

The botanical and the morphological approach in Neogene palynology – a practical comparison*

ANGELA A. BRUCH

Institute of Geosciences, Sigwartstr. 10, 72076 Tübingen, Germany; e-mail: angela.bruch@uni-tuebingen.de

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ABSTRACT. In Cenozoic palynology, there are at least two schools of pollen taxonomy. One focuses on the botanical affinity of the pollen and uses the botanical nomenclature of recent plants. By contrast, the other focuses on the morphology of pollen and uses descriptive names which can (but need not) take into account the known botanical relationships. Both approaches can be applied to Neogene palynology because many, but not all, of the pollen types are of known botanical affinity. Discussions on the advantages and disadvantages of these two different taxonomies seems to mainly consider their nomenclature. Based on various practical examples, comparison of the two schools leads to suggestions concerning both approaches. For future palynological work it is strongly encouraged that attention be paid to clear morphological descriptions and the indication of the botanical affinity in parallel, independent of the nomenclature scheme utilized.

KEY WORDS: palynology, taxonomy, nomenclature, Neogene

INTRODUCTION

The intention of this paper is to provide a short overview of the two main approaches in Cenozoic palynological taxonomy – the botanical approach and the morphological approach. Beside some basic information, this contribution will focus mainly on the practical effects that both approaches have on the palynological work. Far from claiming completeness, the main arguments for and against the methods will be discussed.

The general problems in palynology are based on the fact that pollen cannot be assigned unambiguously to their parent plants by morphology. Even the pollen of a single plant (or even a single flower in case of angiosperms) can look very different, whereas pollen of different plant taxa can be very similar. In the case of the trees *Ulmus* and *Zelkova* for example, even the intrageneric variation of pollen morphology can be greater than the morphological differences between the two

genera although in some cases they might be distinguishable. This problem in general increases with the stratigraphic age of the plants due to increasing uncertainties in terms of their botanical position and affinity. Dispersed pollen can hardly be combined with macrofloristic elements, and even when pollen are found within a flower attached to the parent plant, the botanical affinity, which in this case is clearly determined, needs not to be true in another case. There are numerous examples of independent evolution of plant organs of which the evolution of pollen seems to be amongst most conservative (for a more detailed discussion see e.g. Chaloner 1986, Mosbrugger 1983, Niklas 1997). All this points to the fact that there is no 1:1 relation between pollen and parent plant, thus making the “whole plant philosophy” extremely difficult or nearly impossible in terms of pollen. These basic problems of pollen production and their mosaic evolution should be kept in mind when comparing the two approaches in palynological taxonomy.

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THE TWO PHILOSOPHIES OF PALYNOLOGICAL NOMENCLATURE

In Cenozoic palynology, there are at least two schools in pollen taxonomy. One that focuses on the botanical affinity of the pollen is using the botanical nomenclature of recent plants. The other focuses on the morphology of pollen and uses descriptive names which can (but need not) take account of the known botanical relationships. Discussion on the advantages and disadvantages of the two different taxonomies seem mainly to concern their nomenclature. However, even within the two approaches there are a lot of internal problems and inconsistencies. These problems have been discussed in detail including for the botanical approach Joosten and de Klerk (2002), and for the morphological approach Batten (1986).

The principle difference between the two schools is their taxonomical concept of the pollen as part of the plant, or as an independent taxonomic group, respectively. The philosophy of the botanical approach is based on the assumption that pollen, as part of a (described) plant taxon, needs no independent nomenclature. Thus, the determination and naming of pollen in this approach is exclusively related to the finding of the right parent plant. Because all Quaternary and nearly all Neogene pollen can be related to extant plants, no further nomenclature for pollen taxa is necessary here. The assignment to a modern name can lead to every taxonomical rank. If the pollen cannot be determined on species level it may still be possible to assign it to a genus or family. This can lead to the situation that pollen are determined as belonging to a family that incorporate a great variety of pollen morphologies, whereas the information about the morphology of the determined pollen is lost. On the other hand, the morphological approach treats pollen independently from any botanical interpretation as individual (morpho) taxa. These are described and named based on their morphological features. Only in a second step, the pollen taxon is compared to pollen of a recent plant, on the taxonomic rank that is possible (Tabs 1, 2).

