

# Amber, fossil resins, and copal – contributions to the terminology of fossil plant resins

Norbert VÁVRA

**Abstract:** Terms like "amber", "fossil resin", and "copal" as well as specific mineral names for single types of amber and amber-like organic minerals have been used by various authors in different ways. Discussing the rather confusing present situation of terminology, the author tries to achieve an acceptable compromise and moreover to stimulate further discussions on this subject. After a few "case studies" and a short description of the present situation a few "suggestions" are given which will hopefully contribute to clarify problems of terminology. In respect to the use of terms like "amber" and "copal" a few general recommendations are given.

**Key words:** Amber, resin, copal, organic minerals, terminology.

**Santrauka:** Terminai "gintaras", "fosiliniai sakai", "kopalai", taip pat specifiniai mineralų pavadinimai vienam gintaro tipui arba gintaro tipo organiniams mineralams apibūdinti įvairių autorių vartojami labai skirtingai. Diskutuojama pakankamai paini šiuolaikinės terminologijos situacija, autorius siekia rasti priimtina kompromisą ir skatina tolesnės šios srities diskusijas. Po kelių pavyzdžių analizės bei trumpos šiuolaikinės situacijos aprašymo pateikiami pasiūlymai, kurie galėtų prisidėti sprendžiant terminologijos aiškumo problemą. Siūlomos bendros rekomendacijos, kada vartoti tokius terminus kaip "gintaras" ar "kopalas".

**Raktiniai žodžiai:** Gintaras, sakai, kopalas, organiniai mineralai, terminologija.

## Introduction

Study of resins, ambers, and related "organic minerals" concerns a lot of different fields of research and everyday life – this is without any doubt one of the fascinating aspects of this topic, but it has also resulted in the fact that a considerable variety of terms are in common use. Many of them are either not well-defined at all or used by different authors in different ways. This rather unsatisfactory situation is probably also due to the fact that completely different aspects of human activities have contributed to this terminology: aspects of natural sciences (mineralogy, chemistry, geology, palaeontology, etc.), humanities (archaeology, history of art, etc.) and even commercial aspects. This paper will hopefully contribute to the discussion of the partly contradictory terminology being in present use and stimulate further steps to clarify the situation.

## Modern Plant Resins

Resins have been vaguely defined as sticky plant exudates, a definition sometimes including also substances being largely insoluble in water and hardening when exposed to the air. Definitions of this kind have frequently resulted in confusions with other plant products like

mucilages, gums, latex, and even oils and waxes. Terms like "gum" have sometimes even been used as synonym of "resin". Recently "plant resins" have been defined as a lipid-soluble mixture of volatile and non-volatile terpenoid and/or phenolic secondary compounds that are secreted in specialised structures of plants and have potential significance in ecological interactions (LANGENHEIM 2003). This definition should be sufficient to exclude any possible confusion with gums and mucilages: both are water-soluble polysaccharides. The rather complex structure of exudate gums has been studied in detail by WHISTLER (1993). Details of chemistry, biosynthesis, secretion and storage of plant resins, etc. have been recently summarised by LANGENHEIM (2003).

## Amber – Fossil Resins

Some plant resins have the ability to fossilise and survive in the geological record, and are unique also in their role as natural traps for different organisms, which can thus be preserved embedded in the resin. For fossil resins the general term "amber" is in common use – an exact definition however is far from being easy. One can focus the resulting discussions on two terms: "amber" and "fossil".

**Table 1:** Carbon-14 dates for some subfossil resin samples.

Radiocarbon ( <sup>14</sup> C) age in years	Description of sample	References
50	Resin from Madagascar, sold as amber by gem dealers	LANGENHEIM (2003: 397), based on pers comm. given therein
250	Copal from Columbia (dealer's information: amber from Pena Blanca, Columbia)	SCHLEE (1984: 35)
"younger than 280"	Copal from Dominican Republic, near Cotuí	SCHLEE (1984: 35)
570 ± 80	Resin from Tennengebirge (Salzburg, Austria)	H. FELBER in: VÁVRA & VYČUDILIK (1976)
about 33,100 (+2,000/-1,600)	Mizunami amber, Pleistocene, Japan	SCHLEE (1984: 35)

**Table 2:** Terminology of modern and fossil resins based on ANDERSON (1997) resp. LANGENHEIM (2003: 146, table 4-1).

Resin classified as:	Radiocarbon age in years
Recent	0-250
250-5,000	Ancient resin
5,000-40,000	Subfossil resin
> 40,000	Amber (= fossil resin)

