Mosses used for Caulking the Early Bronze Age Logboat from Degersee, Southern Germany

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Zusammenfassung: *Dickson J.H. et al. (2013) Mosses used for Caulking the Early Bronze Age Logboat from Degersee, Southern Germany*
In einem etwa vor 4000 Jahren aus Erlenholz gefertigten Stammboot wurde im Zwischenraum zwischen einem Heckbrett und einer in den Boden eingelassenen Nut Kalfatmasse beobachtet. Es handelt sich dabei vor allem um *Anomodon viticulosus*, zudem wurden dreizehn weitere Moosarten sowie ein Lebermoos nachgewiesen. Die botanische Auswertung erlaubt die vorläufige Aussage, dass das Boot nicht unmittelbar am Degersee kalfatert wurde, oder aber dass die Moose im weiteren Umfeld des Degersees gesammelt wurden und zum Boot transportiert wurden.

Abstract: *Dickson J.H. et al. (2013) Mosses used for Caulking the Early Bronze Age Logboat from Degersee, Southern Germany*
A boat dug out of a *Alnus* (alder) trunk about 4,000 years ago had the space between the transom (stern) board and the slot cut in the hull caulked with mosses principally a mass of *Anomodon viticulosus* but there were thirteen other mosses and one liverwort. The mosses allow the tentative deduction that the boat may not have been caulked at Degersee or, if caulked there, the mosses had been gathered elsewhere in the vicinity and brought to the boat.

Introduction

Situated a little to the north of the east end of Bodensee (Lake Constance), Degersee is a lake lying west-east in south-easternmost Baden-Württemberg; the border with Bayern (Bavaria) runs north-south at the eastern extremity of the lake. The largest of four small lakes, Degersee lies in an inter-drumlin depression and has a longest axis about 1km, a shorter axis of about 400m and a maximum depth of 12m. There are only trivial inflows from a catchment of some 136ha and there are no outflows.

At the northern shore of the lake submerged prehistoric settlements have been investigated from 2004 on. When a logboat was discovered nearby a Neolithic pile field, a rescue excavation had to

be carried out (Fig.1) Unfortunately, the precise area is a popular bathing site, and the logboat, located in 3,1m depth directly below one of the wooden footbridges used by bathers, showed distinct signs of damage. The canoe, which had been dated to the Early Bronze Age (Radiocarbon date: 1925 – 1880 BC), was documented and raised in 2007. The boat has been taken to file as *Degersee 2004*. It is 5,31m long overall, and max. 0,66m wide (Fig. 2). After investigation it was re-located into the lake and buried into lake sediments (Mainberger 2009).

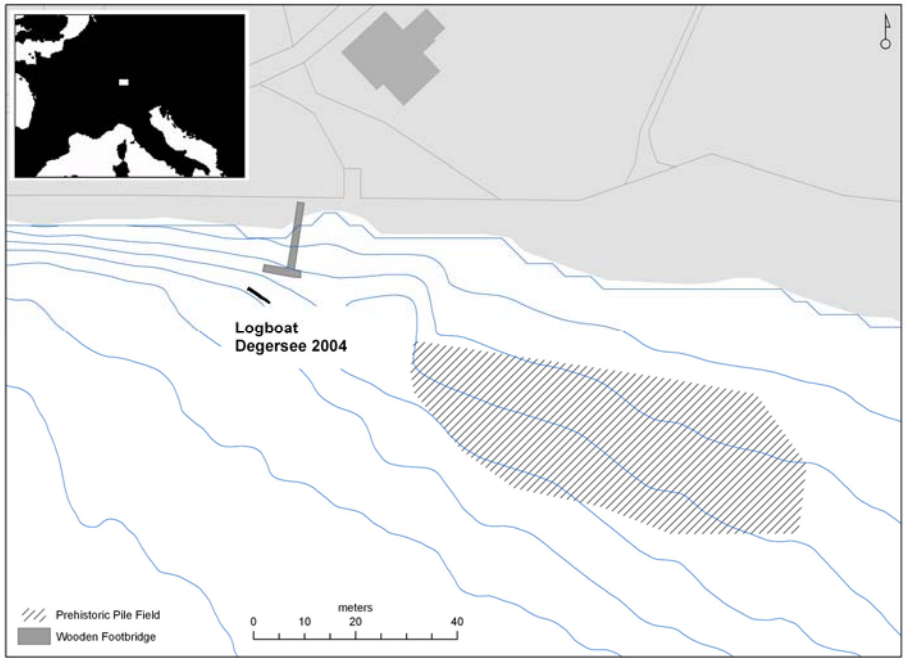

Fig 1: Site plan.

