A UNIQUE PIECE OF AMBER AND THE COMPLEXITY OF ANCIENT FOREST ECOSYSTEMS

VINCENT PERRICHOT1 and VINCENT GIRARD 2

1University of Kansas, Paleontological Institute, Lindley Hall, 1475 Jayhawk Boulevard, room 119, Lawrence, Kansas 66045, USA, e-mail: vperri@ku.edu
2Université Rennes 1, UMR CNRS 6118, 263 avenue du Général Leclerc, 35042 Rennes, France, e-mail: vincent.girard@univ-rennes1.fr

Studies on amber—fossil resin—have attracted much attention from the scientific community in the last decade. Seven Ph.D. theses with amber as the main material of study recently have been completed (Penney, 1999; Azar, 2000; Schmidt, 2003; Perrichot, 2005; Grund, 2006; Solórzano Kraemer, 2007; Girard, 2008), and two more are currently in progress by Malvina Lak and Jaime Ortega Blanco. From our personal bibliographic databases, we estimate that >1080 papers and books on amber have been published between 1999 and 2008 (as of October 2008). These works have dealt not only with the systematics and phylogeny of arthropods, plant remains, and microorganisms preserved as inclusions in the resin but also with the biogeography, taphonomy, paleoecology, paleoenvironmental reconstructions, chemical and physical properties of amber, its archaeo- logical value, and the development of new methodologies for the analysis of its fossil content.

A reason for this recent trend, but a consequence of it, too, was the discovery of several new amber deposits during the last 10 years—from the Triassic of Italy (Roghi et al., 2006), the Jurassic of Thailand (Philippe et al., 2005), the Cretaceous of France, South Africa, Spain, and Wyoming in the United States (Alonso et al., 2000; Grimaldi et al., 2000; Gomez et al., 2002; Néraudeau et al., 2002; Guiliano et al., 2006; Pêehalver et al., 2007), the Eocene of France, India, and Italy (Nel et al., 1999; Almohammadian et al., 2005; Trevisani et al., 2005), and the Miocene of Peru (Antoine et al., 2006).

In France, Didier Néraudeau, professor of paleontology at the University of Rennes 1, revived studies on Cretaceous amber in 1999 when he discovered the deposit of Archingeay—Les Nouillers, in Charentes, which was soon followed by the discovery of five other deposits in the same region (Néraudeau et al., 2002, 2003, 2008; Perrichot et al., 2007a). We subsequently began Ph.D. projects on the paleoecology of these amber deposits, based on the entomofauna and the amber-associated wood flora (Perrichot, 2005), and on microinclusions (Girard, 2008).

Ten years after its discovery, the Albian deposit of Archingeay—Les Nouillers is among the most fossiliferous ones known for the Cretaceous period and has provided the oldest-known fossils for several groups of arthropods (Perrichot et al., 2007b). In addition to the work on its amber content, the deposit is still under study with a combination of various data from stratigraphy, taphonomy, palynology, and paleobotany (Gomez et al., 2004, 2008; Dejax and Masure, 2005; Peyrot et al., 2005; Coiffard et al., 2006, 2008). Apart from the Eocene Baltic, Miocene Dominican, and Oligocene Saxonian amber, the Albian deposit of Archingeay—Les Nouillers is probably the amber deposit with the widest variety of analyses from different geological disciplines, and this contributes to obtaining the best possible reconstruction of the corresponding forest ecosystem.

Soon after we began work on this deposit, in 2000 one of us (Perrichot) concentrated on a particularly important 5 × 3 × 2.5 cm piece of amber. With an unusual gradient of transparency and foliated aspect, it appeared extremely rich in organic inclusions. At the beginning, only macroinclusions were observed, but later microscopic examinations by us, together with Alexander Schmidt (Museum für Naturkunde Berlin) and other microbiologists, also revealed numerous microorganisms. To date, 274 sym-inclusions—co-occurrences of more than one type of inclusion—have been found in this single fragment, composed of 86 arthropods, 181 microorganisms, 7 feathers, and various plant remains, including wood fibers and stellate hairs. The arthropods represent 19 families in 13 orders, and the microorganisms at least 25 families in 9 orders. More significant than the exceptional diversity of fossils occurring in this fragment, however, is the mixture of terrestrial and aquatic organisms trapped in a single fragment. Indeed, in addition to inclusions of terrestrial origin that are commonly preserved in amber, this fragment also includes limnetic and marine crustaceans and protists. To find aquatic organisms in the resin exuded by trees is rather rare, but possible, as recently demonstrated by Schmidt and Dilcher (2007). In the case of the French amber, however, the marine organisms and their co-occurrence with animals that fly, live in litter, or crawl on tree bark raises questions about the ecosystem that produced the resin, as well as the mechanisms involved in the trapping this diversity of organisms. The most likely scenario is that the marine...