"Amber" has been defined by different authors in different ways following various principles and ideas. One main concept to establish a useful definition is the geological age of the fossil resin. This may be done in a rather general way like in SCHLEE & GLÖCKNER (1978: 4) who wrote "Der Name Bernstein gilt als allgemeine Bezeichnung für fossile Harze, also erdgeschichtlich alte, 'versteinerte' pflanzliche Saftflüsse, wenn diese wesentlich älter als eine Million Jahre sind – jüngere ('subfossile') nennt man Kopal." (= The designation "amber" is a general term for fossil resins being old in terms of geology for "petrified" plant exudates, if they are distinctly older than a million of years – younger ones ("subfossil") are called copal.). In the same publication (1978: 52) there is one more statement emphasising that the age has to be "millions of years" – this refers to the German "Bernsteingesetz" (= Amber Law, May 1934), which is still valid law nowadays and has been established to restrict the term "Bernstein" for genuine amber only ("Naturbernstein" – untreated amber, "Echt Bernstein" – treated by heat and pressure, e.g. in the production of pressed amber, no additives permitted). At any case SCHLEE & GLÖCKNER (1978) designate with the term "amber" only fossil resins being at least a million of years old. Anything younger is called "copal".

LANGENHEIM (2003: 143 ff.), following the ideas published by ANDERSON (1997), applies the geological age as a criterion for the definition of amber too. She gives details about the polymerisation process, which is a rather rapid reaction following a free radical mechanism photoinitiated when the plant exudates are exposed to sunlight and air and harden rather quickly. In the course

of the following chemical changes, summarised usually as "maturation of the resin", the limit between "recent" and "fossil" is crossed. LANGENHEIM (2003: 146) confirms that there is no objective chemical method for a reliable determination of the relative maturity of a fossil resin. This is the reason why alternative criteria have to be proposed – resulting in still ongoing discussions. For a fossil resin ("amber") she proposes a minimum age of 40,000 years as suggested by ANDERSON (1997) – a terminology followed by LANGENHEIM in "Plant Resins" (2003). ANDERSON's concepts are summarised in Table 2. The processes resulting in the formation of amber from resin have been summarised in the term "amberisation process" by POINAR (1992: 13).

These two minimum ages proposed for any fossil resin – 40,000 or 1,000,000 years – are, however, in direct conflict with concepts applied by most palaeontologists. The term "fossil" is usually applied to remains of living entities of the geological past, whatever its state of preservation may be. This basic principle can be found – to mention but a few examples – in ZITTEL (1924) or MELENDEZ (1970), and has been more strictly followed by THENIUS (1976) and KLAUS (1987), who admitted that this limit (10,000 years) is an artificial one. At any case we have to face the unpleasant situation that the term "fossil" as used by most palaeontologists is different from the term "fossil" as used in amber studies.

The limit between copal and amber, i.e. between "recent" and "fossil", becomes even somewhat "flexible" if we follow the ideas as proposed by POINAR (1992: 6 ff.): the best criteria to decide whether a piece of fossilised resin is amber or copal are its physical characteristics. Melting point, hardness, solubility and some other characteristics have been summarised by this author to differ between copal and fossil resin in the sense of amber. In reviewing literature dealing with definitions of "amber" one realises rather soon that especially in the older European amber literature "amber" has often been used as a synonym for "succinite". This restrictive use to designate the most common (European) fossil resin can still be found in different modern European languages (LANGENHEIM, 2003: 143 and reference given therein).

A possible compromise in this respect may be suggested in the following way:

- (1) Any fossil resin is to be called "amber" or "Bernstein" – including equivalent terms in other languages.
- (2) "Fossil" means belonging to the geological past: any resin older than Holocene should be regarded as a fossil resin, i.e. as "amber" or "fossil copal".
- (3) "Copal" indicates a special stage of diagenetic change of plant exudates. To use this term only as con-

trast to "amber" would imply that a state of preservation is used as a criterion for fossil/recent. This is not really satisfying. Otherwise following the ideas proposed here we have to realise that there are "recent copals" but also "fossil copals" – for a few authors even "subfossil" ones.

The term "fossil copal" is not new however: it has been used already by SCHLÜTER & GNIELINSKI (1987) and by KOSMOWSKA-CERANOWICZ in 1996 (KOSMOWSKA-CERANOWICZ 2006, and references given therein).