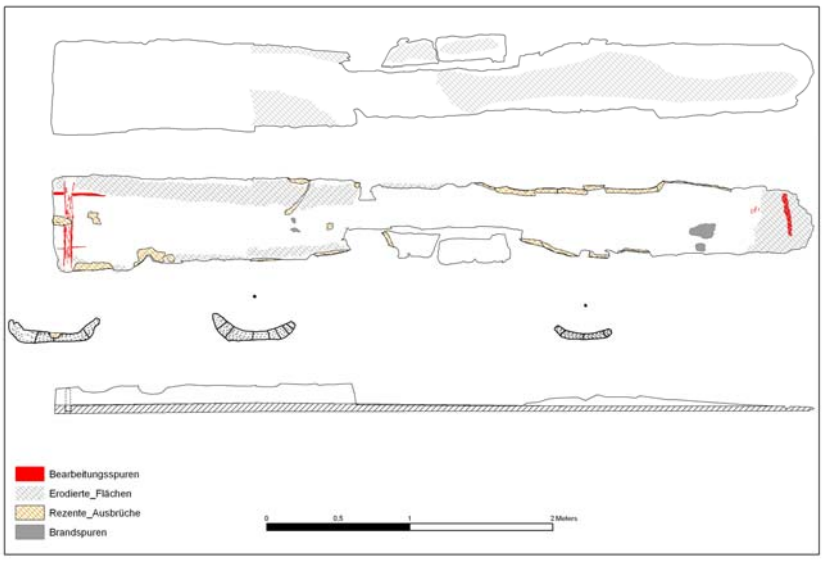

Fig 2: Plans and sections of the logboat 2004

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While the bow sections of the boat were exposed, eroded and fragmented, parts of the massive stern had been still embedded into protecting sediments. The most eye-catching feature of the stern is a transom board fitted into a 4cm deep slot cut into the bottom and into the sides of the canoe.

Fig 3: W. Müller cleans fragments of the stern section.
(Photograph: LAD / M. Mainberger).

At some places in the gap between the transom board and the slot a mass of plant remains could be observed; it seemed to be obvious that this could be the remains of a caulking. When the boat was raised, the stern was treated with special care, and could be observed in detail on dry land (Fig.3). Samples of the plant material were also taken under controlled laboratory conditions.
When the transom board – which was only partly preserved - was removed from its slot it became clear that originally the whole interspace had been filled with moss and other plant remains. All plant material had been rammed into place and resembled flat cakes. Some small stones were also found inside the gap.(Fig. 4). It cannot be excluded that these quartzitic stones are a result of water movements caused by bathers; but it is also possible that at least some of them are part of the caulking. The sharp–edged stones could have been used as wedges to prevent the moss from falling out of the gaps. The cleaned slot showed signs of a sharp tool, possibly a metal chisel (Fig 5).

Fig 4: Fragment of the stern after removing of the transom board.
Mosses and some stones are rammed into the slot (Photograph: LAD / M. Mainberger).

Fig 5: The stern section after removal of the caulking materials.
At the inside of the gap traces of tools can be observed (Photograph: LAD / W. Müller).

Most monoxylous boats in Europe have been made of oak (*Quercus*) (Arnold 1995) but that from Degersee is made of alder (*Alnus*); widespread in Europe, a waterside tree *Alnus glutinosa* grows around the lake.
There were three samples of caulking material labelled 2007-155, quadrant 439/482 and with signature eb, and then 37 or 38 or 39. They were more or less dense, especially 37, with flat sides, hardly surprising because the caulking had been forced between the tramsom (stern) board and the slot cut in the hull of the boat.
Sample 37. This consisted of two pieces, together about 25ml volume. It consists of over 99% of the moss *Anomodon viticulosus* with the rest made up of very small pieces of other mosses, very small fragments of dicotyledonous leaves (tree leaves) and tiny pieces charcoal and some fine sand. (Fig 6 and Fig 7).

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Fig 6: Part of the caulking showing the moss *Anomodon viticulosus* (Photograph. LAD / M. Mainberger).

