueológicos del casco de una pinaza venaquera del siglo XV ha proporcionado fragmentos de ocho musgos: *Eurhynchium striatum*, *Hylocomium splendens*, *Hypnum cupressiforme* var. *cupressiforme*, *Kindbergia praelonga*, *Neckera complanata*, *Pseudoscleropodium purum*, *Rhytidiadelphus triquetrus* y *Thuidium tamariscinum*.

Estos restos fueron descubiertos en el yacimiento arqueológico de Urbietta (Reserva de la Biosfera de Urdaibai, Gernika, Vizcaya, España) y proporcionan la primera evidencia del uso de musgos para el calafateado de embarcaciones en España.

Usos de musgos / construcción naval / calafateado / Arqueología / Urbietta / Reserva de la Biosfera de Urdaibai / España

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INTRODUCTION

In July 1998, during some channelling works at the mouth of river Oka, in the Urdaibai Biosphere Reserve, near the village of Gernika (Basque Country), the remains of a boat were found four metres deep in mud, and later named after the site, the Urbietta wreckage (Fig. 1A).

After giving notice to the pertinent institutions, the archaeological excavation was initiated. As it was not possible to dig the wreckage out without strong damage to the site, a laborious block extraction of the ship in its sediment bed was carried out, and so it was moved to an appropriate building for cleaning. After its reconstruction, Urbietta wreckage is provisionally preserved at the Ría de Bilbao Maritime Museum in Bilbao (Fig. 1B).

The Urbietta wreckage was spread in an area of approximately 12×5 metres. Among other pieces, the find consisted mainly in a fragment of the central part of the boat, about 5 metres of the port side, quite complete since the keel was perfectly preserved, as well as parts of the framework and the hull strakes, from keel to gunwale, joined by rivets. The reconstruction of the wreckage allowed an estimation of 11 metres in length and 2,8 m in breadth. During her construction, the hull was laid before the framework and clinker-built (the planks overlap one another), according to a system used in ship building until XVIth century. The keel was made of beech wood and the rest of the timber, out of oak wood.



Fig. 1. Urbietta wreckage. **A.** A view of the ship remains during the archaeological excavation. **B.** Final appearance of the wreckage after the reconstruction. (photos: M. Izaguirre).

C^{14} analysis dated the find about 1450-1460 A.D. Historians in charge of the excavation and study of the Urbieta wreckage describe it as the remains of a pinnace used for river navigation and for the transport of iron ore and other iron materials, clearly related to the important iron industry documented in the territory at that time.

Further information on the find and details about the characteristics of the boat can be found in Izaguirre *et al.* (2001), Rieth & Izaguirre (2004) and Rieth (2006). The Urbieta wreckage is a most interesting find since it is the only ship of its type and time in the entire Cantabrian coast, providing historic information about traditions and styles in ship construction.

During the cleaning and study of the Urbieta wreckage, the presence of masses of plant material adhered to several pieces of the hull timber was noticed. A more detailed examination proved they were mosses and subsequently the species were identified.

MATERIALS AND METHODS

The two wooden pieces from the hull of Urbieta wreckage containing adhered moss masses that have been studied are the following (Fig. 2):