## Copal

Resins having not yet undergone all the steps of fossilisation like polymerisation and maturation are usually designated as "copals". This is again a typical collective term from its very beginning. As LANGENHEIM (2003: 296, 392) has confirmed this term is derived from the word "copalli" in Nahuatl language and already the Spanish have applied it for all resins used by the Aztecs. Still more confusing aspects result from the fact that Mayas from different geographical areas used different resins depending on materials being locally available. Thus they used "copal" to designate resins in general, for resins from Burseraceae (especially for the genus *Protium*), however, they used the word "pom", meaning something which is to be burned as incense. To make the early use of the term "copal" even more confusing they designated resins used as incense generally as "copal pom". Depending on which resin-producing trees were abundant in the area concerned, the Mayas called resins from *Protium*, *Bursera*, *Pinus*, and *Liquidambar* "copalli". Thus one can say that this term was a collective term from its very beginning indeed. As LANGENHEIM (2003: 392) points out this "led some amber workers, such as POINAR (1992), to categorise all unfossilised resins worldwide as copals". This is certainly true, but the use of "copal" as a general designation for unfossilised resins is far older of course. It is not possible to give a detailed study of the historical aspect of the application of the term "copal" to unfossilised resins within the scope of this paper – a few remarks must be enough for this purpose. In a Polish publication of 18<sup>th</sup> century the term "kopal" has been used already (KLUK 1781: 211-217; quoted according to KOSMOWSKA-CERANOWICZ 1993): "O butszynie, ambrze i kopalu" is the title of one of the chapters in this publication. In fact the term "kopal/copal" became a generally accepted term rather fast as shown by corresponding entries in old encyclopaedias (BROCKHAUS 1908): "Kopal, Name einer Anzahl bernsteinähnlicher, durchsichtiger, harter, schwer schmelzender Harze, deren Stammpflanzen vielfach unbekannt oder ausgestorben sind..." [= "Copal, name for a number of amber-like, transparent, hard resins, to be melted with difficulties only, the botanical

sources being mostly unknown or extinct..."]. Mineralogical handbooks give rather often a lot of detailed information concerning these materials (e.g. DAMMER & TIETZE 1928). Copal is designated here as a collective term, summarising a high number of hard resins of amber-like appearance. They are reported to occur in the tropics "recent-fossil" and "recent". As botanical sources Leguminosae (*Trachylobium* and *Hymenaea*) as well as conifers (*Agathis*) are mentioned. Far more than 20 different types of copals are described, designated mostly according to their geographical origin (DAMMER & TIETZE 1928): "Sansibar-Kopal", "Mosambique-Kopal" or "Kongo-Kopal" are such examples.

Realising that the designation "copal" has been in general use for a rather long time for any type of unfossilised resin, there remains one rather difficult problem, however: how to make a clear distinction between "amber" and "copal". It is even a rather common practice by some mineral dealers to call some typical copals "ambers". The fact that from some countries ambers of different geological ages as well as copals have been described as well, makes the situation even more confusing.

As already mentioned above in connection with amber, the determination of the geological age of resin material can be used to determine if the material under study can be called "amber" or is still "copal". In this discussion age determinations of resins are essential. Studying amber literature one realises rather soon that such studies are rare, however. The first application of C-14-dating for a resin sample of questionable age seems to have been published by VÁVRA & VYČUDILIK (1976): a resin sample from the area of the Tennengebirge (mountain range in Salzburg, Austria) had been dated in the course of these studies by H. FELBER (former "Institut für Radiumforschung und Kernphysik", Austrian Academy of Science). The result was  $570 \pm 80$  years, based on a half-life of C-14 of  $5,568 \pm 30$ , referring to 1950. According to ANDERSON (1997) this sample should therefore be classified as "ancient resin" (see table 2). Age determinations for subfossil resin samples are still rather rare however; a few data are summarised in Table 1.

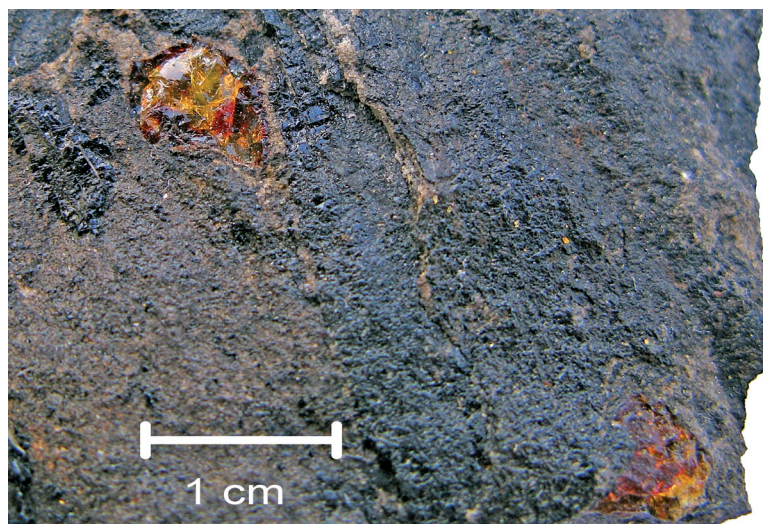
On the basis of radiocarbon dating the following scheme for the classification of modern versus subfossil and fossil resins has been suggested by ANDERSON (1997) and is given also in LANGENHEIM (2003: 146). The resulting terminology is summarised in Table 2.

