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Use of fluorescent microscopy in the study of redeposited palynomorphs in the cave and marine sediments of Moravia (Czech Republic)

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ABSTRACT. Reworked palynomorphs occur in the cave sediments of the Moravian karstic areas as well as in marine sediments of the Carpathian Foredeep (Czech Republic). Their preservation states may be different or similar under the light microscope. The mutual distinguishing features of primarily Quaternary and Tertiary ones, or of the palynomorphs from particular Miocene stages are therefore often very difficult to determine. Observation under the fluorescent microscope can help to determine the reworked palynomorphs in Quaternary as well as Miocene sediments.

KEY WORDS: fluorescent microscopy, redeposited palynomorphs, Miocene, Quaternary, Czech Republic

INTRODUCTION

It is not necessary for palynological studies to be done only in autochthonous sediments (i.e. of organic and chemical development). The sediments develop mostly through disintegration, transport and resedimentation of older rocks. Therefore we can often find the older redeposited palynomorphs in younger sediments.

The occurrence of reworked palynomorphs is typical for cave sediments. These sediments do not contain plant remains in their original positions. Palynomorphs are transported to the sedimentation places with sedimentary particles or through the activity of animals. These facts create the possibility of mixing components of different ages as well as selection of palynomorphs due to their varied degrees of resistance (Doláková & Nehyba 1999, Doláková 2000, 2002). The preservation state of the redeposited grains can be similar to the grains that are contemporary to the development of the sediments and therefore it is frequently difficult to mutually distinguish them.

Very similar problems arise in the Miocene marine sediments from the Carpathian Foredeep. Several transgression and regression cycles occurred in this region. The redepositions of foraminifers and calcareous nannoplankton from the older Miocene stages into the younger ones are commonly known from this area (Brzobohatý et al. 2003). Thus, the occurrence of redeposited palynomorphs is likewise possible. The decision about whether some pollen and spores typical for the climatic zonations are *in situ* or not is therefore of great importance. It is even important to diagnose the potential amounts of redepositions within frequent usual species, because the high percentage of such redeposition could change the image of palaeovegetation.

Observation under fluorescence microscopy introduces a possibility to detect the reworked palynomorphs. These methods were elaborated mostly by van Gijzel (1967a, b, 1971, 1975, 1978).

All our macerated sediments were rich in clays; they were partly calcareous, and for the most part not coalified. For the maceration,

HCl, HF (not heating) and heavy liquid $ZnCl_2$ were used. Pure glycerine was mostly used as the observation medium. Part of the samples (especially from the cave sediments) were microscopically studied directly in $ZnCl_2$ due to the exclusion of further dilution of mostly very small palynomorph amounts.

RESULTS

The sediments of the karstic formations from the Moravian part of the Czech Republic (Moravian, Javoříčko and Hranice Karsts) are of Holocene, Pleistocene and Miocene ages (Doláková 2000, 2002, 2004a, b, Doláková & Nehyba 1999). The mixing of components of different ages – especially Quaternary and redeposited Tertiary – is common in these areas. Observed under the light microscope, their preservation states can be very similar. It is therefore often very difficult to distinguish the ages of individual palynomorphs known both from the Quaternary and Tertiary e.g. *Pinus*, *Ulmus*, *Alnus*, *Quercus*, *Corylus*, and *Betula*, which consequently causes complications in age determination and climatic reconstructions. For example, 300 Quaternary and 80 verifiable Tertiary palynomorphs were determined in one sample from Ochoz cave (Doláková & Nehyba 1999), their preservation states being very alike (Pl. 1, fig. 3a, b).

Similar problems arise in the Miocene marine sediments from the Carpathian Foredeep. The occurrence of redeposited Cretaceous palynomorphs is quite usual and well detected. Under the optical microscope, the existence of palynomorphs redeposited from the older Miocene stages is often not possible to prove. We try to use the observations under the fluorescent microscope to detect some redeposited palynomorphs (Burešová 2005).

