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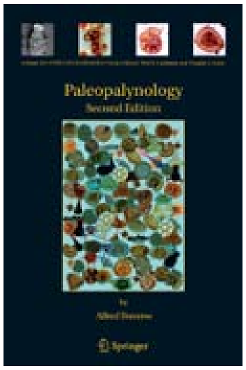

Paleopalynology, 2nd ed., by Alfred Traverse, 2007, Topics in Geobiology, Volume 28, Springer, Dordrecht, The Netherlands, 813 p.; hardcover, USD279.00; ISBN 978-1-4020-5609-3; softcover, USD129.00; USD102.77 on amazon.com; ISBN 978-1-4020-6684-9.

It took Alfred Traverse 19 years to publish the second edition of his comprehensive book on paleopalynology, and it was worth the long wait! This book is a valuable asset to paleopalynology and highlights its importance as a micropaleontological discipline. Some geologists are unfamiliar with palynology, which is the study and application of organic-walled microfossils. There is heavy emphasis on spores and pollen in the book because of Traverse's expertise on these palynomorphs, but he also discusses all other groups of palynomorphs. In this second edition, extensive revisions have been made to material on dinoflagellates, acritarchs, cryptospores, palynofacies, paleoecology, thermal alteration of palynomorphs, and the application of palynology to sequence stratigraphy.

The first 5 chapters introduce the concept of paleopalynology, the natural history of palynomorphs, and the basic biology and morphology of spores and pollen. The next 11 chapters focus on stratigraphic palynology spanning the Precambrian to the Holocene, while the last 3 chapters discuss spore and pollen production, dispersal, sedimentation and taphonomy, palynofacies, and paleopalynological applications. Fifty-two pages of appendix are devoted to palynological laboratory techniques and are followed by a very detailed glossary section. Discussions are supplemented by black-and-white and color photomicrographs of palynomorphs, palynodebris and palynofacies, including line drawings of morphological features and stratigraphic range charts. Traverse must be commended for supplying updated literature and citing papers appropriately. As with the first edition, one interesting aspect of this book is the integration of the historical context of paleopalynology with the various topics of discussion. Photographs, brief biographies, and the author's narrative of the contributions of key players in the discipline occur throughout the book.

Chapter 1 defines paleopalynology, introduces the reader to the various groups of palynomorphs from four kingdoms (Protista, Fungi, Plantae, Animalia), and chronicles the history of palynology. It also provides an annotated bibliography of useful publications (mainly textbooks, edited journal volumes, monographs, atlases, indices), databases, websites, and software aimed mostly at students. Chapter 2 explains the usefulness of paleopalynology for geochronology, biostratigraphy, correlation, paleoecology, and, by inference, paleoclimatology. It notes that palynology works because palynomorphs occur in every type of environment, permit correlation between marine and nonmarine environments, and have been around for 1.4 byr. Palynomorphs are abundant and durable, and have undergone relatively fast evolution. Facies control (they are sparse to absent in well-sorted sandstones, fine-grained claystones, and carbonates), reworking, and sensitivity to oxidation, alkalinity, high temperature and pressure, and crystallization, however, limit their use. In addition, light microscopy, which is routinely used for their study, can limit identification only to generic and sometime higher taxonomic rank.

In Chapter 3, there are detailed discussions about wall composition of palynomorphs, why they tend to be resistant, and their functions. Sporopollenin constitutes the basic structure of most palynomorphs, such as plant spores, pollen, some algae, dinoflagellates, and acritarchs, although dinoflagellates contain a sporopollenin variety called dinosporin. Chitin is found in spores, mycelia, and other organs of fungi, scolecodonts, and inner linings of foraminifera, while the walls of chitinozoans are composed of pseudochitin. The chapter ends with a chronicle of the general occurrence of palynomorphs through time. The basic biology of spores and pollen in Chapter 4 explains the life cycles of bryophytes, pteridophytes, gymnosperms, and angiosperms and dovetails nicely into their morphology in Chapter 5. Students will find this chapter very informative because of extensive illustrations, descriptions, and terminologies of spore and pollen wall structure, sculpture, orientation, and shape, including the three-symbol Shell Code for designation of morphological types.

