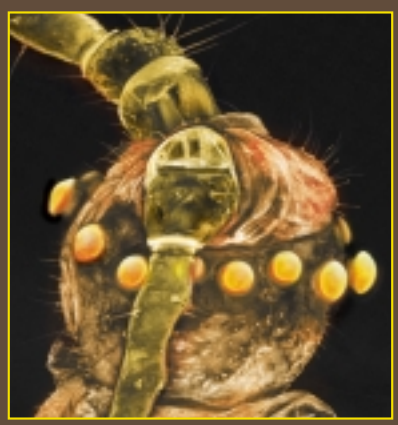
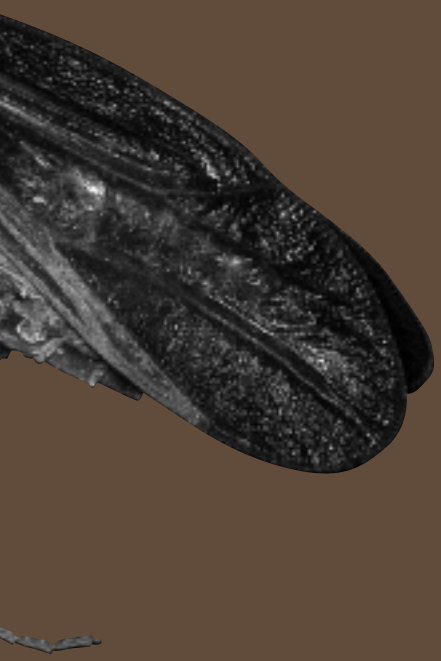
Fascinating Amber



Figs 1 and 2 (above):
Amber with inclusion. On the right, Chironomus plumosus.

Figs 3 and 4:
A tick and detail of a scale insect.

Amber, the fossil resin of long-vanished forests has fascinated mankind from times immemorial. The frequent inclusions of plants and animals have made amber not only a material of choice for religious artifacts and works of art, but also an object of scientific interest. The oldest fossil-rich amber we know originates from Lebanon and is roughly 130 million years old. The best known European amber comes from the Baltic and is about 40 to 50 million years old. The inclusions – usually small insects – are often very well preserved and provide an exceptionally detailed impression of what living creatures were like millions of years ago.



The often very small inclusions are usually studied under stereomicroscopes in reflected or oblique light. However, the resolutions achieved in this way are often not sufficient to identify minute morphological structures (e. g. mandibles, genital organs, extremities) required for the systematic classification of insects.

Other microscopic methods can hardly be used for this purpose: transmitted-light examinations are unsuitable due to the thickness and material of the specimens involved, while reflected-light examinations are impaired by reflection, refraction and schlieren in the amber. At high magnifications, the complex 3D structure is almost completely superposed by stray light from non-focal planes.

details

Amber

Scientifically speaking, amber is a *biolith* (bios – life, lithos – stone) and is found in all continents except the ice-covered Antarctic.

Arguably the most famous amber comes from the Baltic, the "mare balticum". Ancient records frequently describe it as "gold of the north", and Nordic sagas speak of "tears of the sea". The most abundant deposits are found near Kaliningrad and on the Samland shore.

The Roman Empire also mentions amber in mythological treatises, describing it as "petrified sun beams" or "tears of the gods". Amber was burnt as incense, its powder was long considered a remedy, and under the name of "eye stone" pieces of amber were used as a cure for eye diseases.

Amber is the petrified resin of primeval trees. In the Baltic region, a species of pine tree from the tertiary period – *pinus succinifera* – is assumed to be the source of amber. The primeval plants and animals trapped in amber are called inclusions. Apart from its individuality and paleogeological significance, the distinctive feature of amber is its vast and fascinating diversity of colors which developed over millions of years of amber formation, depending on the crystallization conditions involved.

The color spectrum ranges from yellow, white, red and green through blue, brown and black to silver and gold, and a single piece of amber may typically display fascinating color variations besides its basic color. The scientific facts look far more sober: amber consists of 67% to 87% carbon, 8.5% to 11% hydrogen and up to 15% oxygen. In addition, it contains small quantities of sulphur, turpentine, derivates and resin acids. The colors of amber range from honey-yellow to nearly transparent and dark brown. Amber dissolves in alcohol and ether, it melts at 300° C and begins to burn.