Trying to review amber literature and searching for publications involving age determinations of amber samples one is convinced rather soon that in this field of studies further investigations are still badly needed. In ad-





**Fig. 1:** Copaline, Gablitz, Höfersbachtal, author's collection (Inv.No.527, donation from the late Mr. HAUSMANN, Vienna, 1975).



**Fig. 2:** Plaffeite, Locality: Weiler Zollhaus near Plaffeien, c. 15 km SE Fribourg, Switzerland, Gurnigelflysch, Upper Paleocene; author's collection (Inv.No. 1187).

**Fig. 3:** Schraufit, Wamma (former Bukowina), Institute for Mineralogy and Crystallography, University of Vienna (Inv.No. 4877).



dition to radiocarbon dating only a casual study of possibilities to apply fission track method for dating of amber samples can be mentioned (UZGIRIS & FLEISCHER 1971).

## Mineral names for ambers

More than one hundred different names have been introduced in the way of "descriptive mineralogy" into scientific literature to designate more or less well-defined organic minerals having been regarded as fossil resins at least at the time of their discovery. Various mineralogical encyclopaedias have tried to summarise them and to apply some sort of systematic (e.g. DANA 1892, DAMMER & TIETZE 1928, HEY 1950, 1962). Ajkaite, allingite, ambrite, beckerite, birmite (also: "burmite"), bucaramangite, cedarite, copaline (Fig. 1), durglessite, gedanite, gedano-succinite, glessite, guayaquilite, kansasite, krantzite, muntenite, oxikrantzite, pi-auzite, plaffeite (Fig. 2), rosthornite, rumanenite, scheibeite, schraufite (Fig. 3), sieburgite (Fig. 4), simetite (Fig. 5), stanektite, stantienite, succinite, telegdite, trinkerite, walchowite may be mentioned here, just to give some examples for such mineral names. There is also quite a number of names which had been introduced for organic minerals, which later turned out to be no fossil resins at all: ixolithe, jaulingite, koeflachite are at least largely mixtures of various hydrocarbons (VÁVRA 2005). Dopplerite is another example of this kind: it had been listed among fossil resins by various authors (e.g. SIGMUND 1937), has been identified as a mixture of different salts of humic acids (e.g. HINTZE 1933: 1349-1351). Modern textbooks list this substance among "gel-xylites", i.e. among remains of wood impregnated by humic gels (KLAUS 1987: 93). Hartite (synonyms: Iosene, Josene, bombiccite, hofmannite, and branchite) has been identified as a special hydrocarbon (phyllocladane), a substance well-known to organic chemists involved in studies of chemistry of coals. A modern revision from the mineralogist's standpoint has been published by BOUŠKA et al. (1998). Mineral names for fossil resins are still in common use in amber research, new ones are generally not introduced at all – the publication by FUHRMANN & BORSODORF (1986) being one of the few exceptions in modern amber studies. They described a number of new amber minerals (goitschite, bitterfeldite, durglessite, and pseudostantienite) from the Early Miocene of Bitterfeld (Germany) thus giving rise to considerable discussion (KOSMOWSKA-CERANOWICZ & KRUMBIEGEL 1989). For more or less well-defined minerals of this kind in German publications the collective term "Akzessorische Harze" has been re-introduced by KRUMBIEGEL & KRUMBIEGEL (1994), a term already used since the 19<sup>th</sup> century. For the sake of shortness something like "unofficial working terms" may also be



used by the one or the other author. An example of this kind from more recent years is "schlierseerite" used to designate a special Mesozoic amber from Bavaria (KRUMBIEGEL & KRUMBIEGEL 1994: 28). In the following a few examples for such amber minerals which have successfully survived modern revisions will be given. By means of one amber mineral (copaline from the Vienna Woods) an example will be given of how such names have been used or even abused by various authors. By carefully searching the older literature we may finally also come across mineral names which had been introduced by describing a new amber mineral but have not been used for hundred years or more, very much like the "nomina oblita" in the International Code of Zoological Nomenclature. Kochenite, an amber mineral from the Triassic of Tyrol is an example of this kind.

