

Knut Faegri & Johs. Iversen

TEXTBOOK OF POLLEN ANALYSIS

SECOND REVISED EDITION

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with a chapter on Pre-Quaternary pollen analysis
by

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CONTENTS

Preface	9
Outline of the History of Quaternary Pollen Analysis .	11
The Pollen Grain, its Form and Function	14
The Production and Dispersal of Pollen Grains	31
Peat and Sediment Types	42
Sediment and Peat Symbols	47
Field Technique	53
Laboratory Technique	66
The Principle of Pollen Analysis	83
The Pollen Diagram	86
Fossil Vegetation Maps	96
The Interpretation of Pollen Diagrams	99
Sources of Error	114
Statistical Errors	124
Pollen-Analytical Zones	137
Pre-Quaternary Pollen Analysis	140
The Applications of Pollen Analysis	154
Some other Micro-Fossils	163
Pollen Keys	168
References	203
Index and Glossary	218
Plates	229

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PREFACE

This book is a second edition of the "Textbook of modern pollen analysis" (1950). That has been out of print for a few years, and a new edition might be said to be over-due. However, it has been no easy task to prepare another edition: the situation in pollen analysis to-day being rather different from what it was in 1950. We then said in our preface: "The object of this book is to present to our colleagues a summary of those methods and principles which have guided us in our pollen-analytical work. Pollen analysis is still a very young science and far from reaching perfection; nevertheless, we consider it useful to sum up our present position. We hope that this book will provoke discussion, and contradictions if necessary, thus serving as a stimulus for the development of pollen analysis into a more refined instrument of research. We also hope that our treatment of the subject is sufficiently simple to be understood by the beginner, and that this book may serve as an introductory text-book."

When this was originally written, available textbooks were, for various reasons, inadequate, at any rate outside their individual fields. The same cannot be said to-day. However, although a number of authoritative texts has appeared, they are not all in widely understood languages, and so we think there may still be room for this book.

Other differences are more important when we compare with conditions in 1950. The term "modern" in the title of the first edition was a challenge: the challenge of botanists that botanical reasoning should be applied in what is essentially a botanical method, as against the "old-fashioned" geological pollen analysis. What was then a challenge has now been generally accepted, at least in principle. If we may speak of any "modern" trend in present-day pollen analysis, it is at any rate not to be looked for in this context.

Pollen analysis has spread: geographically, more and more areas are opened to analysis, from the Arctic to the Antarctic; in time, older deposits are studied more and more intensely; and in penetration, not only in overall analysis, but also in pollen morphology. Still supporting ourselves mainly on European examples we have endeavoured to make this book as universal as possible, with no geographical bias. As we have little practical experience

beyond the Late-Quaternary, we asked Dr. H. T. WATERBOLK of the University of Groningen to contribute with regard to the second point above. To this, our colleague has generously responded. As to the third point, especially the refinements of pollen morphology, this has been taken into account as far as it is considered to have a bearing on pollen analysis, but this is no text-book of pollen morphology.

We should like to repeat here another statement from the preface of the 1950 edition: "no key, however ingenious, and no illustrations, however masterfully executed, can replace the personal knowledge of pollen forms acquired from working with actual preparations. Every pollen analyst should have access to a well-stocked "pollen herbarium" for comparison of any problematic form that may occur in his preparations. If properly executed, keys and illustrations may serve as guides in the identification of a pollen grain, but all identifications should be verified by comparison with recent pollen material. To the experienced worker a key may substantially serve as an aid to the memory, to the beginner it may serve as an instruction in the very difficult art of observing pollen-morphological features."

The first edition was dedicated to LENNART VON POST. It was a sad satisfaction to its authors that the last thing he ever published, was a review of that book. We are not going to dedicate this one to any particular person, but to all the pioneers in pollen analysis of whatever aspect. Quaternary pollen analysis was born in Scandinavia, perhaps because there is hardly any other region in the world where problems are so simple from the Quaternary pollen analysis angle. Pre-Quaternary analysis had its origin elsewhere, and so had some of the other modern trends. We hope that this book may serve to integrate all branches of pollen analysis, whatever their origin or scope.

A generous grant from the *Danish State Research Foundation* has made it possible to make an extensive, renewed investigation into the problem of pollen grain size. This has been carried out in the laboratories of the Geological Survey of Denmark by Mr. C. VANG NIELSEN. We render our thanks for this support, and also to the *Geological Survey of Denmark* for the use of the printing blocks for a majority of the illustrations, and to Mr. BRORSON CHRISTENSEN who again has contributed artistically with supplementary drawings. For linguistic advice we are indebted to Mr. JOHN AMBROSEN.

Bergen and Copenhagen, 1963.

OUTLINE OF THE HISTORY OF QUATERNARY POLLEN ANALYSIS

The observation that certain remains of former vegetation are preserved in peat bogs is certainly as old as the practice of peat cutting itself. Nobody cutting peat, e.g. in a de-forested region, can help noticing trunks and roots or pine cones preserved in the bogs; reflections upon the changes in vegetation will come automatically. A closer inspection will soon reveal that remains differ in different depths of the bog, and whereas some of these differences may be due to the natural development of the deposit itself, e.g. the filling in of a lake, others demand a more radical explanation, e.g. climatic changes.