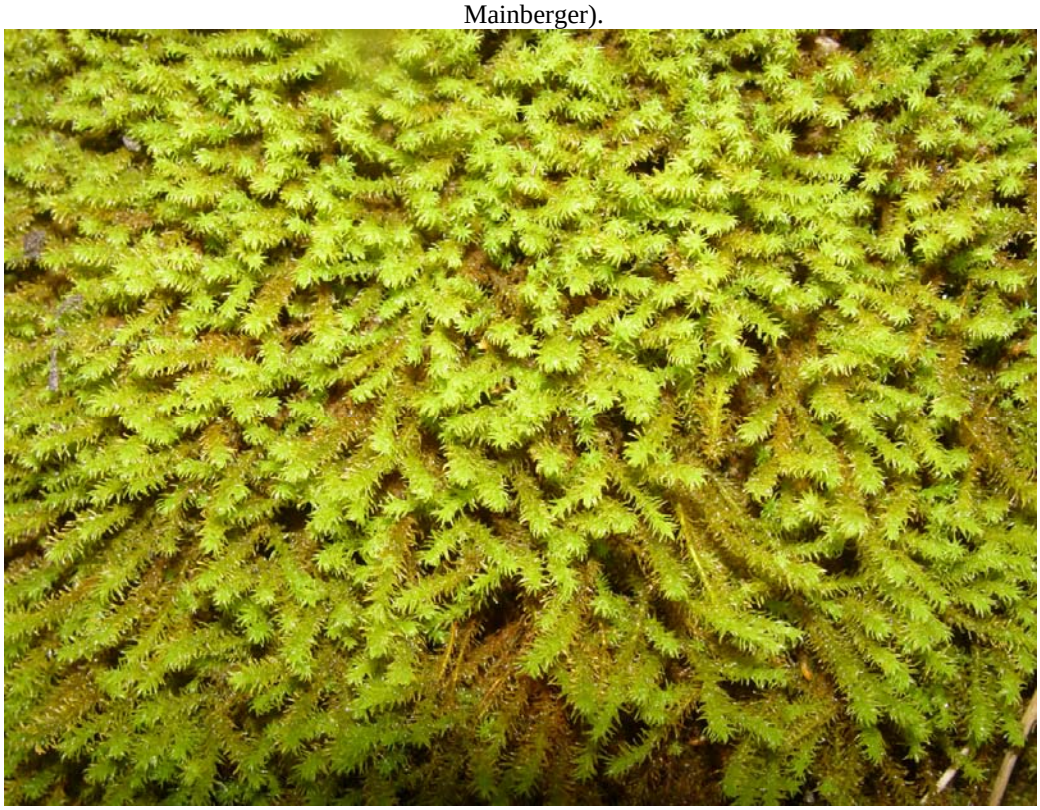

Fig.7: The moss *Anomodon viticulosus* growing on a limestone wall near Chemilly, Haute-Saône, France (Photograph J.H.Dickson).

Sample 38. This was about 37.5 ml volume in total but when the plastic bag was opened it was in several pieces, one much larger than the rest. It was obviously mossy but also gritty to the naked eye, with twigs and pieces of wood and charcoal, sand and small fragments of tree leaves.

Sample 39. This was about 62.5 ml volume and crumbled somewhat when removed from the bag. It was obviously mossy with much grit and sand, even a few small pebbles, substantial pieces of wood and charcoal, twigs and small fragments of tree leaves.

Table 1 shows the mosses and one liverwort found in the three samples and also the other kinds of plants, charcoal, the alga *Chara* and the bryozoan *Cristatella* and a contaminant grass.

Results

Table 1 Plants identified from the three samples of caulking

Bryophytes (Mosses and Liverworts)	**Bryophyte Code**	**37**	**38**	**39**
Amblystegium serpens	1st; 2mm; g		+	
Anomodon longifolius	7st; 7mm; g	+		+
Anomodon viticulosus	Many st: 80mm, vg	+		+
Antitrichia curtipendula	1st; g; 60mm			+
Brachythecium rutabulum	3st; 25mm;g		+	+
Eurhynchium angustirete	Many st; 20mm, vg	+	+	+
Homalia trichomanoides	1lf; b	+		
Hypnum cupressiforme s.l.	6st; 15mm; g. 2lf;g		+	+
Neckera complanata	3st; 7mm; g. 3lf; g	+		+
Neckera pumila	1lf; g			+
Plagiomnium undulatum	2st; 10mm,b		+	
Rhytidiadelpus triquetrus	7st; 80mm;g		+	+
Thuidium delicatulum	3st; 10mm; g		+	+
Thuidium tamariscinum	Many st; 80mm;vg		+	+
Leafy Liverwort	1st; 15mm; vb			+
Woody Plants				
Abies alba	11 leaves/fragments		+	+
Alnus glutinosa	4 seeds			+
Fagus sylvatica	1 seed			+
Frangula alnus	2 seeds			+
Malus/Pyrus	1 seed			+
Rosaceae	1 prickle			+
Rubus fruticosus	4 seeds			+
Rubus idaeus	1 seed			+
Rubus sp	1 seed			
Sambucus nigra	2 seeds			+
Sambucus sp	1 seed			+
Tilia cf . platyphyllos	1 seed			+
Non-woody plants				
Carex sp tricarp	3 seeds		+	+