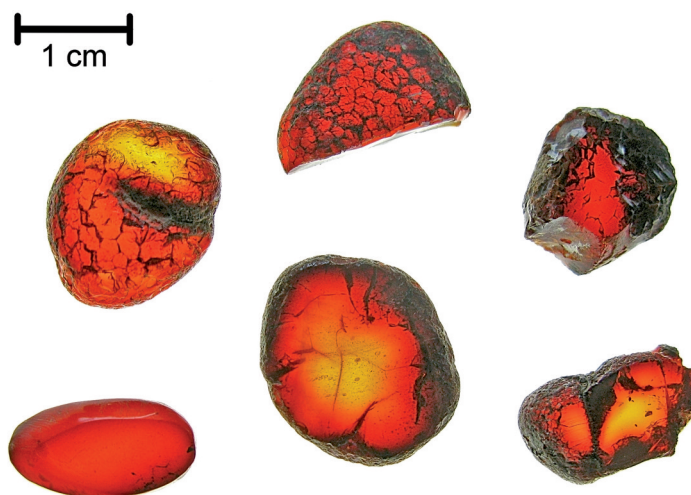
## Some examples for well-defined and generally accepted mineral names for ambers

### Glessite

This fossil resin being extremely rare among Baltic amber material and far more common in Saxonia (e.g. Goitsche coal mine, Bitterfeld) has been regarded already since the early days of amber studies as something uncommon and distinctly different from succinite and any other fossil resin. This has been rather recently also confirmed by KRUMBIEGEL & al. (1999), who studied remains of the WIENHAUS collection, which contained among others also glessite from the HELM material. The label attached to the glass tube in which this sample was kept said among others "Glessit vielleicht Gummiharz" (= glessite, possibly gum-resin). The very special chemistry of this material has been repeatedly studied in more recent years. After FRONDEL (1969) had already identified special types of pentacyclic triterpenes, the amyrines, in glessite from the Baltic area by means of thin layer chromatography, these substances were shown to occur also in glessite from Bitterfeld (KOSMOWSKA-CERANOWICZ et al. 1993) by means of combined gas liquid chromatography/mass spectrometry. Amyrines are generally regarded as reliable biomarkers indicating angiosperms as botanical source of resins. Whereas FRONDEL (1969) as well as KOSMOWSKA-CERANOWICZ et al. (1993) discussed genera of the tropical to subtropical family Burseraceae as probable botanical source, a recent study has identified by means of more advanced methods 10 more different triterpenoids in material from Bitterfeld, one of them being allobetul-2-ene (YAMAMOTO et al. 2006). However, according to SIMONEIT (2002) this is a very specific biomarker of birch-trees (*Betula*). At any case an angiosperm origin has



**Fig. 4:** Sieburgit from Sieburg, Rheinland, author's collection (Inv.No. 1035) – concretions containing a special (small) percentage of fossil resin only.



**Fig. 5:** Simetite, Sicily, Department of Paleontology, University of Vienna.

been confirmed again for glessite. In the course of our discussion glessite (together with the rosthornite mentioned below) can thus be regarded as a well-established species of angiosperm amber material.

### Rosthornite

From a coal mine, operated at the Sonnberg, a hill near Guttaring (Carinthia, Austria) in the years 1773-1933 HÖFER (1871) described under the designation "rosthornite" a new fossil resin, a reddish to brownish material to be found at this time in the coal seams in rather large nodules: "one inch thick and diameters up to six inches" are mentioned. This mineral name has been recorded in numerous handbooks and registers dealing with organic minerals (DAMMER & TIETZE 1928; HINTZE 1933; PACLT 1953 etc.). The identification of  $\alpha$ - and  $\beta$ -amyryne in an authentic sample of this material by VÁVRA (1999) established the hypothesis that this fossil

resin from the Eocene of Carinthia can be regarded as being of angiosperm origin. Burseraceae have recently been discussed as a possible source again (VÁVRA 2005).

In the course of our discussion the term "rosthornite" may serve as an example for an amber found so far at one locality only but having received a designation as organic mineral which has been accepted by the scientific community.

### Sieburgite (Fig. 2)

This rather rare fossil resin, now generally accepted as a typical representative of a Class III Resinite as described by ANDERSON et al. (1992), is one of the very few examples of a polystyrene resin. It has been first described already by LASAULX (1875), mentioned in all handbooks dealing with organic minerals (e.g. DAMMER & TIETZE 1928: 521) and restudied carefully in recent years in a number of studies (KRUMBIEGEL & KOSMOWSKA-CERWANOWICZ 1990, 1992; PASTOROVA 1997; PASTOROVA et al. 1998; KOSMOWSKA-CERANOWICZ 2000; CEBULAK et al. 2003; YAMAMOTO et al. 2006). Realising all these facts one can accept this mineral name for a fossil resin as a well-established example for a term being "in general use".

