On the relative geological ages of amber and copal

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Radiocarbon analysis of selected amber and copal specimens yielded infinite radiocarbon ages for amber as expected, but all the copal samples proved to be recent (less than 100 years old), emphasizing the need to base the study of insect inclusions in copal on directly dated material. Some previously studied material assumed to be of Pleistocene age may need to be reassessed.

Introduction

There is a wide variety of hydrocarbon mineral ambers (Rumatite, Burmite, Succinite) and copals (African copals, Kauri gums), all derived from hardened tree-resins. Copal is mainly derived from species of Leguminosae, especially Acacia, whilst Baltic amber, the main source of amber in the jewellery trade until recent years, is generally considered to be derived from a coniferous tree, although there is still some dispute over the exact nature of the tree (Larsson 1978). Baltic amber is generally regarded as of Tertiary (Eocene/Oligocene) age (40 MY), Burmese amber is considered to be Miocene (7 MY), and other ambers like Siberian, Canadian and Lebanese are Cretaceous (75–120 MY).

Insects trapped within these materials when they were freshly produced by naturally damaged trees are frequently preserved in a near-perfect three-dimensional state with all the external characters visible. For the evolutionary and palaeogeographic study of insects amber and copal provide some of the finest fossils known (Lower Cretaceous amber from Lebanon, for example, has preserved entire insects that were contemporaneous with the dinosaurs); for such studies the clarity of the material and certainty as to its geological age are important factors. Amber in particular is often found in river deposits or on beaches, for instance in the Baltic region and along the east coast of Britain, so that its exact provenance may be uncertain, although comparisons using infra-red spectroscopy can sometimes be made with stratified material. Copal is known to be relatively of much more recent origin and for comparison of, for example, the Recent zoogeographic versus palaeogeographic distribution of insects, material less than about 25 000 years old is of little value. For this reason it was decided to subject a number of samples taken from specimens of copal having abundant insect inclusions to radiocarbon dating in the expectation that these would prove to be at least a few tens of thousands of years old. When the results showed rather unexpectedly that these copal specimens were very recent indeed (see table and discussion below) a few specimens of amber were also subjected to radiocarbon analysis (Burleigh et al. 1982, 256) in case these too proved to be within the radiocarbon age range (<50 000 years). All the amber
Amber and copal samples from the BM(NH) collection subjected to radiocarbon measurement

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Ref.</th>
<th>Material</th>
<th>Source</th>
<th>Date coll.</th>
<th>Presumed geological age</th>
<th>Radiocarbon age rel. AD 1950 (5570 year half-life)</th>
<th>$\delta^{13}C$ % rel. PDB</th>
<th>Lab. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>amber</td>
<td>Baltic</td>
<td>1919</td>
<td>Eocene/Oligocene</td>
<td>&gt; 40000 bp</td>
<td>-24.3</td>
<td>BM-1439</td>
</tr>
<tr>
<td>2</td>
<td>Ins 19103</td>
<td>amber</td>
<td>Burma</td>
<td>1919</td>
<td>Miocene</td>
<td>&gt; 40000 bp</td>
<td>-20.2</td>
<td>BM-1417</td>
</tr>
<tr>
<td>3</td>
<td>19135</td>
<td>amber</td>
<td>Burma</td>
<td>1919</td>
<td>Miocene</td>
<td>&gt; 40000 bp</td>
<td>-20.4</td>
<td>BM-1440</td>
</tr>
<tr>
<td>4</td>
<td>amber</td>
<td>amber</td>
<td>Lebanon</td>
<td></td>
<td>Lower Cretaceous</td>
<td>&gt; 40000 bp</td>
<td>-21.5</td>
<td>BM-1441</td>
</tr>
<tr>
<td>5</td>
<td>copal</td>
<td>East Africa, ex Mombasa, Kenya</td>
<td></td>
<td></td>
<td>? Pleistocene</td>
<td>modern</td>
<td>-257</td>
<td>BM-1243</td>
</tr>
<tr>
<td>6</td>
<td>In 25790</td>
<td>copal</td>
<td>East Africa, ex Dar es Salaam, Tanzania</td>
<td>1925</td>
<td>? Pleistocene</td>
<td>modern</td>
<td>-23.3</td>
<td>BM-1418</td>
</tr>
<tr>
<td>7</td>
<td>copal</td>
<td>? Pleistocene</td>
<td></td>
<td></td>
<td>modern</td>
<td>-26.0</td>
<td>BM-2115</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>copal</td>
<td>? Pleistocene</td>
<td></td>
<td></td>
<td>modern</td>
<td>-21.5</td>
<td>BM-2116</td>
<td></td>
</tr>
</tbody>
</table>
samples proved to be of infinite radiocarbon age and there is no reason on this basis to
doubt the geological ages ascribed to them. Amber and copal differ chemically,
perhaps as a function of their respective ages, but it is reassuring to know that
although some amber has not been precisely dated stratigraphically (for example the
Burmese amber in the table), none of the specimens analysed is recent, for a piece
associated with sample ref. Ins 19103 (BM-1417) contains Holotype specimens.

Radio carbon analysis

A search of 40 000 or so radiocarbon dates stored on magnetic tape (the contents
of *Radiocarbon*, volumes 1–16, 1959–1974) showed that natural resins have seldom
been subjected to radiocarbon dating. Less than 150 measurements based on resin
were recorded. Most of these were archaeological dates in the range 2000–3000 bp
(radiocarbon years before 1950 based on the 5570 year half-life for $^{14}$C) and included
only three $^{14}$C measurements of copal itself (0–4000 bp), and none of amber (Burleigh
*et al.* 1982, 256). Later volumes of *Radiocarbon* are not on magnetic tape and were not
searched, but the proportion of dates for resin is unlikely to have increased in the
meantime.

Details of the samples analysed are given in the table. For each of the eight
measurements listed in the table 3–8 g of amber or copal were used. No special
pretreatment was given. The radiocarbon ages of the samples were determined by
the liquid scintillation method. Stable carbon isotope ratios ($^{13}$C values, see table)
were within the range normally observed for woody plant materials with C<sub>3</sub>
photosynthetic pathway.

Discussion

As expected the amber samples were all found to be of infinite radiocarbon age
and, as already stated, in default of a finite radiocarbon age there is no basis for
questioning their attribution to the Tertiary or earlier periods. The particular
interest of these results lies in the recent dates that were obtained for the series of
copal samples. Although the antiquity of copal has been doubted some pieces in the
BM(NH) collection have always been regarded as ‘upwards of 1 million years old’
and while this can neither be proved nor fully disproved by radiocarbon, the failure
so far to obtain dates even as old as 100 years for copal tends to strengthen these
doubts. The enhanced $^{14}$C content (due to artificial $^{14}$C from thermonuclear weapon
tests) of one of the copal samples measured (BM-1243) indicates that it was formed
around 1960 and none of the others is more than about 50 years old, although
material older than this may well exist. It is now important to reassess each piece of
copal containing insects in the light of these results, especially where there has been a
study of the insect inclusions on the understanding that these were of ‘Pleistocene’
age. Entomological study of African copal cannot now be undertaken without
obtaining a definite (minimum) age for the piece studied. It may be that the new and
essentially non-destructive accelerator and small-counter methods of radiocarbon
dating with their much smaller sample requirements (1–10 mg C) can make a useful
contribution to this.

References

Burleigh, R., Matthews, K., and Ambers, J., 1982, British Museum natural radiocarbon
Science Press (Entomonograph, volume 1).