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Fragaria cf. vesca	2 seeds			+
Najas intermedia	1 seed			+
Najas marina	6 seeds		+	+
Triticum astivum/durum (carbonised)	1 seed			+
Miscellanea				
Chara (Alga)	2 oospores		+	+
Cristatella mucedo (Bryozoan)	1 statoblast			+
Poaceae (Grass, germinated, contaminant)	1 seed			+
Charcoal		+	+	+
Sand		+	+	+
Grit			+	+
Pebbles				+

Moss code: number of stems, length of longest stem, state of preservation. Vg very good, g good, b bad, vb very bad (Dickson 1973).

Apart from *Anomodon viticulosus*, sample 37 had three other mosses: two, very short and very slender stems of *Anomodon longifolius*, two very short and slender stems of *Neckera complanata* and one leaf of *Eurhynchium angustirete*. Very common in southern Germany and elsewhere in central and western Europe, *Anomodon viticulosus* grows on more or less shaded, often vertical outcrops of limestone, walls and on trunks of trees growing on limy soils. It can form very extensive patches and often grows with *Neckera complanata*, another very common calcicolous moss. The *Neckera complanata* from sample 37 is so very small and thread-like that it probably came from the filiform shoots that *N. complanata* very often produces; these act as propagules. So the *N. complanata* need not have been growing in the gathered patch of the *A. viticulosus*. *Anomodon longifolius*, like the *N. complanata*, also grows filiform shoots and is often found with *A. viticulosus*. Shady calcareous rocks are the habitat and so are trees, though rarely.

A mere single leaf from sample 37 but with much better representation in the other two samples, *Eurhynchium angustirete* is usually ground-dwelling and often abundant in woodland on limestone. The *Neckera* and *Eurhynchium* are very common in southern Germany, the *A. longifolius* less so but locally abundant (Frahm and Lobin 2006, Meinunger and Schroder 2007, Nebel and Phillipi 2000).

There are eight mosses from sample 38, twice as many as from sample 37, and the precise habitats from which they were collected could have been varied. The two most numerous species are *Thuidium tamariscinum* and *Eurhynchium angustirete*; both are primarily ground-dwelling mosses of woodland often on base-rich soils. This also true of *Rhyidiadelphus triquetrus*, *Thuidium delicatulum* and *Plagionmium undulatum*.

It is possible that sample 37 was taken from a tree trunk or base-rich rock in woodland while sample 38 derives from a woodland floor. Sample 39 has no less than *eleven* mosses and one liverwort. However, it derives from a mixture of habitats: Trees or rocks *Anomodon viticulosus*, *A. longifolius*, *Antitrichia curtipendula* and *Neckera complanata* and woodland floor *Eurhynchium angustirete*, *Thuidium delicatulum* and *Thuidium tamariscinum.*

The one liverwort from sample 39 has cells of a liverwort but the leaves are very battered with not a single intact leaf or even part of a middle or upper margin; this makes further identification very difficult, perhaps impossible.

It is striking that no remains of algae, coniferous plants or flowering plants were found in sample 37. This is in contrast with sample 38 with four such plants and especially sample 39 with no less than seventeen.

In both 37 and 38, the alga *Chara*, which always grows submerged, must have come from the lake, as did the two species of *Najas*, both submerged aquatics. The statoblast of the bryozoan *Cristatella mucedo*, an aquatic organism, found in sample 39, must also have come from the lake. Usually a waterside tree, the *Alnus* has fruits adapted for dispersal by water could have come from the lake but if the caulking mosses were gathered from near the edge of a lake or river, a not improbable scenario, then the fruits could have dropped from the tree straight onto the mosses. The needles of *Abies* could also have dropped directly onto the mosses. Sample 39 contained twelve plants, not found in the other two samples. The *Fagus* (beech) could have been in the woodland and the fruit dropped onto the mosses.