Van Gijzel (1967a, b, 1971, 1975, 1978) focused his attention on the methods of determining the properties of UV-fluorescence on fresh and fossil pollen and spores. He found that the fluorescence spectra are closely related to the chemical composition of palynomorphs. They also depend on the different levels of resistance to geological age, corrosion and coalification of pollen and spore walls. Similarly, weathering redepositions connected with the oxidization of rocks and activities of bacteria and fungi also change the intensity and colours of the studied pollen and spores (van Gijzel 1971). These characteristics are then significant for determining the systematics and age of palynomorphs. Most of these methods require a lot of complicated measuring and equipment (van Gijzel 1967a, b, 1975) for routine palynological studies. For the orientational detection of the reworked palynomorphs, the relative observation of the colour spectra seem to be convenient. It is necessary to attentively observe the change in colour for a single type of palynomorph. With increasing age, coalification and corrosion, the colours shift from blue-green, white or yellow and strong fluorescence to orange, red or brown and weak fluorescence. Thus, each type of secondary pollen shows a larger variation in fluorescent colours than the autochthonous material (van Gijzel 1971). New data about the effect on fluorescence of the physical processes associated with peat erosion and re-sedimentation in reservoirs during the Holocene were provided by Yeloff and Hunt (2005).

According to van Gijzel (1967b), the maceration methods may also cause variation in fluorescence (the use of hydrofluoric acid can shift fluorescent colours of pollen to the red end of the spectrum and darker). From our experience, glycerine gelatine was found not to be a suitable mounting medium for the study of fluorescence. In a short time, the gelatine changes colour (develops a dark circle) and the palynomorphs fade. Glycerine as well as $ZnCl_2$ seem to be suitable. The studied objects have sufficiently stable colours for the duration of observation.

The autochthonous pollen grains (except grasses), both from the studied Quaternary cave (Pl.1, fig.1a, b, 3a, b, 5a, b) and Miocene marine sediments (Pl. 1, fig 2a, b), have light colours (white, light-yellow, light-orange) and intensive fluorescence during UV observation. The pollen grains in the brackish more coalified material from the Lower Miocene sediments manifest shifts of colour towards brownish-orange and a decreasing intensity of fluorescence (Pl. 1, fig.6).

Verifiably redeposited palynomorphs from the Moravian Quaternary karstic sediments have typical dark brown colours with a very low intensity of fluorescence (i.e. pollen grains of Taxodiaceae – Pl. 1, fig. 3a, b). It is therefore possible to assume the grains of similar colours to also be redeposited (Pl. 1, fig. 1a, b).

Good identification of redeposition is possible (from the different colours) in the mixture of specimens of several ages of the one genus e.g. *Pinus* from the Quaternary (Pl. 1) and from the Miocene (Pl. 1, fig. 2) palynospectra. The detection of single unusual pollen grains and spores brought out more difficulties. Some types of palynomorphs have primarily low fluorescence or their exines are easier disintegrated than others (i.e. Poaceae, *Lygodium*); therefore, the redepositions are very hard to confirm or eliminate.

Other interesting observations are connected with the different colours of the algal bodies. After Brooks (1971) and Yeloff and Hunt (2005) the sporopollenin content of lower plants is chemically different from that of higher plants. The rate of corrosion of the algal remains and fungal spores is different from that of spores and pollen grains (van Gijzel 1971); therefore, they differ considerably in fluorescence from the other plant remains in the fossil material. In the studied Quaternary sediments (cave sediments, soils), the cenobia of *Botryococcus* and *Pediastrum* show striking blue-green colours (Pl. 1, figs 7, 8a, b). In the Miocene sediments these were yellowish-white with a very high intensity (Pl. 1, fig. 6). These phenomena enable the detection of even small parts of algae among other plant remains.

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PLATE

Plate 1

1a. Part of pollen spectrum of the Late Glacial cave sediments – light microscope – red circle *Pinus* sp. autochthonous, green circle *Pinus* sp. redeposited, Ochoz cave

1b. The same under the fluorescent microscope (UV light)

2a. Part of pollen spectrum from the Badenian marine sediments – light microscope – green circle redeposited *Pinus* sp. (the cubic caves in the grain are caused by crystallization of pyrite in the anoxic marine environment), Židlochovice

2b. The same under the fluorescent microscope (UV light)

3a. Redeposited Taxodiaceae from the Late Glacial cave sediments – light microscope, Ochoz cave

3b. The same under the fluorescent microscope (UV light)

4. Taxodiaceae from the Badenian marine sediments, the fluorescent microscope (UV light), Židlochovice

5a. *Helianthemum* sp. from the Late Glacial cave sediments – light microscope, Ochoz cave