Chapters 6–16 cover stratigraphic palynology and are partitioned into groups of periods or epochs (some of which overlap) and significant boundary events. Chapter 6 discusses the evolution, morphology, and distribution of acritarchs during the Precambrian, and their distribution alongside chitinozoans and scolecodonts during the Cambrian and Ordovician. Chapter 7 chronicles the origins of cryptospores and early embryophytes, and suggests that *Ambitisporites* was perhaps the first true embryophyte recovered from the Llandovery stage of the early Silurian. It should be noted that a considerable part of this chapter is devoted to acritarchs. The Devonian saw a rapid diversification and expansion of embryophytic plants, mainly lycophytes, ferns, and progymnosperms. It marked the transition from microspores and isospores through megaspores to seeds, and bisaccates appeared by the end of the period. Acritarchs reached their peak in the marine environment, were severely decimated by the Frasnian–Famennian mass extinction, and never fully recovered ecologically until the Late Triassic. Chitinozoans disappeared at the end of the Devonian during the Kellwasser event, which also severely affected land plants and scolecodonts. During the Carboniferous and Permian further diversification of spores and pollen occurred, and extensive coal forests formed during the Carboniferous. There are discussions in Chapter 9 about Robert Potonié's turmal classification system for spores and pollen and modification of it (including a simplified classification on p. 235–263), paleobotanical issues, *in situ* production of Paleophytic spores and pollen, megaspores, paleoecology, morphology of bisaccates, the Permian–Triassic mass extinction, and acritarchs. The Late Carboniferous glaciation appears to have marked the beginning of provincialism in the floras of Gondwanaland.

A conifer-glossopterid-gnetalean association represented by striate and taeniate bisaccate and nonsaccate pollen dominated Permo–Triassic palynofloras (Chapter 10). Other spores and pollen included trilete fern spores, and monosulcate pollen, mostly *Monosulcites* and *Cycadopites*. These palynofloras appear to be endemic and mark the so-called Paleophytic–Mesophytic boundary. Acritarchs were stratigraphically useful, especially in phosphorites. The next chapter on Triassic–Jurassic palynology notes the dominance of nonstriate bisaccates and monosaccates, fern spores, monosulcates, inaperturate pollen, and exotic pollen such as *Eucommiidites*, *Classopollis*, and *Circulina*. In a review of circumpolloid systematics, Traverse reinforces his earlier proposal to conserve *Classopollis* over *Corollina*. There are also brief reviews of various studies in Europe and North America, including those in the Richmond Basin, which have yielded specimens of Triassic angiosperm-like columellate-reticulate pollen with sulculi. Chapter 12 also discusses Triassic and Jurassic palynology but focuses on megaspores, dinoflagellates, and other microplankton. Heterosporous lycopods and ferns produced megaspores of potential stratigraphic significance, and there were abundant but low diversity acritarch assemblages. The first unquestionable dinoflagellates appeared during the Late Triassic. Many dinoflagellates with chorate cysts were called hystrichosphaerids and grouped with acritarchs until Evitt (1961, 1963) demonstrated that they were indeed dinoflagellate cysts and formally proposed the acritarchs as a separate group. Detailed information about dinoflagellate cyst-wall structure, life cycle, cyst types, archaeopyles, and overall morphology can be found in this chapter.

Chapter 13 on Jurassic–Cretaceous palynology treats the origin of angiosperms in great detail, including trace evidence for possible Jurassic origins and coevolution with insects suggesting a Neocomian origin. Unquestionable angiosperms appeared during the Barremian as tricolpate and tricolpate-derived pollen (eudicots) in equatorial Southern Hemisphere areas. They reached the middle latitudes of the Northern Hemisphere in Aptian-Albian time and Arctic areas by the Cenomanian (e.g., Brenner, 1976; Doyle et al., 1977; Friis et al., 1986). Several pollen groups with unique characteristics, e.g., Normapolles, *Aquilapollenites,* and *Wodehousia*, evolved by the Late Cretaceous and were dominant elements of the spore-pollen associations. Several palynological provinces, such as the African-South American (ASA) and northern and southern Gondwana provinces, existed during the Cretaceous. Dinoflagellates were abundant and fast evolving in the Jurassic and Cretaceous, and acritarchs were stratigraphically important. The terminal Cretaceous mass extinction event affected very few dinoflagellates and several spores and pollen. Overall, palynological extinctions were less dramatic that those of megafossil floras. Paleogene palynology in Chapter 14 examines the effect of the Paleocene–Eocene Thermal Maximum (PETM) on the palynological record, late Paleogene cooling, characteristics and taxonomy of spores and pollen, decline of Normapolles types, and the rise of fungal spores. This chapter ends with a comprehensive treatment of Paleogene–Neogene dinoflagellates.

Chapter 15 (Neogene) contains some information already discussed in earlier chapters and treats the last 10 myr as the Ultimogene. Traverse notes that practically all angiosperm remains, including pollen, that are referable to modern families had evolved by 20 Ma, although it was not until about 1.8 Ma that 100% of the pollen recovered was referable to modern genera. This chapter includes a discussion about the development of the C_4 photosynthetic pathway in grasses and many dicot families during the late Miocene, significant cooling events, palynologically significant boundaries, general vegetation trends, the Pliocene record, and Pleistocene palynology (glacial-interglacial cycles, chronology). Stratigraphic palynology concludes with Chapter 16 (Holocene) and focuses on extant plant associations, human influence on archaeological palynology, methods of study, presentation of data, chronology, applications, and the theory of pollen analysis.