### Simetite (Fig. 5)

A rather rare fossil resin highly-priced among collectors, well-known for its various shades of red colour but also known to occur as a black variety has been found at Sicily already since ancient times and has been used for local jewellery in the 19<sup>th</sup> century already. If it had been known already in Roman and Greek times is still a matter of discussion among specialists. If this amber had been known to Arabic scientists of the 13<sup>th</sup> and 14<sup>th</sup> century is still a matter of debate too (for details see KOHRING & SCHLÜTER 1989). Having been mentioned in a few historical publications of the 17<sup>th</sup> century it has finally been described by HELM (1881, 1882) and received finally the designation "simetite" by HELM & CONWENTZ (1886). There exists a considerable number of publications dealing with simetite including even studies of various inclusions. A comprehensive summary reviewing the rather widespread literature on this subject has been published by KOHRING & SCHLÜTER (1989). Studies involving modern chemical or physicochemical methods in the study of amber from Sicily are rather rare with LAMBERT & FRYE (1982) being one of the exceptions from the rule. A very close similarity with succinite is, however, generally accepted as it seems.

Though modern studies of this interesting fossil resin are still badly needed, the designation "simetite" seems to have been generally accepted among scientists and may serve in this connection as an additional exam-

ple for a mineral name for some type of amber being in general use.

### Succinite

Though amber in the sense of the mineralogical term "succinite" has been known already since prehistoric times and has been studied by scientists in connection with its possible medical use and has been discussed in respect to its (botanical) origin, it was not until 1820 that this mineral name has been established officially (BREITHAUPT, fide BECK 1999). Mainly by German-speaking scientists "succinite" and "Bernstein" have been regarded as synonyms rather often. By and by "Bernstein" and "amber" have been accepted as collective terms for any fossil resin, whatever its botanical and/or geographical origin might be. "Bernstein" having had therefore two different meanings – in the sense of "Bernstein sensu stricto" and "Bernstein sensu lato" – for a considerable time, "succinite" has always been restricted to a special, well-defined organic mineral. At the present time succinite designates the typical representative of Class Ia Resinites in the sense of the systematic for fossil resins as introduced by ANDERSON et al. (1992). The polymer fraction of this fossil resin (called "succinin" in former times) is a product of polymerisation of communic acid, partially copolymerised with communol, the corresponding alcohol. One of the characteristics for succinite is the occurrence of succinic acid (as a mineral: "succinellite" – see HEY 1950: 276), its function being probably cross-linking of different polymer chains by means of esterification.

Realising the detailed knowledge available nowadays in respect to the chemical structure and qualities of succinite this mineral name can serve in our discussion as a generally accepted, well-established name.

### "Copaline" – an example how to use and abuse a mineral name (Fig. 1)

A detailed description concerning the discovery of copaline and other fossil resins in the flysch zone of the Vienna Woods has been recently summarised by VÁVRA (2005: 266-268), therefore only a few facts concerning the terminology will be given here. Copaline and its discovery is a very instructive example for a number of reasons: (1) the original publication by STARKL (1883) is a very careful investigation utilising practically all possibilities of his time for a detailed chemical and mineralogical characterisation including different comparisons. (2) The author gave exact data about the locality and – to use a modern term – information about its lithofacies. (3) The name "copaline" has been transferred by later authors to an other fossil resin found in the flysch zone, the "copaline" from Gablitz, being im-

portant because of the only finds of inclusions in flysch resins from the Vienna Woods. They have been described by BACHMAYER (1962, 1968, 1973) and recently restudied and confirmed by A. SCHMID (Georg-August-Universität, Göttingen – pers. comm.). (4) The original publication contained also the information that the material under study had been deposited in a public collection at Vienna where it could be relocated in fact by the present author some time ago (VÁVRA 2005: 267).