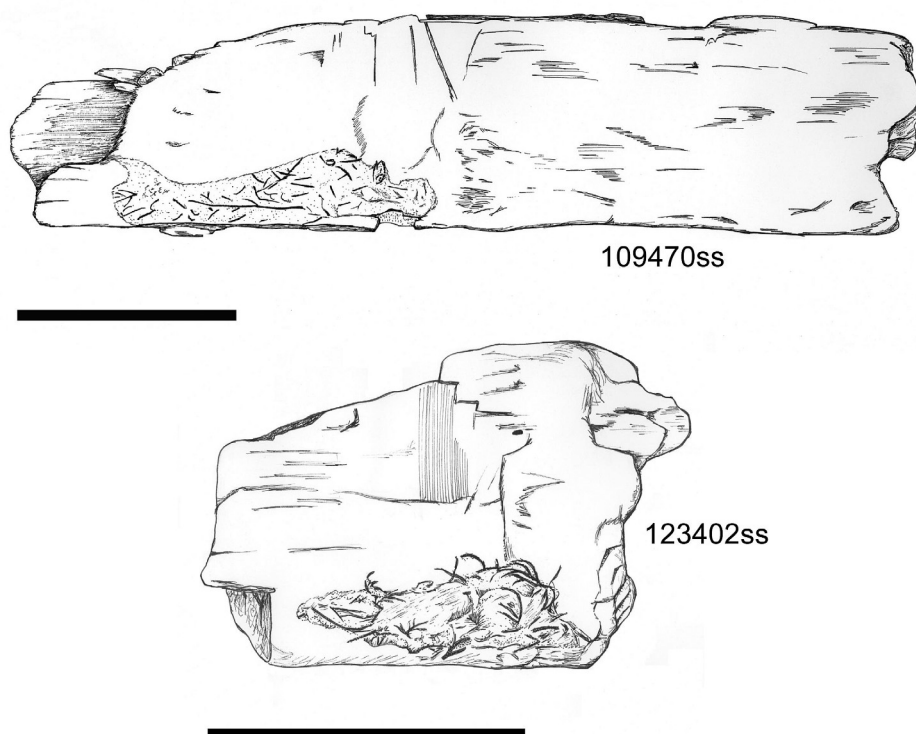


Fig. 2. Wooden pieces of Urbieta wreckage, showing adhered moss masses. Scale bars: 10 cm (drawings: M. Infante).

- 109470ss: the biggest one, elongated, approximately $41 \times 9,5$ cm. It contained a moss mass about $14,7 \times 3$ cm covering approximately 28 cm^2 of its surface, right on the edge of the plank near one of its endings.
- 123402ss: much smaller, more or less quadrate, about $15,5 \times 10,5$ cm. It held a moss mass about $9 \times 3,4$ cm and 12 cm^2 in surface, also on its margin.

In both cases, in the adhered masses, stems and branches of mosses were visible to the naked eye (Fig. 3). These masses were formed of a mixture of mosses in a hydrophobic matrix, supposedly some kind of solidified resin.

A sample of the moss mass in each wooden piece was taken for study (12 cm^2 from 109470ss and 6 cm^2 from 123402ss) and submitted to a dispersion process in KOH solution (10%). After 24 hours the moss remains were already separated; then they were washed under running water and filtered through a sieve with a 0,5 mm net. The moss remains were trapped in this net, collected and preserved in closed tubes, in a preservation medium containing ethanol (70%), distilled water (25%), glycerine (5%) and benzoic acid which acts as a fungicide.

Portions of the treated material were dispersed in Petri dishes and examined to recognize the different remains under a binocular microscope. Fragments of the different types were taken and examined under a transmitted light microscope. Identification was achieved comparing with recent specimens in VIT Herbarium (Álava Museum of Natural Sciences), where the studied samples of the Urbieta wreckage have also been deposited. The nomenclature used is that proposed by Hill *et al.* (2006).

RESULTS

In all, remains belonging to eight moss species were recovered.

Table. Recorded moss species and their frequency in the Urbieta wreckage.

Taxon	109470 SS	123402 SS
<i>Eurhynchium striatum</i>	-	+
<i>Hylocomium splendens</i>	++	+++
<i>Hypnum cupressiforme</i> var. <i>cupressiforme</i>	+	-
<i>Kindbergia praelonga</i>	+	-
<i>Neckera complanata</i>	+	-
<i>Pseudoscleropodium purum</i>	+	+
<i>Rhytidiadelphus triquetrus</i>	+++	++
<i>Thuidium tamariscinum</i>	++++	++++
++++: abundant, dominant remains		
+++ : frequent remains		
++ : scarce remains		
+ : rare remains		

Eurhynchium striatum (Hedw.) Schimp.

The remains of this moss are very rare in the studied samples, and were found only in piece 123402ss, in the form of secondary stem fragments 2 – 3 mm long and branches 5 – 13 mm long, still bearing leaves.

