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ANCIENT MONUMENTS LABORATORY

Report no. 2611

BAYHAM ABBEY WOOD -- CONSERVATION

Experiments with the freeze-drier

B. Knight & M. Foley

ABSTRACT

As a test of the performance of the Edwards EF2 freeze-drier, three very different waterlogged wooden objects were treated, and the results compared with the acetone/rosin method. In this case the freeze-drying proved more satisfactory than the acetone/rosin.

AM LAB REPORT: BAYHAM ABBEY WOOD - CONSERVATION

1. Experiments with the freeze-dryer

As a test of the performance of the Edwards EF2 freeze-drier, three very different waterlogged wooden objects from Bayham Abbey were treated by Marga Foley (Institute of Archaeology) and myself.

The objects treated were:

775133 (114) Rectangular block of oak* (After photo BA4) Small hole in top centre, slight signs of charring on top surface. Had started to crack before treatment commenced, but otherwise in good condition.

775134 (173) Turned bowl (?) fragment in ash* (After photo BA3) Remains of an iron nail in the centre of the round part. In very bad condition, severely worm eaten, soft and spongy to the touch.

775135 (174) Ball of alder* (After photo BA5) Originally in two parts; various fragments missing. Soft but fairly good condition. Evidence of insect activity under a tightly adhering layer of leaves on the surface.

For comparison, another object was treated by the acetone/rosin method:

775136 (175) Thin strip of boxwood* (After photo BA1).

In good condition, with slight cracking.

* Wood identifications by Carole Keepax (AM Lab)

2. Methods of treatment

(1) Following Ambrose (1) and Rosenqvist (2), the three objects to be freeze-dried were immersed in a 10% solution of PEG 400 in water for 5 weeks, at a temperature of about 40°. It is probable that the PEG had penetrated well into the very degraded and porous and comparatively thin ash object (775134), but less well into the more solid and thicker oak block (775133). (Ambrose recommends at least 3 months soaking, up to 12 months for large objects, while Rosenqvist says that 3-4 weeks is sufficient for objects 1-2 cm thick).

The object of impregnating with PEG 400 is not consolidation, as with PEG 4000, but to prevent damage to the wood on freezing, and to reduce stresses as the water sublimes away. It also reduces shrinkage.

The objects were then placed in the freeze-drier and pre-frozen at about - 40°C for 24 hours. A thermocouple was placed in one of the cracks in the oak block, but this did not penetrate very deeply so the core temperature was not measured. They were weighed, and the chamber was evacuated to about 0.2 torr. No artificial heat was applied to aid sublimation of water. Every day the vacuum was broken and the objects were removed and weighed. This was done sufficiently quickly that they did not thaw out. Drying was continued until constant weight was obtained.

(2) Acetone/rosin treatment

The method used was substantially that of McKerrell et al (3), except that the hydrochloric acid wash was omitted. This was not felt to be necessary as the object treated was very thin and not at all iron-stained.

The strip of wood was dehydrated in successive baths of acetone for a total of four weeks and then immersed in a saturated solution of acetone in rosin at about 40°C for five weeks. At the end of this period, the object was removed from the rosin solution and allowed to dry out. Finally excess rosin was removed by swabbing with acetone.

Results

(1) The weights of the objects declined roughly exponentially. After nine days the very degraded bowl fragment 775134 and the smaller fragment of the alder ball 775135B had reached constant weight. The larger ball fragment 775135A required 16 days, while the oak block 775133 required 23 days. During the drying process some leaves which had been closely adhering to the ball came away, and were kept separately.

The surface texture of the ball and the bowl fragment was rather powdery, but the bowl fragment was no longer soft and spongy to the touch. No new cracks appeared to have opened up, and the two fragments of the ball still fitted well. The two objects felt very light, similar in density to balsa wood.

The surface of the oak block had cross-checked slightly, but the surface was quite strong and the pre-existing cracks had not opened further.

It was decided to consolidate the ball and the bowl fragment, which was done by dropping a 7% solution of Paraloid B72 in toluene onto them until no more was absorbed. The solvent was then allowed to evaporate in the fume cupboard. The consolidation caused a darkening of colour which improved the appearance of the grain of the bowl fragment.

The oak block was weighed daily after being removed from the freeze-drier to see how it readapted to conditions of normal humidity. Over a period of a week the weight increased by about 5% and then fluctuated from day to day - in the same way as a normal piece of wood.

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(2) The object treated by the acetone/rosin method has warped and shrunk, causing the cracks in the object to widen. The object is fairly brittle but the surface is quite hard.

Conclusions

Freeze-drying has proved very successful, particularly with the bowl fragment, which was so degraded that it would have been difficult to treat in any other way. The cross-checking of the surface of the oak block is rather worrying, always assuming that these small cracks are a result of freeze-drying and did not exist previously, being closed up because the wood was waterlogged.‡

The results of the acetone/rosin method were disappointing, considering that this treatment has been successfully used by others. The only possibility in this case is that the rosin concentration in the solution was insufficient because the temperature was too low.

B KNIGHT

July 1978

‡ This cross-checking is reminiscent of that caused by dry-rot fungus. The possibility exists that the wood had been attacked by dry rot before it became waterlogged.

References

(1) W Ambrose "Freeze drying of Swamp-Degraded Wood" in "Conservation of Wooden Objects" (vol 2 of contributions to the New York conference on Conservation of Stone and Wooden Objects, 1970) 2nd edition 1971 (IIC London).