The production, dispersal, sedimentation, and taphonomy of spores and pollen are the subjects of Chapter 17. These palynomorphs are mostly silt sized with low specific gravities (~1.4), are preserved as hollow objects after the destruction of their protoplasmic interiors, and behave as sedimentary particles. Unlike insect-pollinated varieties, wind-pollinated seed plants and some spore-producing plants produce enormous amounts of pollen and spores. Their propensity to be preserved depends largely on (1) the amount of sporopollenin in the exine, as higher amounts promote preservation; (2) depositional conditions (better preservation in acidic, reducing, and quiet conditions); and (3) other factors such as sedimentation pattern. The chapter further discusses pollen rain, sampling techniques of pollen in water, use of isopoll maps, and other quantitative methods for vegetational analysis, as well as methods of presentation (pollen per gram, pollen influx). The section on the sedimentation of various palynomorph types reviews Jan Muller's Orinoco Delta work (Muller, 1959), sedimentation in nonclastic environments such as the Bahamas, and how the features of dinoflagellate cysts and acritarchs (smooth vs. spiny, for example) can be used to infer shallow or nearshore and deep-marine conditions. The discussion of differential sorting of palynomorphs into sediments in Chapter 18 draws upon information presented in the preceding chapter. Since Combaz (1964) introduced the term palynofacies as the general aspect of organic matter (palynodebris) in palynologic preparations, its application by palynologists and geochemists has been expanded to include paleoenvironmental interpretations, sequence stratigraphy, inferring geothermal maturity, and petroleum source-rock evaluation. Traverse proposes the term palynolithofacies if organic-matter distribution is geologically controlled, but palynobiofacies if it is biologically controlled. He does not recommend the use of kerogen for palynodebris. There is currently no standard classification for palynodebris, and Table 18.1 (p. 562) proposes one based on palynofacies classification schemes published by several authors. This chapter also discusses the methods of palynofacies study and presentation of data, amounts of palynomorphs in sediments, reworking, recycling, and stratigraphic leaks (caving).

The last chapter of this book (Chapter 19) reviews some factors affecting the practical applications of paleopalynology. These factors include post-depositional alteration of palynomorphs, poor preservation, and carbonization of specimens. Heating causes chemical changes to sporopollenin and chitin, resulting in color changes from pale in fresh exines to orange, brown, dark brown, and eventually black in transmitted and reflected light. Chitin responds more slowly to color change than sporopollenin. The chart of spore and pollen coloration (Pearson, 1984) correlated to various color indices and vitrinite reflectance (Fig. 19.2, p. 584) is very useful. A dichotomous stratigraphic key to spore and pollen assemblages in Figure 19.5 (supplied by W.C. Chaloner) is intended for age approximations in productive samples. Traverse notes that palynostratigraphers still employ concurrent zones, Oppel zones, or assemblage zones in their studies, even though data management is now achieved mainly by using computer programs for probabilistic methods, multivariate techniques (principal components analysis, cluster analysis), graphic correlation, and relational methods (range charts). A review of systematics reinforces the usefulness of Linnean taxonomy for paleopalynology, which has been challenged only seriously once by Hughes (1989). The International Code of Botanical Nomenclature governs the taxonomy of most palynomorphs, chiefly spores, pollen, fungi, dinoflagellates, and acritarchs, whereas the International Code of Zoological Nomenclature governs chitinozoans, scolecodonts, and foraminiferal linings. Chapter 19 concludes by recommending several important resources for fossil palynomorph systematics.

This book will serve as a useful reference for palynologists and nonpalynologists, and for professionals and students, but its high price may prevent students, who will benefit the most from using it for their courses and research, from purchasing it. I note here that the book has several shortcomings. There are repeated statements throughout because some topics (e.g., the need to do away with the Quaternary and Pleistocene from the geologic time scale) are discussed in several chapters. Repetitions are also partly due to the book's layout. For example, topics related to basic palynomorph morphology and composition discussed in the earlier chapters of the book are reviewed again in later chapters dealing with paleopalynological applications. Many figure captions are two pages long or are not even on the same pages as the figures themselves because of Traverse's propensity to add discussions to figure captions before explaining the illustrations themselves. Some references cited are missing from the bibliography. Overall, these distractions pale in comparison to the wealth of information presented in the book.

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