So far everything seems fine and no further problems involved. Going into detail, however, a rather confusing picture arises. STARKL (1883) compared his material with "Highgate resin" from Highgate Hill near London, as described by JOHNSTON (1839). He believed this material to be identical with his finds from the Flysch Zone at Hütteldorf and quite obviously derived the name for the Austrian material – copaline – from "copalite" (= Highgate Resin, etc.), one of the names used to designate the fossil resin from Highgate Hill. This involves nowadays something like an unpleasant additional effect however. The Highgate resin is meanwhile regarded as an angiosperm resin, probably derived from Burseraceae (FRONDEL 1967, 1969). Yet for resins from the Austrian part of the Flysch zone an angiosperm origin can be excluded. The use of "copaline" has been extended in the course of the 20<sup>th</sup> century to include also material from the Eocene of Gablitz, SIGMUND (1937) has probably been the first author doing this. Rather simple tests (different solubility, different behaviour under ultraviolet light) easily show that these two resins are different from the chemical standpoint at least. They are also different in respect to their geological age: the material described by STARKL (1883) from Hütteldorf occurs in Reischelsberg sandstone of mid-Cretaceous age whereas the material from Gablitz is found in Greifenstein sandstone (Eocene, early Cuisian). For details see PLÖCHINGER & PREY (1993), where also a short but modern description of the quarry at Hütteldorf can be found. The situation became even more complex by chemical studies of various resins from the Flysch zone and the Gosau formation by GRÖBNER (1998). She could show that a fossil resin designated as "schraufite" from Purkersdorf was identical with copaline from Gablitz. Moreover, a certain degree of similarity with authentic material of schraufite from the Bukowina could not be denied. The name "copaline" has occasionally also been used for other fossil resins too. EXEL (1993: 157) designated amber samples from the Early Cretaceous (Roßfeld strata) of Salzburg as "copaline nodules". Even for Triassic amber from Lunz (Lower Austria) the designation "copaline" has been used (SIGMUND 1937); this fossil resin has already been mentioned by ZEPHAROVICH (1859 – "resinite"), more details about this material having been reported by BERGER (1952).

The different ways in which the designation "copaline" has been used so far leads to a very confusing situation at any case. To avoid any further complications in this respect "Flysch resins" has been proposed as a preliminary "working term" to summarise amber finds from the Flysch zone as long as the situation can not be successfully clarified by further studies (VÁVRA 2005: 268).

## Kochenite from the Triassic of Tyrol – a "nomen oblitum" among amber minerals?

From the Kochental (a valley in Tyrol, Austria) tiny amber droplets have been described by PICHLER (1868). This material from Raibler strata (Triassic) has been characterised in respect to its physical and chemical properties by this author and designated with a new mineral name – "kochenite". This is an interesting example for a (nearly) forgotten mineral name. In the sense of the sophisticated rules for zoological nomenclature this mineral name has been a good candidate for a long time to become a so-called "nomen oblitum". The name is indeed – as far as I know – missing in all handbooks published in the 19<sup>th</sup> and 20<sup>th</sup> century. In connection with a description of amber finds from the Triassic of Italy this mineral name has been mentioned rather recently again however (GIANOLLA et al. 1998, ROGHI et al. 2006). Until then it had been only listed once among various examples for mineral names of "akzesorische Harze" (KRUMBIEGEL & KRUMBIEGEL 1994).

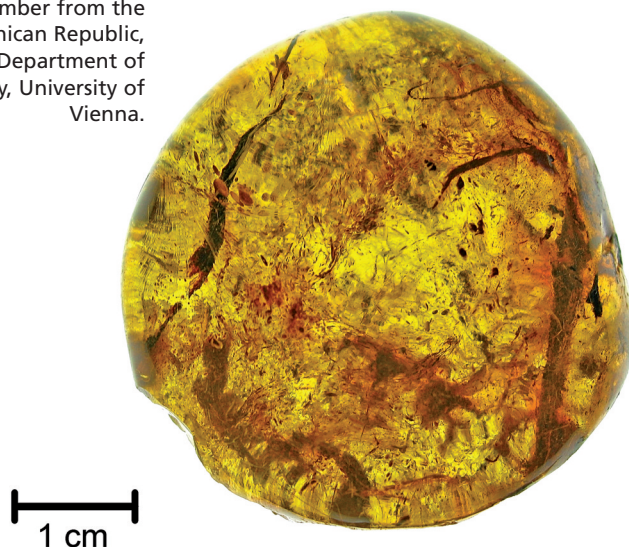
## "No-name ambers"

The establishment of special mineral names for single fossil resins has become rather uncommon in the course of the last few decades. The result is the amazing fact that for quite a number of fossil resins, being not only of great scientific interest but also of commercial importance, no special designations have been introduced at all. For such materials – here summarised as "no-name ambers" – usually the geographical origin is used for a closer designation resulting in terms like "Mexican amber", "Dominican amber" (Fig. 6) etc. This situation is – at least in respect to the material from the Dominican Republic – not really satisfactory however. Resins coming from one of the many amber localities in this country have been partly suspected to come from deposits of different geological ages: Eocene, Oligocene, Miocene, and even Pleistocene has been suggested (GRIMALDI 1995). The present standpoint in this discussion confirms, however, that the primary deposits have been formed in a single sedimentary basin during the latter part of the Early Miocene to Middle Miocene (LANGENHEIM 2003: 179, and references given therein).

