



## Fundamental reassessment of the taxonomy of five Normapolles pollen genera



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### ARTICLE INFO

#### Article history:

Received 16 June 2016

Received in revised form 28 March 2017

Accepted 2 April 2017

Available online 6 April 2017

#### Keywords:

Normapolles Province

Late Cretaceous

Paleogene

Europe

USA

### ABSTRACT

Diagnoses of the Normapolles pollen genera *Hungaropollis*, *Krutzschipollis*, *Longanulipollis*, *Oculopollis* and *Trudopollis* and 55 of their species are emended and many specimens illustrated in order to provide a basis for more successful and consistent identification than has been possible hitherto. These taxa were recovered from palynological preparations of selected samples from Upper Cretaceous deposits in Europe and the eastern USA. As indicated on an accompanying range chart the majority are encountered in Santonian and/or Campanian deposits. Eleven of the species described have been transferred from other genera and are therefore in new combinations, namely: *Hungaropollis granulatus* (Kedves et Herengreen), *Longanulipollis coronatiformis* (Góczán et Siegl-Farkas), *L. orbicularis* (Góczán), *L. ornatus* (Kedves et Diniz), *L. parvoculus* (Góczán), *L. skarbyae* (Kedves et Diniz), *Oculopollis artifex* (Weyland et Krieger), *O. rector* (Pflug), *O. triceps* (Skarby), *Trudopollis cuneolus* (Góczán et Siegl-Farkas), and *T. spinulosus* (Skarby). Six are new: *Hungaropollis pinguis*, *Krutzschipollis cucullus*, *K. immanis*, *Longanulipollis amabilis*, *L. lobus* and *Oculopollis viriosus*. Thirteen genera are regarded as synonyms of *Hungaropollis* (*Aveiropollenites* and *Romeinipollenites*), *Longanulipollis* (*Coronatipollis*, *Intercalaripollis*, *Portaepollenites* and *Verruculopollis*), *Oculopollis* (*Druggipollenites*, *Pseudoculopollis* and *Semiculopollis*) and *Trudopollis* (*Cuneipollis*, *Felderipollenites*, *Hofkeripollenites* and *Kriegeripollenites*) respectively. As a result of some of these nomenclatural changes, 14 other species are in new generic combinations but are not otherwise considered. Seven morphotypes are identified in open nomenclature and two placed in comparison. This taxonomic synthesis, which updates work published since the 1950s, is aimed primarily at rendering biostratigraphic analyses easier, but it is also a necessary first step towards the resolution of Normapolles taxonomy and the relationships between these pollen grains and biological species.

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### 1. Introduction

More than 160 genera identified as members of the Normapolles group of angiosperm pollen grains have been described. According to Batten and Christopher (1981, p. 359), who referred to the criteria documented by Pflug (1953), Góczán et al. (1967) and Tschudy (1975), the Normapolles are “oblate, mostly triporate or brevitricolp(or)ate pollen having complex, commonly protruding apertures and typically a triangular amb, although some are more or less circular in polar view.” Although there is considerable morphological variation within the group, and the apertures are not as complex as originally thought, these characteristics continue to differentiate Normapolles from the majority of other pollen types, at least within the Late Cretaceous to early Paleogene Normapolles Province.

Many Normapolles grains display characters that overlap to varying degrees and to such an extent that it can be difficult to decide which genus, let alone species, is most appropriate to accommodate a particular morphotype. The fact that the number of genera purported to belong to the Normapolles group has almost doubled since Batten and Christopher (1981) published a dichotomous key to their recognition serves to demonstrate that there has been no satisfactory basis for reliable identification of most representatives of the group. Many of the descriptions fail to indicate truly diagnostic characters and, therefore, can equally apply to other genera and species. It follows that the majority of the species that have been erected are not adequately compared with, or distinguished from, other similar forms.

In this paper, we deal with some of the issues that pertain to the identification of five Normapolles genera: *Hungaropollis*, *Krutzschipollis*, *Longanulipollis*, *Oculopollis* and *Trudopollis*. We clarify the basis for differentiation of morphotypes attributable to them in order to make it easier to place specimens in appropriate genera and species with greater confidence than has been possible hitherto. This necessitated a

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detailed examination of palynological preparations of rocks from different locations within the European and eastern North American parts of the Normapolles Province. Numerous species of Normapolles pollen have been described previously from several of these (e.g., from Scania, southern Sweden, the Aachen Formation in Germany, and boreholes in Hungary: see below). By photographing many hundreds of specimens, we found it easier to determine both the range of variation that might be expected within a species and the characters that seemed most reliable for distinguishing them. We then compared our observations with the original diagnoses and descriptions of almost all of the species that have been described previously, the exceptions being a few that have apparently been diagnosed in literature we have been unable to obtain so far (see Supplementary Files). This enabled us to determine to which previously described species it might be possible to refer our material, in each case once we had emended the original diagnosis in order to accommodate the characters that distinguish it.

In this paper, we briefly comment on the significance of the Normapolles Province with respect to our analysis and supply more background to the problem of identifying taxa and the approaches that have been adopted hitherto before providing revised diagnoses and synonyms of 55 species of the five genera noted above. Six new species are also erected. Numerous illustrations accompany our presentation. We conclude with a discussion of the significance of our study, which, among other things, we think will render future biostratigraphic analyses using species of the genera described a little easier than has been possible previously. A range chart based on our records and those from the literature is included.