It is obvious that these basic differences have appeared in the historical context of early palynology. Besides investigations on recent pollen, first attempts in palynology have been made to obtain stratigraphic information

Table 1. The two philosophies of nomenclature

Morphological approach	Botanical approach
not all pollen can be related to their parent plant;	pollen are part of the plant, not individual morphotaxa
thus, pollen are treated as individual morphotaxa	thus, no independent taxonomy necessary
independently determined morphotaxa can be related to recent morphotaxa from case to case	determination is a question of finding the right parent plant
nomenclature is independent from knowledge about the botanical affinities	almost all pollen can be related to recent taxa (at least in Neogene)

for Quaternary sediments. These were based on the fluctuations within the vegetation and migrations of elements forced by climatic changes during glacial and interglacial episodes. Thus, for palynologists working in Quaternary time frames, it was always evident that all pollen in their samples are related to (known) recent plants.

This method was successfully established by the beginning of the 20th century (e.g. von Post 1918), and was subsequently expanded to older stratigraphic levels of the Tertiary and Mesozoic in the attempt of using pollen as stratigraphic markers as well as to understand the history of vegetation and climate. Nevertheless, the fossil pollen record is so diverse with numerous extinct or still unknown tropical or subtropical forms that a restriction only to known taxa is obviously impossible. This led to an independent and mainly descriptive nomenclature established by Potonié (since 1931), Thomson and Pflug (1953) and developed by others subsequently.

Within the last decades, the palynology of the Neogene has become more and more the

Table 2. Steps of taxonomical determination

Morphological approach	Botanical approach
treatment of pollen as an independent fossil group	treatment of pollen as part of the plant
description of morphological features	description of morphological features
taxonomical division after morphological features	comparison with recent pollen
nomenclature according to ICBN (morphotaxa)	botanical interpretation
comparison with recent pollen	nomenclature of recent botany
botanical interpretation	

focus of scientific interest, especially in terms of ecological and climatic reconstructions. It is in the nature of these aims that they are highly dependent on proper botanical interpretations of the taxa. Thus and because in the Neogene already most of the extant plant species existed, actuo-palynologists started to extend their botanical knowledge into the past. Beside the resulting competition of the two approaches, even a mixing of both nomenclatures within one palynoflora can be observed in recent literature.

A PRACTICAL COMPARISON OF THE TWO APPROACHES

In the following, the differences between the morphological and the botanical approach will be discussed with some practical examples (Tab. 3). The determination of a pollen grain in most of the cases will lead to the same result with both methods, to the same botanical interpretation, respectively. No matter if the pollen will be called *Alnus* (after e.g. Birks & Birks 1980), *Alnus* type (after e.g. Punt et al. 1994), *Alnipollenites verus* Potonié 1934 (after e.g. Nagy 1985) or *Trivestibulopollenites verus* (Potonié 1931) Thomson & Pflug 1953 (after e.g. Thomson & Pflug 1953), every author agrees that he/she is dealing with pollen of the tree *Alnus* sp., and the implication for ecological or climatological interpretations will therefore be the same.

However, there are several examples, where differences of approach become evident. There are pollen such as the small reticulate tricolporate forms that can be divided into several groups with different botanical affinities,