The grit and certainly the small pebbles in sample 39 would never have been used as caulking they must have come from the lake or river and so got washed into the caulking slot. The photograph (figure 8) in Mainberger (2008) shows small stones in the slot.

After picking out and being kept briefly in water with the other plant remains, the grass from sample 39 germinated. It is a contaminant and this raises the possibility that some of the other seeds may also be contaminants, though they need not be so. However, there are three fully aquatic plants: the two species of *Najas* and the *Chara*. It is improbable that they were naturally among the mosses, all gathered from non-aquatic habitats, used for caulking. They arrived in the slot after the caulking or at some time during the last four thousand years when the boat was in use or after it was abandoned and sank. None of the non-aquatic woody and non-woody plants need be considered as deliberately used as caulking but were accidentally present among the gathered mosses as minor components.

Discussion

The fourteen mosses and one leafy liverwort recorded here as caulking of the Degersee logboat are all more or less familiar from prehistoric and later archaeological contexts and, indeed, some are very commonly found. For example, *Neckera complanata* and *Anomodon viticulosus* were both found with the Tyrolean Iceman, as were *Amblystegium serpens* and *Antitrichia curtipendula* (Dickson 2000, Dickson *et al.* 1996, Dickson *et al.* 2009, Dickson 2011). It is more directly apposite to discuss whither any of the mosses have previous records as caulking and the answer is affirmative. There is nothing surprising in finding any of the 14 species of mosses (and the one liverwort) for use as caulking material and, moreover, some of them have other very noteworthy records as caulking for prehistoric, historic and even modern boats. Again, the two best examples are *Anomodon viticulosus* and *Neckera complanata* (Saatkamp *et al.* 2011).

It has been known for several decades that mosses have been used for caulking Bronze Age boats including the elaborate, sewn-plank, seagoing craft from North Ferriby, Yorkshire, England (Dickson 1973) and from Dover, Kent, England (Clark 2004). Numerous bryophytes have been

recorded as caulking for prehistoric canoes at least twice before; no less than 23 species were found in the stern board slot and a patch on a Bronze Age canoe found at Brigg, Lincolnshire, England (Dickson 1973). Another English canoe, this time from the Iron Age (at Holme Pierrepoint, Nottinghamshire) had six mosses plugging a crack (Dickson and Ransome 1968, Dickson 1973).

One ecological aspect covers all the Degersee mosses. They can be characterised as woodland mosses, though none can be stated to be completely exclusive to such a habitat. However their microhabitats can differ. Some are epiphytic (growing on tree trunks and branches) while others are terrestrial, that is growing on the ground often in woodland. It is entirely plausible that the gatherer of the mosses stripped the *Anomodon viticulosus* from a tree trunk in a humid woodland and then bent down and collected *Thuidium tamariscinum* and *Eurhynchium angustirete* from the very ground below the tree. The tree trunk habitat and the ground habitat are not as entirely clear-cut as they may sound. It is true that, for instance, *Thuidium tamariscinum* grows mainly terrestrially but it can grow on stumps and well up trunks too; JHD has seen it as high as almost 2m up trunks in deciduous woodlands of Haute-Saône, France. *Eurhynchium angustirete* could have spread from the ground over exposed roots and onto the lowermost parts of trunks.

A recurring topic in considering mosses for caulking is "Were the species of mosses deliberately selected rather than simply any mosses picked up because they were common and so easily found and large enough for the task?" Excepting *Amblystegium serpens*, the fourteen Degersee mosses are more or less large ones. The latter idea seems the better in this case.

Do the caulking mosses have any geographical significance? Where was the *Alnus* trunk dug out to make the canoe, the transom board fitted and then caulking rammed into place? Were the mosses gathered from near where the boat was found or not? The answer is that there is nothing whatever that can be taken as a clear indication of collection from far away from Degersee though there is nothing to exclude that possibility either.

Could the mosses have been collected from around the very lake? To try to answer that question JHD and GM-JL visited the area on 2nd and 3rd August 2010.We recorded bryophytes on the north side of the lake and especially at the south side by walking around the Höhenberg, a rounded hill reaching 528m a.s.l., a mere 50m above the lake surface (Fig. 8). This low hill is heavily wooded with various trees and tall shrubs. Much of the tree cover may be the product of planting in the last hundred or so years. There were no rock outcrops but stones and small boulders were encountered and these result from Wurmian glacial activity. We encountered no species of *Anomodon*, and no species Neckeraceae anywhere we looked in the immediate vicinity of the lake. In this precise context the superficial geology matters greatly. The two species of *Anomodon* and *Neckera complanata* show a preference for limy or otherwise base-rich geology and so their absence from the vicinity of the lake is unsurprising.