The method of investigating Late-Quaternary changes of vegetation and climate by identifying the individual fossils – ranging from tree trunks to bud scales or seeds – and arranging them according to their occurrence in different layers of the deposits, was that of the so-called palaeo-floristic school. However, at the same time, another school, the palaeo-physiognomic, tried to investigate the climatic changes, not by utilizing the fossils directly, but by reconstructing the so-called mother-formation, i. e. the plant community, represented at each level, and by drawing conclusions from the changes of mother-formations. In their original form both schools now belong to history, and we mention them here because they – and especially the polemics between their distinguished leaders GUNNAR ANDERSSON and RUTGER SER-NANDER – form the back-ground to pollen analysis.

The specific identification of seeds and other small fossils found during the examination of peat required the use of some magnification, and using strong magnification quite naturally led to the discovery of even smaller fossils, which would then also include pollen grains. Oddly enough fossil pollen grains were apparently first observed in Pre-Quaternary deposits, by GÖPPERT (1836 and later) and EHRENBURG (1838 and later, both quoted after KIRCHHEIMER 1940). The first to utilize the occurrence of pollen grains in Post-Glacial deposits were, as far as we know GEINITZ (1887, analyses by FRÜH) and C.A.WEBER and his school (1893 and later), whereas ANDERSSON, the leader of the palaeofloristic school in Northern Europe, apparently never attached much importance to the occurrence of pollen grains in the deposits (cf. ANDERSSON 1898: 87). There is, however, a difference in principle be-

tween these early, qualitative registrations (quantitative in STEUSLOFF 1905) and pollen analysis proper, i.e. the percentage calculations. The first percentage calculations seem to have been carried out by LAGERHEIM (in WITTE 1905), and later by C.A.WEBER himself (1910, quoted in H.A.WEBER 1918, although it is not quite clear if the actual calculations were carried out in 1910, cf. *l.c.*: 259). As pollen analyses these early works are of historical interest only, though HOLST (1909: 30) evidently realized the great importance of LAGERHEIM's calculations.

The real potentialities of the method were, in fact, not realized until LENNART VON POST, then state geologist, took it up with LAGERHEIM as his micro-morphological instructor. VON POST presented the first modern percentage pollen analyses in a lecture to the Scandinavian scientists' meeting at Kristiania (now Oslo) in 1916, repeated later the same year in Stockholm. A rather short abstract of the latter was published in 1916, whereas the report of the Kristiania meeting was not published until 1918.

In the meantime VON POST's students and collaborators continued his work; SANDEGREN, HALDEN, and SUNDELIN published (1916 and 1917) bog monographs including pollen-analytical data. As these papers were all published in Swedish, pollen analysis passed rather unnoticed outside the Scandinavian language region (quoted by C.A.WEBER in H.A.WEBER 1918), and the first pollen-analytical investigations outside Sweden were published in Denmark (JESSEN) and also in Norway (HOLMSEN), in 1919 and 1920. The first time VON POST's methods were published in a congress language was in 1921 (ERDTMAN). After that they were adopted almost everywhere, supplementing and supplanting older methods in Quaternary geology, and pollen-analytical literature grew rapidly – in quantity, not always quality. ERDTMAN published a regular series of extremely valuable, complete bibliographies (in "*Geologiska Föreningens i Stockholm förhandlingar*", beginning with vol. 49) leading up through the year 1954 (vol. 77). Later, this work has been taken up by the periodical "*Pollen et Spores*".

From the middle twenties pollen analysis has been the dominant method for investigation of Late-Quaternary development of vegetation and climate. It has been perfected into a very refined instrument of research, highly versatile and giving surprisingly intimate glimpses into the conditions of life during earlier periods. It has thus become one of the most important auxiliary sciences for archaeology, adding to the picture given by human relics. Still, the macro-fossils have their story to tell, and even if it is poorer than that told by pollen, it may elucidate points not covered by a pollen diagram. On the other hand the pollen-analytical control serves to increase the value of the information given by macro-fossils, and especially, to lend a previously unexpected exactitude to palaeophysiognomy.

Like all microscopical techniques pollen analysis is time-consuming, and

it has taken a long time before any comprehensive picture could be drawn of the development within any extensive region. So far, it has only been possible within few: Central Europe (FIRBAS 1949), the British Isles (GODWIN 1956), USSR (NEJŠTADT 1957).

Among comprehensive methodological texts we may mention those of DYAKOWSKA (1959) and PLA DALMAU (1961). A well-balanced brief account has been given by PONS (1958).

Regional "pollen floras" have been published or are being published from Hawaii (SELLING 1946-48), New Zealand (CRANWELL 1952), South Africa (VAN ZINDEREN BAKKER 1953), Japan (IKUSE 1956), Brazil (SALGADO LABOURIAU 1961), Chile (MARTICORENA 1961), India (NAIR 1961), cf. also ERDTMAN (1943), POKROWSKAJA (1958), VAN CAMPO and collaborators (1957). Similar, less comprehensive, works covering other regions have been published. All of these papers, in their treatment, follow the ordinary taxonomic systems, and so does ERDTMAN's general survey (1957). BEUG's manual from Central Europe (1961) is the first one to base the treatment solely on criteria of pollen morphology.