In respect to the chemistry of the Dominican and Mexican ambers there exist a number of detailed studies.



**Fig. 6:** Amber from the Dominican Republic, Department of Paleontology, University of Vienna.



In both cases the "polymer backbone" of the material represents polymers of labdatriene carboxylic acids. Therefore ANDERSON et al. (1992) mention them as representatives of Class I Resinites. They establish for them a special subgroup however: "Class Ic". Like East African resinites, Mexican as well as Dominican amber contain resin acids with labdatriene structure, but they are of a very special type: ozic acids and/or zanzibaric acid. As botanical source for this material species of the genus *Hymenaea* have been repeatedly confirmed on the basis of various methods. To summarise such angiosperms ambers under the designation "Leguminous Amber" is therefore very well justified (LANGENHEIM 2003: 179 ff.).

In addition to these two examples there exists a countless number of other "no-name ambers", most of them being available only in tiny amounts which can be reviewed only after carefully searching the geological and mineralogical literature. Following data as given by SCHLÜTER & GNIELINSKI (1987) and accepted also by KRUMBIEGEL & KRUMBIEGEL (2001), about 300 different sorts of amber have been discovered world-wide. For perhaps more than 100 of them mineralogical names have been established, the rest are "no-name ambers". A few of them are of considerable scientific interest, however – Lebanese Amber as recently reviewed (POINAR & MILKI 2001) may be mentioned as an important example of this type.

### How to proceed in the future – a few suggestions

(1) Existing and generally accepted mineral names for ambers, well-defined according to modern standards, should be used and by no means generally suppressed. There should be followed a restrictive policy in those cases where misunderstandings are to be expected.

(2) Revisions of organic minerals (fossil resins) are still badly needed. Such revisions should use "type material" which belongs to the first publication in which this new mineral name had been established. If not available or obviously lost, one should study at least material from the type area, which comes as close as possible to the original description.

(3) If there are no modern revisions available, mineral names should be used only tentatively, e.g. "name". They may be useful in the sense of "working terms" only.

(4) A very restrictive policy should be followed in establishing new mineral names for ambers in general.

Recommendation: in describing new types of amber some sort of "open nomenclature" may be an acceptable intermediate solution. Such designations should include locality data, and geological age.

(5) If different sorts of fossil resin are occurring at the same locality letters or figures may be added. Example: Amber B from the Early Cretaceous of xyz (country or locality).

### "General recommendations"

Having summarised various aspects concerning the terminology of fossil resins/ambers the author hopes to stimulate possible further discussions on this topic by suggesting a number of "recommendations" to be followed – or disapproved – by future authors.

- (1) "Amber" should be maintained as a collective term designating any fossil amber material. "Amber" and "fossil resin" (as well as the equivalents in any other language) should be used as synonyms for macroscopic samples, whereas "resinite" should be used as a designation for microscopical material. This follows a suggestion by ANDERSON (1997) having also been accepted by LANGENHEIM (2003: 143).
- (2) "Copal" should be maintained as a collective term for any non-fossilised resin material whatever its geological age may be. Copal older than Holocene should be called "fossil copal".
- (3) Well-established mineral names for ambers should be maintained – for details see above.

### Summary

In discussing the present situation concerning the terminology of fossil resins and copals the author tried to avoid unnecessary changes and to establish rather something like a compromise. A few "suggestions" and "recommendations" added will hopefully contribute to



avoid confusions and to minimise misunderstandings in future. The author would appreciate if this publication should stimulate further discussions on this topic.

## Zusammenfassung

Begriffe wie "Bernstein", "Fossile Harze" und "Kopal" wurden ebenso wie spezielle Mineralnamen für einzelne fossile Harze und harzähnliche organische Minerale von den verschiedenen Autoren in unterschiedlicher Weise verwendet. Nach einer Diskussion der gegenwärtigen, etwas verwirrenden Situation versucht der Autor einen annehmbaren Kompromiss vorzuschlagen und darüber hinaus weitere Diskussionen zu diesem Thema anzuregen. Nach einigen "Fallstudien" sowie einer kurzen Beschreibung der Ausgangslage werden einige "Anregungen" gegeben, die hoffentlich dazu beitragen werden, die Probleme der Terminologie zu klären. Bezüglich der Begriffe "Bernstein" und "Kopal" folgen dann einige allgemeine Empfehlungen.

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#### Address of author:

Norbert VÁVRA  
Department of Palaeontology  
Geozentrum, University of Vienna  
Althanstrasse 14  
1090 Wien, Austria  
E-Mail: [norbert.vavra@univie.ac.at](mailto:norbert.vavra@univie.ac.at)