h29 Extraordinary preservation of DNA < resin fixed tissue, bees >

> The wood of the tree is chopped up and put into ovens and heated by means of a fire packed all round outside. The first liquid that exudes flows like water down a pipe; in Syria this is called 'cedar-juice' [in Latin: *cedrium*], and it is so strong that in Egypt it is used for embalming the bodies of the dead. —Pliny the Elder.[1]

Thick, sticky, sap called *resin* that oozes from the gashed bark of conifers, can trap whatever small thing comes in contact with it. These then become embalmed by overflowing resin.

Resin contains volatile aromatics that can replace the water of organic materials and kill bacteria. Resin hardens by drying and by polymerization (end-to-end bonding) of its long ($C_{10}H_{16}O$) molecules when exposed to and heated by sunlight. Hardened resin can fall and become incorporated, after some transportation, as rounded clasts in sediments. Its hardening by polymerization and loss of volatiles continues even when it is buried, but more slowly. After millions of years, it becomes the hard, chemically inert, substance known as amber (which sinks in freshwater but floats in seawater or saltwater in which plastic or glass imitations sink). A test for amber, although not definitive, is that after it is rubbed on hair, it can electrostatically attract and pick up a bit of paper.)

Recently, entomologists (people who study insects) have discovered that fossils in amber can contain unshrunken, dehydrated, tissue. The cells of such "resin fixed" tissues often have intact mitochondria and segments of unaltered DNA. However, fossil DNA found in very old amber announced in headline-grabbing claims by some workers has not been found by others.

In 1992, a very large termite (*Mastotermes electrodominicus*) with wings slightly parted and legs splayed (fresh looking for all that it was entombed) was sliced out of 30 million year old Hispaniola amber. Its DNA was extracted and sequenced. When compared to living termites, cockroaches and prying mantises (all Dictyoptera) the DNA of *M. electrodominicus* was close only to living Mastotermes (which are termites). The DNA results show that Mastotermes were early divergent from cockroaches and mantises. DNA preserved in Dominican amber has since been sequenced from a Drosophila fruit fly, a stingless bee, a wood gnat, a fungus gnat, a tree leaf, and chrysomelid beetles. Whole frogs and geckos have been found embalmed in the amber.[2] Fossil-bearing amber from northeastern Peru records evidence of Amazonian rain forest present in the Miocene.[3]

Famously abundant is washed-to-shore early Oligocene & late Eocene amber of the Baltic.[4] A source of Cretaceous amber is central New Jersey (the site location, however, is a well kept secret).[5]

A few bacterial groups under worsening conditions for their life become spores. These specialist survival structures have a thick protective protein coat and when their cytoplasm is partially dehydrated and mineralized, enzymes in it become inactive and the cytoplasm-DNA is stabilized. In 2000, R. H. Vreeland, revived from their "cryptobiotic" state, spores of bacilli (genetically like Dead Sea *Bacillus marismorti*) retrieved from tiny pockets of brine in 250 million year old salt crystals.[6] Less reliable, for the technique of its extraction, was H. J. Dombrowski's first finding, in 1960, of a spore-forming bacillus, *B. circulans*, from a 650 million year old salt formation. Be this too confirmed, "the potential implications are profound" writes R. John Parkes: "For instance, can spores effectively be immortal?" [7]

Whoa! Martin Jones in *The Molecule Hunt*, 2001, tells how traditional archaeological research to elucidate origins of humans, domestic animals, and agriculture, by describing skulls and pottery fragments, is benefitted by genetic and biochemical methods. What is also learned is that chemical decay of DNA makes *futile* the search for analyzable DNA beyond about 100,000 years.[8] The oldest, Jones maintains, are short fragments of mitochondrial DNA from woolly mammoths and mastodons. These cannot be confused with introduced contaminants as they show great similarities to modern elephants—not known to be wandering around in the lab. Shown is that extant elephants are but a small remnant of a once great diversity in many quite distinct mammoth types. ❑