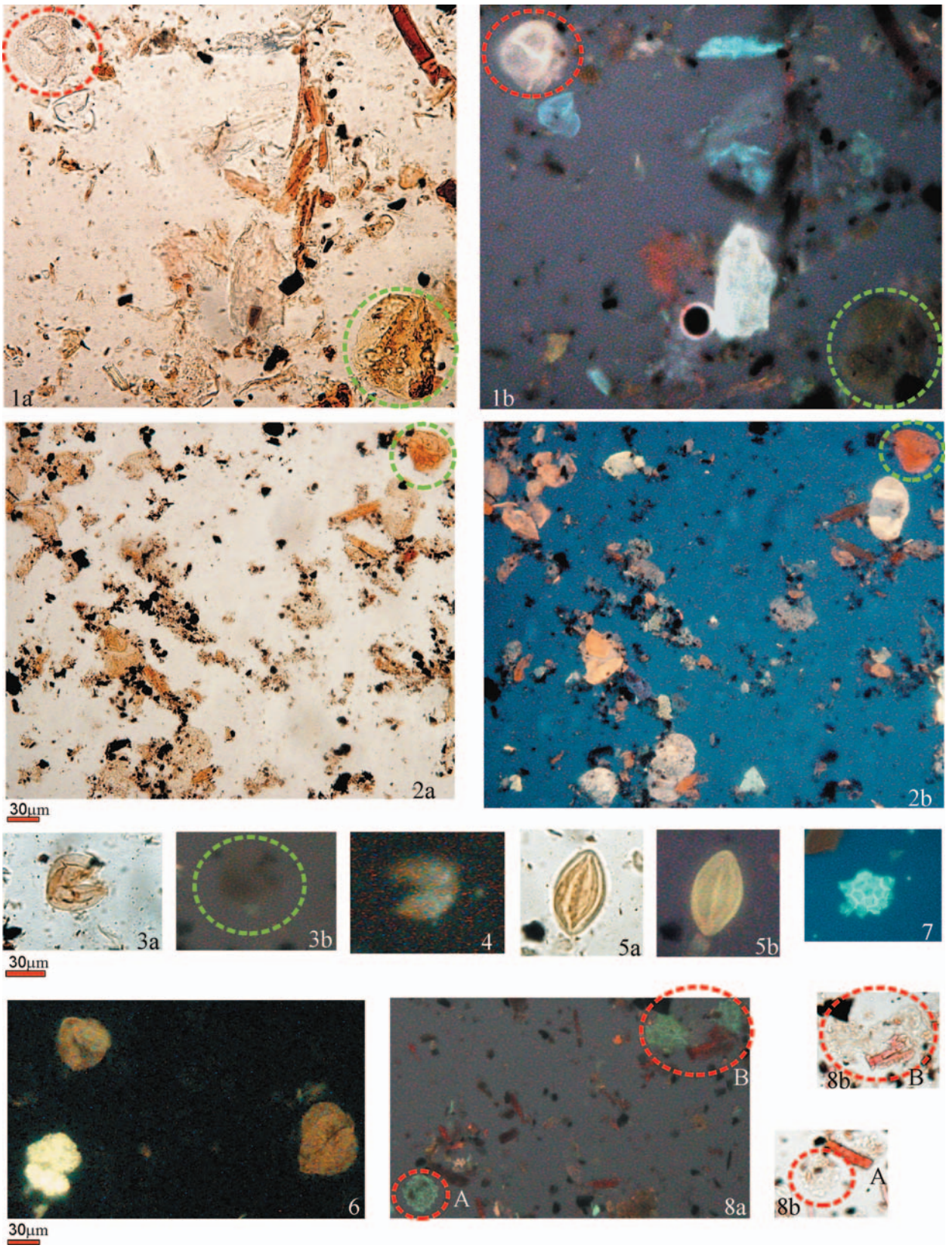
5b. The same under the fluorescent microscope (UV light)

6. *Pinus* and *Botryococcus* sp. from Eggenburgian brackish sediments, the fluorescent microscope (UV light), Trboušany

7. Cenobium of *Pediastrum* sp., fluorescent microscope, late Pleistocene, Krumlov Forest

8a. A – cenobium of *Pediastrum* sp. and B – several parts of another *Pediastrum*, fluorescent microscope, late Glacial cave sediments, Ochoz cave

8b. A, B part of the same under the light microscope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