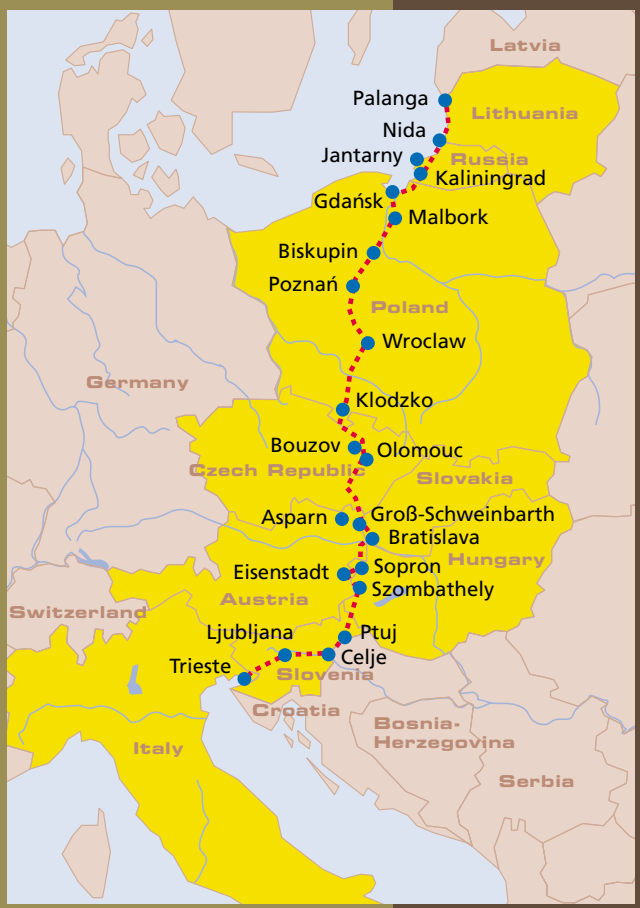


Fig. 5:
Route of the Amber Road from the Baltic to the Adriatic.

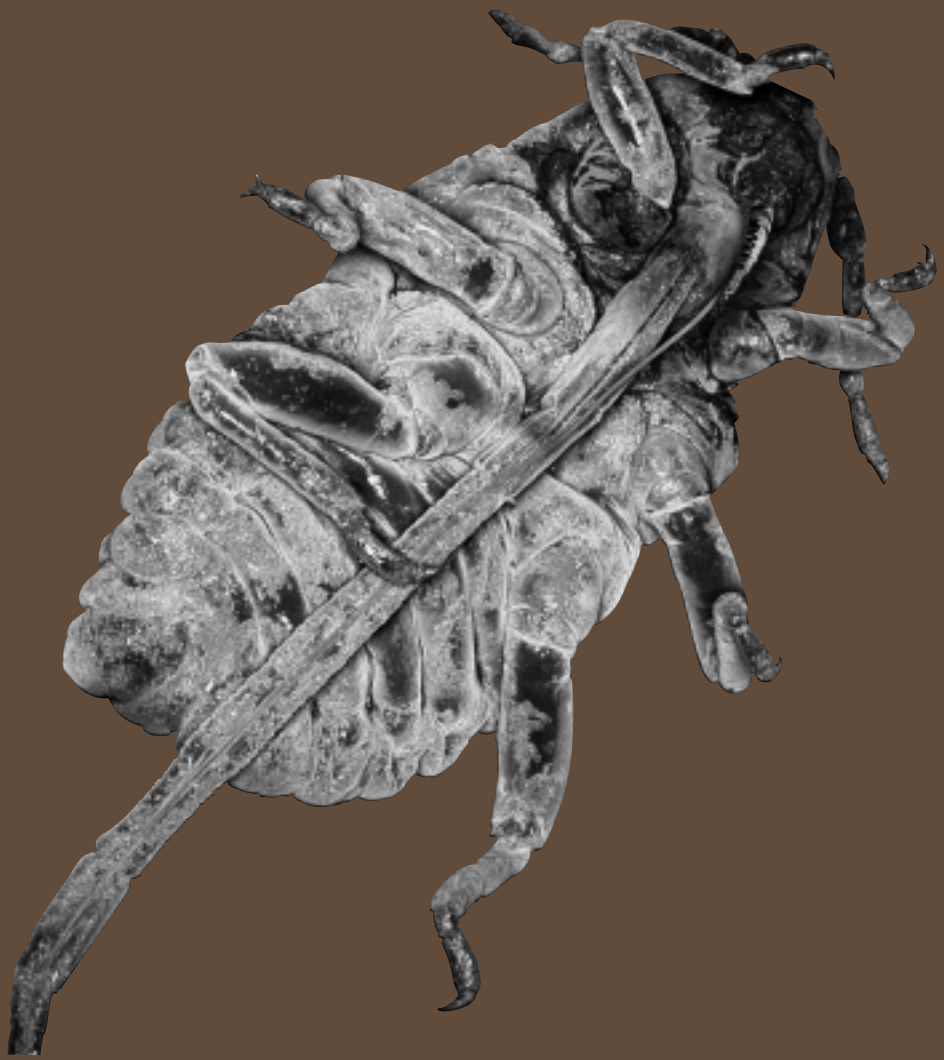


Fig. 6:
Homoptera.