***Hylocomium splendens* (Hedw.) Schimp.**

Fragments of leaved stems 0,5 – 1 cm long were recovered, as well as leaved first and second order branches and loose leaves. Its remains were frequent in piece 123402ss and considerably rarer in 109470ss. Both stem and primary branches fragments still preserved their paraphyllia.

Hypnum cupressiforme* Hedw. var. *cupressiforme

Very rare fragments of apical parts of branches 1,2 – 1,7 mm long, bearing leaves, and some loose leaves, exclusively found in piece 109470ss.

***Kindbergia praelonga* (Hedw.) Ochyra (*Eurhynchium praelongum* var. *stokesii* [Turner] Dixon)**

Very rare remains were recovered just from piece 109470ss, consisting in stem fragments 1 cm long maximum which still kept leaved primary and secondary branches. These remains are attributed to var. *stokesii* since they show two types of branches (bipinnate moss), because of the size of medial cells in leaves from secondary branches (30-35 x 4-5 µm, 6 – 8,2 times as long as wide) and of the squarrose acumen of the stem leaves.

***Neckera complanata* (Hedw.) Huebener**

Just an apical fragment of branch (3,8 mm long) was recovered from piece 109470ss. Even leaf axillary hairs were preserved in this remain.

***Pseudoscleropodium purum* (Hedw.) M. Fleisch.**

Rare leafy stem and branch fragments, sometimes branched, about 0,4 - 1 cm long, as well as loose leaves, were recovered from both pieces.

***Rhytidiadelphus triquetrus* (Hedw.) Warnst.**

Its remains appeared in both pieces, frequent in 109470ss and rarer in 123402ss. They consisted in thick and rigid stem fragments (0,7 – 1 mm diameter), up to 2 cm long and sometimes showing remains of branches. Most of these stems appeared leafless, although leaf bases were still present. Stem leaf fragments were also recovered, even some leaves which were almost complete but torn because of their size and rigidity (Fig. 4A). Anyway, their characteristic areolation could be observed, showing rectangular cells with porose walls (Fig. 4B). Even the branch leaves were more abundant and, being smaller, they used to appear entire.

***Thuidium tamariscinum* (Hedw.) Schimp.**

The remains of this moss were the most abundant and present in both pieces. Leafy stem fragments with exceptionally well preserved branches, even tripinnate, 1,5 – 2 cm long, were recovered, as well as first and second order leaved branches and loose leaves. These fragments kept their paraphyllia intact.

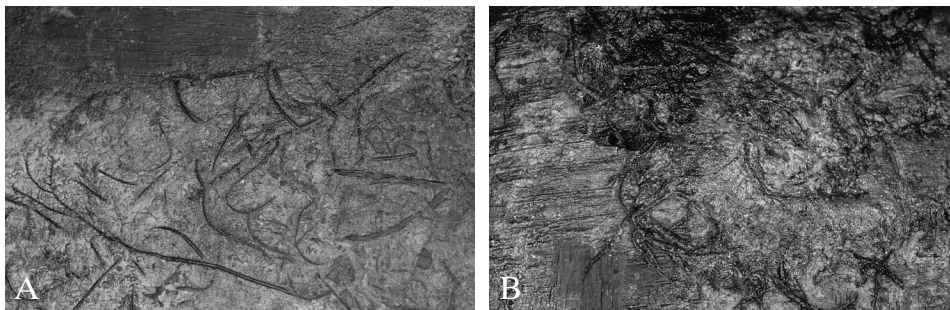


Fig. 3. Moss masses agglutinated by presumed resin. **A.** piece 109470ss, **B.** piece 123402ss (photos: P. Heras).