(2) AM Rosenqvist "Experiments on the conservation of waterlogged wood and leather by freeze-drying" in "Problems in the Conservation of Waterlogged Wood" ed. WA Oddy. Maritime Monographs and Reports no 16 (National Maritime Museum, Greenwich, 1975) (Proceedings of a symposium at the NMM, 1973).

(3) T Bryce H McKerrell & A Varsanyi "The Acetone-Rosin method for the conservation of waterlogged wood, and some thoughts on the penetration of PEG into oak" in ref 2 above.

Appendix

775134 (Bowl fragment)

Weight wet: 173 g
Weight dry: 38 g
Weight of water lost: 135 g
Water represented 78% of the original weight, or in other words, the dry wood had absorbed 3.5 times its original weight of water.

775135A (larger ball fragment)

Weight wet: 516.5 g
Weight dry: 97 g
Weight of water lost: 419.5 g
Water represented 81% of the original weight, or in other words, the dry wood had absorbed 4.3 times its original weight of water.

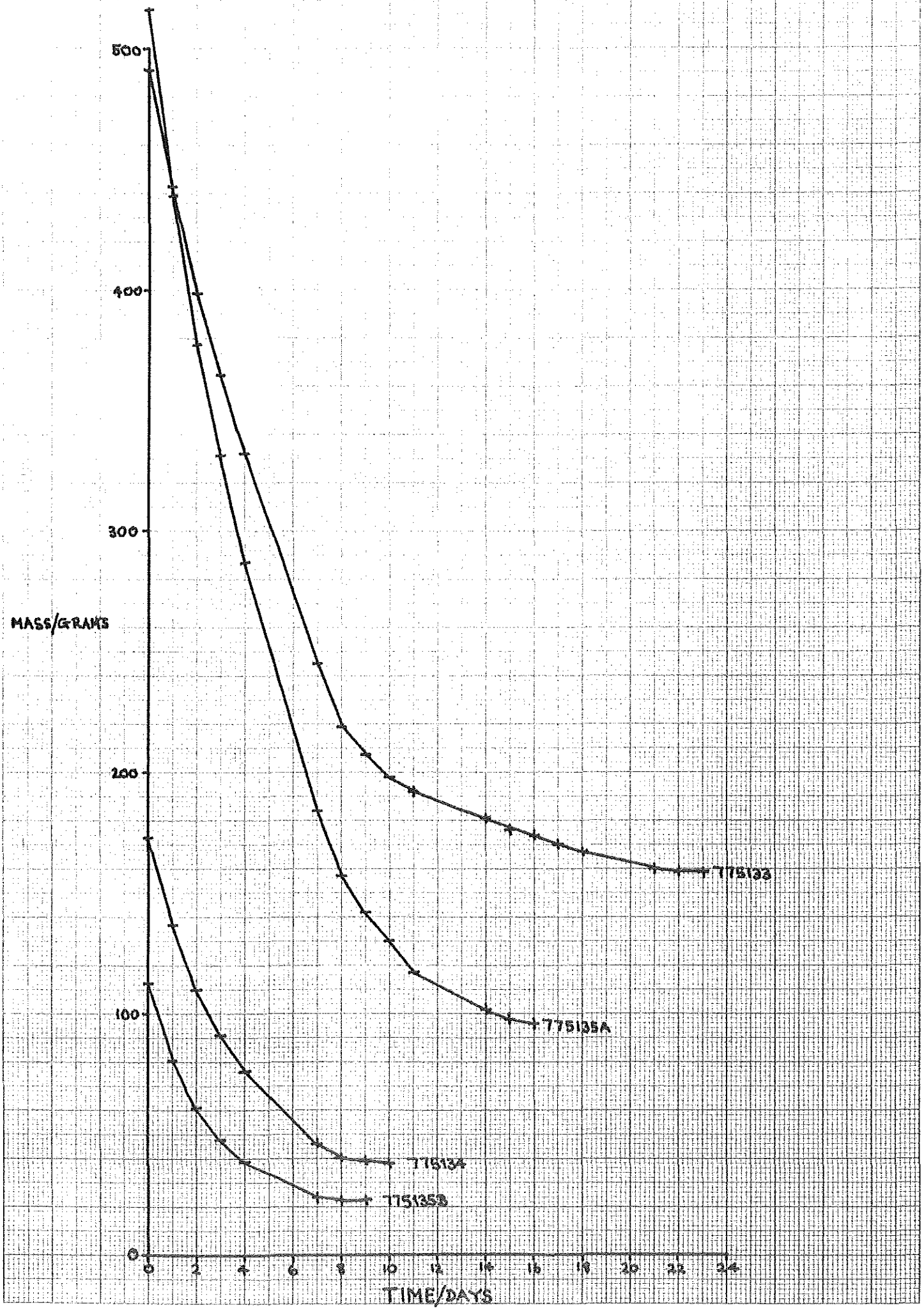
775135B (smaller ball fragment)

Weight wet: 113 g
Weight dry: 23 g
Weight of water lost: 90 g
Water represented 79% of the original weight, or in other words, the dry wood had absorbed 3.9 times its original weight of water.

775133 (oak block)

Weight wet: 491 g
Weight dry: 159 g
Weight of water lost: 332 g
Water represented 67% of the original weight, or in other words, the dry wood had absorbed twice its original weight of water.

This shows that the oak block was rather less degraded than the other objects, and probably had a sound core of unaltered wood.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MASS/GRAMS
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22
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TIME/DAYS
775133
775135A
775134
775135B