Fig 8: View across the Degersee to the south. In the right background the Höhenberg (Photograph: LAD / M. Mainberger).

Therefore, assuming that the bryoflora around Degersee has not changed drastically over the last four thousand years or so, the boat was not caulked there and so perhaps was not constructed there either. Or if indeed the boat was built there then the caulking mosses came from some area nearby with more base-rich conditions. To deduce anything more would need very detailed bryological surveying of the region but we did find both the *Anomodon viticulosus* and the *Neckera complanata* on the trunk of a large willow (*Salix*) on the bank of the river Argen just upstream of the suspension bridge, some 5km southwest of Degersee. If the canoe was used for many years then perhaps there was more than one episode of caulking. However, there is no hint from the mass of mosses of multiple caulking.

MM (2013) has drawn attention to the lack of caulking reported from the many prehistoric logboats found in southern Germany, especially at the archaeologically rich Federsee where there have been no less than 56 logboats documented. If any of these canoes had transom boards, deep cracks or patches then the practice of caulking, particularly with mosses, must surely have taken place. The caulking had been lost before, possibly long before, or during the recoveries or was simply missed or even ignored by the discoverers. The Degersee boat shows the potential of information to be gained from investigating plant caulking, particularly mosses. It is information of interest to both archaeologists, bryologists and ethnobiologists alike.

Literature

Arnold, B. 1995. Pirogues Monoxyles d'Europe Central. *Archéologie Neuchâteloise* 20, 1-187.

Clark, P. 2004. *The Dover Bronze Age Boat.* Swindon; English Heritage.

Dickson, J. H. 1973. *Bryophytes of the Pleistocene* Cambridge Uiversity Press.

Dickson, J.H. 2000. Bryology and the Iceman: Chorology, Ecology and Ethnobotany of the Mosses *Neckera complanata* Hedw. and *Neckera crispa* Hedw. Pages 77-88 in Bortenschlager, S. and Oeggl, K. (editors) *The Iceman and His Natural Environment. The Man in the Ice Volume* 4. Wien: Springer Verlag.

Dickson, J.H. 2011. *Ancient Ice Mummies.* Stroud: The History Press.

Dickson , J. H, Bortenschlager, Oeggl, K., Porley, R. and McMullen, A. 1996. Mosses and the Tyrolean Iceman's Southern Provenance. *Proceedings of the Royal Society of London B*, 263, 567-571.

Dickson, J.H., Hofbauer, W., Porley, R., Schmidl, A., Kofler, W. and Oeggl, K. 2009. Six Mosses from the Tyrolean Iceman's Alimentary Tract and their Significance for his Ethnobotany and the Events of his Last Days. *Vegetation History and Archaeobotany* 18, 13-22.

Dickson, J.H. and Ransom, M.1968. Report on the caulking from the Home Pierrepoint Canoe No. 2. *Transactions of the Thoroton Society of Nottingham* 72, 29.

Frey, W. Frahm, J-P. and Lobin, W. 2006. *The Liverworts, Mosses and Ferns of Europe.* Colchester; Harley Books.

Mainberger, M.2009. An Early Bronze Age Logboat from Degersee, Southern Germany. *The International Journal of Nautical Archaeology* 10, 1-10.

Mainberger, M. submitted. Die Einbäume der Siedlung Forschner und des Federseeriedes. Die früh- und mittelbronzezeitliche Siedlung "Forschner" im Federseemoor. Naturwissenschaftliche Untersuchungen. Bohlenwege, Einbäume und weitere botanische Beiträge. *Siedlungsarchäologie im Alpenvorland XIII. Forsch. u. Ber. Vor- und Frühgesch.* Baden-Württemberg.

Meinunger, L. and Schröder, W. 2007. *Verbreitungsatlas der Moose Deutschlands* Band 3. Regensburg; Regensburgische Botanische Gesellschaft.

Nebel, M. and Philippi, G. 2000. *Die Moose Baden-Württembergs Band 1, 2 and 3.* Stuttgart: Eugen Ulmer.

Saatkamp, A., Guyon, M. and Philippe, M. 2011. Moss caulking of boats in Upper French Rhône and Saône (Eastern France) from the 3rd to the 20th century and the use of *Neckera crispa* Hedwig. *Vegetation History and Archaeobotany* 20, 293-304.