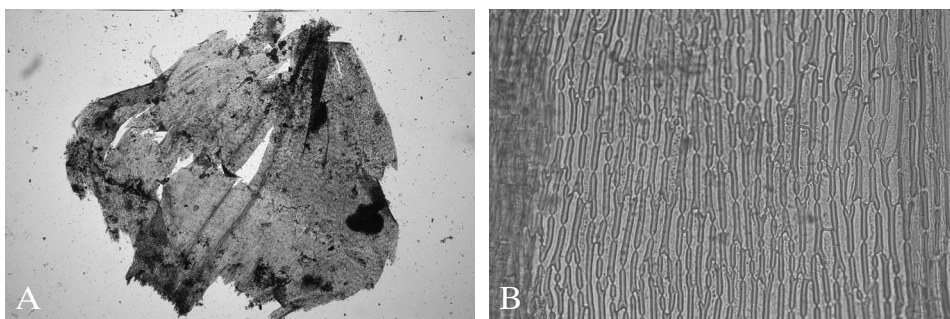


Fig. 4. *Rhytidiadelphus triquetrus* from Urbieta wreckage. **A.** Stem leaf. **B.** Cell areolation of a stem leaf (photos: P. Heras).

DISCUSSION

The study of the Urbieta wreckage provides evidence for the use of bryophytes in ship construction in Basque late medieval shipyards. In total, eight moss species were used in the construction of this pinnacle destined to fluvial navigation during XVth century.

Among these eight species, the remains of just three (*Hylocomium splendens*, *Rhytidiadelphus triquetrus* and *Thuidium tamariscinum*) were abundant or frequent, dominating in the masses adhered to the timber in the boat hull. These three species were found in both studied wooden pieces. The rest (*Eurhynchium striatum*, *Hypnum cupressiforme* var. *cupressiforme*, *Kindbergia praelonga*, *Neckera complanata* and *Pseudoscleropodium purum*) is represented by small quantities and disperse fragments, most of them just present in one of the studied pieces.

All the recovered remains belong to mosses (Bryopsida), large perennial pleurocarps that live on humus-rich soils in forests and fresh humid shrub land. The only exception is *Neckera complanata*, a moss typically from vertical parts of calcareous humid rocks and trunks of big trees. It is important to notice that none of them is an aquatic species which could have grown *in situ* over the wreckage.

All the recorded moss species share some characteristics. They are large and branched or highly branched species that form conspicuous populations in large lax and spongy masses which can be compacted, and so, very adequate for fillings and paddings. In particular, *Hylocomium splendens* and *Thuidium tamariscinum* have paraphyllia that give them an additional ability to absorb and retain liquids. These properties point clearly to the intentionality of filling spaces among the boat timberwork.

All the found species are common in the forests and shrub lands of this region (Heras Pérez & Infante Sánchez, 2000), which supports the belief of archaeologists in charge of the Urbieta wreckage that the boat was built not far from the area where her remains were found.

In summary, the final interpretation is that these mosses were *ex professo* collected in the forests and shrub lands not far from where the Urbieta wreckage was found, intentionally mixed with resin into a paste and used as caulking material for the boat in the shipyards.

The Urbieta wreckage is so far the only notice of mosses used in the history of naval building in Spain. However, the use of bryophytes as caulking material in other European countries is well documented, especially in The Netherlands, where, in addition to *Sphagnum* remains, 35 different bryophytes (1 liverwort, 7 acrocarpous an 37 pleurocarpous mosses) have been recorded in 98 different shipwrecks (Cappers *et al.*, 2000; Kuijper, 2000). Besides, this use has been also reported in Germany and Denmark (Frahm & Wiethold, 2004) and England (Dickson, 1973). Chronologically, although the majority of the findings have been dated from mediaeval times, the use of bryophytes in the shipbuilding as caulking material extends from the Bronze Age in England (Dickson, 1973) until very recent times (XVIIIth and XIXth centuries) in The Netherlands (Cappers *et al.*, 2000) and the Northwestern Highlands of Scotland, where a boat builder was observed using moss mixed with tar for caulking (Dickson, 1973: 194).

Acknowledgements. We wish to thank Prof. James H. Dickson, Jan-Peter Frahm and Wim J. Kuijper for their help providing information and literature on the uses of bryophytes as caulking material.

Dedicamos este trabajo a la Dra. Casas, para quien el trabajo bien hecho siempre fue lo verdaderamente importante.

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