## 2. The Normapolles Province

During the Late Cretaceous Epoch, the core of the Normapolles Province extended from eastern and southern North America across Europe, including southern Scandinavia, to the West Siberian Plain, the longitudinal boundaries being around 95–100°W in the Western Interior of North America and 80°E in West Siberia. The northern and southern boundaries are less precisely delineated but in current geographical terms, they are approximately 56°N and 36°N respectively in Western Europe. In North America, both are further south, i.e., very approximately around 46°N and 25°N. Taking into account the configuration of the continents during the Late Cretaceous, the northern and southern boundaries were somewhere in the region of 20 and 40°KrN (Batten, 1984).

It is apparent that the boundaries became rather more diffuse during the early Paleogene, with representatives of some of the Normapolles being recorded from much further north (e.g., *Trudopollis* in Spitsbergen: Manum, 1962) and east (e.g., *Trudopollis* and other genera in China: Zhao et al., 1982; Wang et al., 1990; Song, 1996a–c) in particular, but a few papers on Late Cretaceous palynofloras have also served to suggest that at least some Normapolles grains were dispersed well beyond the floral province as delineated above, in India for example (e.g., Nandi, 1983) and again in China (e.g., Song and Huang, 1997). On the other hand, several taxa in these and other publications (e.g., *Oculopollis tropicus*, recorded from Gabon by Boltenhagen, 1976) are not convincing representatives of the group. A few Normapolles-like pollen have even been reported from Australia (Jarzen and Dettmann, 1992), but these are considered to have been derived from plants having evolutionary origins that differ from those of the northern taxa. This latter observation may also apply to Normapolles-like grains in the Indian Subcontinent and the Far East. Some of the records from these regions are clearly suspect and call into question the basis for recognizing Normapolles pollen as opposed to other, similar grains that are not, or are only doubtful, representatives of the group, despite being identified as, for example, species of *Oculopollis*, *Trudopollis*, *Pseudotrudopollis* and *Subtrudopollis*.

## 3. Problems with identification

A common problem with much of the taxonomic literature on Normapolles pollen is that many of the species and genera erected are from single localities and are compared only with other morphotypes from the same locality. Even if there are comparisons with taxa described from elsewhere, these seldom refer to more than one or two forms when in fact many others could also have been considered. An equally common problem is that likely morphological variation is not taken into account. Single specimens have all too often formed the basis for erecting species and even genera. Both practices effectively render the majority of these taxa very difficult to identify subsequently. It is apparent that when faced with identifying Normapolles grains, some palynologists have resorted to erecting many new genera and species for their material because they found it difficult to place specimens in previously described taxa. It is not surprising, therefore, and somewhat ironic that despite the very large number of genera and species available, many Normapolles forms reported in the literature are identified in open nomenclature (e.g., Christopher, 1979; Méon et al., 2004: see also Section 9.2).

Skarby (1968) was highly critical of the taxonomic approach of Pflug (1953), Thomson and Pflug (1953) and Weyland and Krieger (1953). She noted that several of the supposed diagnostic characters are based on misinterpretations or are otherwise insignificant. She also pointed out the tendency of others subsequently (e.g., Góczán, 1964) to erect more genera to accommodate what are commonly only minor differences in basic morphology. She found that with few exceptions, the species referred to *Extratropipollenites* and other genera of Pflug (1953) and in Thomson and Pflug (1953) could not be satisfactorily identified on the basis of their descriptions. She was also unable to locate on their slides the specimens that they illustrated. Some of those described and figured by Weyland and Krieger (1953) and Weyland and Greifeld (1953) were identifiable, but their slides were generally poorly preserved. As a result, in her study of Normapolles grains from Scania, she referred all of her assemblage to a much more broadly defined *Extratropipollenites*. In so doing she erected 14 new species, transferred to this genus several other previously described forms that had been referred to different genera, and placed others in synonymy with her new combinations.

Although use of more broadly defined genera would have alleviated the problem of identifying Normapolles at generic level, referring all of them to *Extratropipollenites* was not the answer. Tschudy (1975) maintained that the paper by Góczán et al. (1967), in which 56 Normapolles genera were described and differentiated, removed most of her objections. He noted that he had little difficulty in distinguishing genera on the basis of their observations and did not believe that Skarby's decision to refer a large range of morphotypes to species of *Extratropipollenites* served any useful purpose. Skarby did not mention the work of Góczán et al., perhaps because she was unaware of it or it was published while her own paper was in press. Regardless of the reason, the fact that she did not modify her taxonomy subsequently indicates that, unlike Tschudy, she did not agree that their synthesis was especially helpful. Nevertheless, as she noted later (Skarby et al., 1990, p. 146), her attempt at evaluating the morphological characters that she regarded as diagnostic and reducing the number of taxa had "met with little positive response." We think that the solution to the genus and species identification problem lies somewhere in between her approach and that of Góczán et al., otherwise there would not have been the perceived need to erect so many more genera after 1967.

This problem was well demonstrated by Hultberg et al. (1984). These authors applied Fourier analysis to three species of dispersed Normapolles grains from southern Sweden, identified as *Extratropipollenites triceps* Skarby, *E. artifex* (Weyland et Krieger) Skarby and *E. firmus* Skarby, and of pollen extracted from a single anther identified as *E. artifex*. They found that some specimens initially identified as *E. triceps* are indistinguishable from *E. artifex* on the basis of their analysis, the overlap being a result of the fact that the apertures of the former are less pronounced than usual so that they are more similar to those of *E. artifex*. According

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