Razor-sharp images

This is where confocal laser scanning microscopy opens up totally new possibilities. A laser beam scans the inclusion point by point and plane by plane, and stray light is effectively suppressed by the confocal pinhole. The instrument detects either the reflected laser light or fluorescence produced in the specimen. The result is a stack of individual high-contrast planes with minimized stray light known as optical sections, permitting 3D reconstruction of the specimen. The images which are reminiscent of those obtained with scanning electron microscopes display a resolution by far surpassing anything seen before. This ensures a significantly higher degree of reliability in systematic classification, especially of insects.

An accidental discovery

The excellent suitability of confocal laser scan microscopy for this highly specialized application was discovered more or less by accident. A private collector contacted Carl Zeiss to inquire about state-of-the-art examination methods for amber, enclosing a few specimens with his letter. The results obtained were so impressive that the collector presented them on his home page in the Internet. The team of *Professor Rust* (now at the University of Bonn) came across these pictures when looking for preservation methods to prevent normal aging in the amber artifacts of the famous Kaliningrad collection which is managed and researched at the University of Göttingen. This was the beginning of a very fruitful cooperation culminating in the exhibition "The Amber Forest by Laser Light" at the Goldfuß Museum of the University of Bonn. This exhibition was part of the "Year of Geo-Sciences" and displayed a selection of outstanding photos plus a host of interesting information about amber and a large number of valuable original pieces.

The wide coverage in regional and national newspapers and in different scientific magazines on TV testifies to the unbroken fascination evoked by amber and the creatures trapped in it millions of years ago. The European Amber Road project – leading from Palanga to Trieste – was recently launched in Austria.

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details

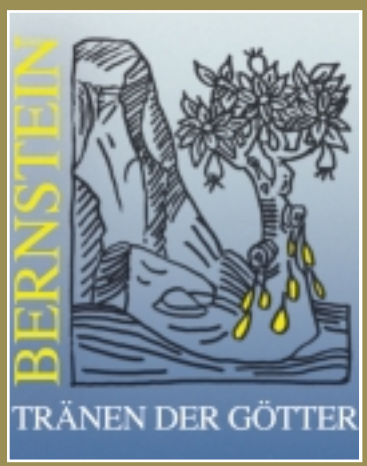
Amber – Tears of the Gods

In the second book of his mythological world history entitled "Metamorphoses" the Roman poet *Publius Ovisius Naso* writes in the chapter "Phaeton" about tears turning into amber.

… quid faciat mater, nisi, quo trahat inpetus illam,
huc eat atque illuc et, dum licet, oscula iungat?
non satis est: truncis avellere corpora temptat
et teneros manibus ramos abrumpit, at inde
sanguineae manant tamquam de vulnere guttae.
'parce, precor, mater', quaecumque est saucia, clamat,
'parce, precor: nostrum laceratur in arbore corpus!
iamque vale' – cortex in verba novissima venit.
inde fluunt lacrimae, stillataque sole rigescunt
de ramis electra novis, quae lucidus amnis
excipit et nuribus mittit gestanda Latinis.

Publius Ovidius Naso,
known as *Ovid*

Ovid was born on March 20, 43 BC in the small provincial town of Sulmo (Sulmona) in central Italy. He was educated in Rome, but soon devoted himself to poetry, renouncing a career in law or as a politician. For reasons uncertain to this day, he was banished by *Emperor Augustus* in 8 AD to Tomi on the Black Sea where he died in 17 or 18 AD, leaving behind him an extensive literary legacy.



Amores (love elegies), Heroides (letters written by mythological heroines to the men who left them), Ars amatoria (an instructive poem on the art of love), Remedia amoris (cures for love), Metamorphoses (a mythological world history centered on transformation), Fasti (the Roman festive calendar), Tristia (an elegiac poem), Epistulae ex Ponto (Tristia continued), Ibis (a diatribe on an unnamed enemy in Rome), Medea (a tragedy), De medicamine faciei feminae (an instructive poem on facial treatment for ladies), Halieutica (an instructive poem on fishing), Phaenomena (a poem on celestial phenomena).

Figs 7 to 9:
Brachycera (detail).
Trichoptera.
Sciara (detail).