which are often not clearly distinguished in fossil material with the morphological approach. For example, it can be assumed that *Tricolporopollenites microreticulatus* Thomson & Pflug 1953 covers several taxa that are frequently determined with the botanical approach (Salicaceae/*Salix*, Oleaceae/*Olea*, *Phyllirea*, *Fraxinus*, Brassicaceae, and others). The loss of information on ecology, climate and biodiversity is obvious in this case. Clear morphological descriptions should be published for each of these groups, which could lead to new descriptive names. In several cases like this, morphological taxonomy is not yet precise enough. On the other hand, there are groups of pollen in which all specimens belong to the same botanical genus, but show several morphological variations that cannot be related to recent species. The genus *Tsuga* is an example for this case. Several morphotaxa can be distinguished, which have stratigraphic significance even during the Neogene e.g.: *Zonalapollenites pliocaenicus* Krutzsch 1971 ex Ziemińska-Tworzydło 2002 (Stuchlik et al. 2002), and *Zonalapollenites igniculus* (Potonié 1931) Thomson & Pflug 1953. There are several similar cases that appear with various morphologies in Cenozoic sediments and are not separated by the botanical approach (e.g. Sapotaceae). This shows that for fossil pollen botanical nomenclature is not always sufficient. In particular with increasing stratigraphic age, the taxonomic resolution of the botanical approach decreases leading to a loss of information about biodiversity, extinctions or other stratigraphically relevant events. The question still remains about where the stratigraphic limits of the botanical approach are. However, due to the problem of mosaic evol-

Table 3. A practical comparison of the two approaches

Morphological approach	Botanical approach
- new names necessary → descriptions after ICBN!	+ no need to introduce new name → less work!
+ more precise indication of descriptions, authorship etc.	+ faster in the lab
- danger of missing botanical interpretation	- danger of too fast botanical interpretation
- still too many morphogroups	- no distinction of fossil/unknown taxa and within known taxa
+/- additional stratigraphic and ecological information in some cases	+/- additional ecological information in other cases
+ applicable on floras of all stratigraphic ages	- only useful for floras of Neogene and Quaternary age
+ an increasing knowledge of botanical affinities need not affect nomenclature	
- revision necessary	- revision necessary

ution of plant organs (as discussed above) there will be always the obligation to introduce new names for fossil pollen, even if they can be related to macro-remains or recent taxa.

One fundamental difference between the botanical and the morphological approach is the treatment of unknown pollen types. Whereas in the former all these grains are labeled as undetermined, morphological nomenclature has the possibility to give names without any knowledge of botanical affinities. This, on one hand, has the advantage to store information for future work – if the taxon is carefully described the botanical interpretation can be added later when this information is available. On the other, it can encourage the author to disregard the responsibility to look carefully for the botanical rank. In the worst case, taxa can be described and named without any knowledge of botany but even then, the morphological descriptions can reflect the biodiversity of the flora, and yield stratigraphic information. Moreover, in the frame of a careful study and analysis of the whole flora, in some cases it is still possible to determine the ecological requirements of pollen with an unknown botanical affinity.

In summary, both approaches have their advantages and disadvantages. A profound knowledge of morphological details is crucial in any case. Whereas the morphological approach needs more precise distinctions within morphogroups, the botanical approach needs a distinction of unknown fossil taxa, which is only possible with a morphological nomenclature. Both approaches would benefit from an exchange of information about botanical affinities. Thus, both approaches should be improved by taking the experience of the other into account.

SOME QUESTION AND REMARKS FOR THE FUTURE

In Neogene palynology, either the morphological or the botanical approach can be used, because for many, but not all, pollen the botanical affinity is known. Nevertheless, still there is the question as to if it is realistic to use both approaches in parallel (in the scientific community or in one scientific investigation). For the practical work of a palynologist

this is of course possible, because his/her aim should be to get as much information as possible about the investigated flora. So, in the lab one can use “the best of both worlds” and take all the names one can get. But for the sake of comparability of results, for publications and taxonomic descriptions one standardized method is needed, to make clear decisions about the diagnosis, authorship, priority of names etc. To obtain clear, reproducible determinations in the future, we need a nomenclature that is consistent between authors, between samples (also of different stratigraphic ages), and not at least within one sample.

The main goals for future work in palynology should be to obtain comparable palynological results and interpretations. Here a practicable way should be found. To reach at least a convergence of the two approaches, both methods have to be improved. Beside the urgent need to describe and give names for yet not described forms that affects both sides, in all publications should be given references for each pollen taxon where the description can be found matching exactly the determined pollen. At the moment the latter is especially missing in publications utilizing the botanical approach. On the other hand, authors using the morphological approach should always give the botanical affinities in parallel. In any case, whichever of the two approaches is preferred, the author should define the aim of the study to indicate the reason for using one or the other approach.

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