The Study of Pollen

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INTRODUCTORY NOTE

Apart from wishing to provide interest and pleasure for Beekeepers, the National Honey Show has the serious aim of raising the standards of production of honey and all other bee-produce.

With this objective in view, leading; authorities have been invited to write for our Schedules on a number of subjects and their work is here available for more general distribution. We wish to thank all our contributors, they are leading exponents of their skills, we have, however, to make it clear that the advice which they give is their own individual method, we feel sure that they would be the first to encourage new alternative ways of preparation with a view to continual advancement and progress within the Craft.

Hon. General Secretary
NATIONAL HONEY SHOW

THE STUDY OF POLLEN

By Rex Sawyer

At the National Honey Show you see hundreds of jars of beautiful clear and crystallised honey. It is difficult to realise that every jar contains a million or more unseen pollen grains. Straining through the finest cloth will not remove them, nor would it be desirable, for they form a natural and beneficial part of the honey. To the ancients pollen was seen as fine flour and they named it accordingly. Like dust it floats invisibly in the air but collected m mass by bees it forms the coloured loads which they carry on their legs. For as colourless drops of water form the blue seas so the apparently colourless pollen grains form loads of many colours according to the plants from which they are gathered.

Yet each minute grain is a complete organism carrying the characters and the beauty of the parent plant and seeking the opportunity to pass these characters to succeeding generations. To achieve this the pollen must be transferred to the stigma of a flower of the same species. Thus pollination is effected; the pollen grain can now germinate to set the fruit and seed. The earliest flowering plants, the Cycads, the Maidenhair Tree and the Pines, relied on the wind to carry their pollen but gradually a fascinating

relationship was built up between the flowering plants and the bees giving advantages to both but making them completely dependent upon one another. In exchange for their pollination services, plants supply bees with nectar for making honey, their essential energy food, and pollen, a protein food from which the nurse bees make the royal jelly for feeding the larvae. Many interesting mechanisms, born of this association, may be found in flowers. They may scatter or dust the pollen over the visiting bee or provide coloured guide lines to the stores of nectar. In the course of time some plants, particularly the grasses and cereals, have returned to wind pollination, but the pollination value of bees in the setting of fruit and the seeds of many flowers and vegetables far exceeds the value of the few pounds of honey the beekeeper may obtain at the end of the season.

The Assyrians realised the need for pollination and left, recorded in glazed brick relief, scenes showing somewhat mythical figures dusting the female palms with pollen from their male counterparts. But it was not until the discovery of the compound miscroscope by Robert Hooke in the middle of the seventeenth century that the real nature of pollen was revealed. It was seen that each plant species produced its own unique type of pollen grain; all exactly the same but different from those of every other species. There followed an era when the beauty of pollen was discovered. Early in the 19th century, Francis Bauer, the Botanical Painter to His Majesty George III and resident draughtsman to the Royal Botanic Gardens at Kew, made a series of sketches of the pollen grains of 175 species in which, as recorded on his tomb in the church at Kew, “he united the accuracy of a profound naturalist with the skill of an accomplished artist.” His quite remarkable sketches may be seen in the library of the British Museum (N.H.) at South Kensington.

There followed some of the richest years in botanical history. Hugo von Mohl, a German professor of botany who was able to polish and set lenses, made improvements in the microscope and microscopical measurement. His great work, published in 1834, in German, on “The Build and Shape of Pollen Grains” shows the state to which the science had advanced, for he describes the pores and furrows and discusses their

structure; how some “have a lid to them while some are surrounded by a halo”; he discovers that “they are not real openings but are closed by a membrane which is generally thin”, he goes on to describe the shape of the grain, the layers of its coat and the structure of its surface, finally producing a descriptive classification based on these morphological features, which even to-day, with our modern microscopes, can hardly be bettered.

By the turn of the century good microscopes were freely available while the structure and development of pollen was well understood. The next advance came from the Scandinavian geologists who were examining the fossil pollen in the peat deposits. The coat of a pollen grain, known as the exine, which gives it its characteristic appearance, is made of an almost indestructable material. Long after the contents of the grain and the plant itself have rotted away the pollen exine remains perfectly preserved in the peat to show its floral origin. This identification of plants associated with other fossil remains is in itself important. But a far more important discovery was made by Lennart von Post, the Swedish state geologist, who showed how the percentage analysis of the tree pollen in a layer of peat could give the date of its deposition. It was known that during the recent Post-glacial period, say the last 12,000 years when civilisation was developing in Central Europe, there were long-term climatic variations of humidity and temperature. These climatic changes caused dominance or recession of the several tree species comprising the primeval forest. This in turn caused changes in the relative percentages of the pollen which was deposited by each species as time progressed. A statistical examination of these relative percentages of tree pollen in the succeeding layers of peat gives a time scale applicable to the associated archaeological discoveries. This is Pollen Analysis which as a dating system proved invaluable to archaeologists in tracing the development of civilisation and the history of agriculture from the earliest periods. It has now been largely superseded by carbon dating.

In the 1930’s with the establishment of Bee Research Institutes in Germany and other Continental countries, the study of pollen and the other particles in honey became the subject of scientfic investigation known as Melissopalynology or the Pollen Analysis of Honey. Experimental work in Germany and by Todd and Vansell in America showed that the nectar in a flower and that gathered from it by bees in their

honey-sacs contained the pollen from that flower and no other. The quantity of pollen in the nectar differs with the structure of the flower and the quantity and size of its pollen grains. Some pollen is removed and consumed by the bee on her return journey but every drop of nectar which arrives at the hive for processing contains a large number of grains which eventually find their way into the honey. The pollen-loads which bees collect on their legs are stored separately but some of this pollen may also be mixed with the honey as it is extracted. A further contribution is made by the honeydew, the sweet sticky secretion found on the leaves and stems of plants. Many unseen particles floating in the air-the pollen of the wind pollinated plants, particularly that of the grasses, fungus spores and algae, specks of soot and dust, are caught in it to be collected up by the ever foraging bee.

It can thus be seen that a simple percentage analysis of the pollen in honey may be very misleading. All the pollen certainly comes from the local environment, contributed by the local flora, but many other factors must be considered in order to interpret the results of microscopic examination either as an evaluation of the honey or of the apicultural resources of its area of production.

In 1936 Professor Enoch Zander of the Institute of Agriculture in Erlanger, Germany produced the first book of his monumental series on the origin of honey and honeydew, in which he gave detailed descriptions and photographs of the pollen of many thousands of plants together with the results of the analysis of a wide range of honeys. He made a detailed study of the production of the famous German honeydew honeys and even extended his research to investigate the honey production of modern Egypt and compare the honey with that found in the tomb of a mummy dating back 1350 years B.C. These books remain an invaluable reference and have been followed in recent years by large volumes describing the pollen grains of many countries. Among these may be mentioned

Professor Masa Ikuse's "Pollen Grains of Japan" (fortunately with English sub-titles); "Pollen et Spores d'Afrique Tropicale" and Dr. Louveaux's work which was produced for use in France as the official method of analysis by the "Service de la repression des fraudes et du controle de la qualit'e." Quite recently a large and beautiful book on the Apicultural Flora of Italy with coloured photographs of the plants and photomicrographs of their pollen has been received from the Italian Ministry of Agriculture.

A. S. C. Deans, working at the North of Scotland College of Agriculture made a "Survey of British Honey Sources" published by the I.B.R.A. in 1956, based upon the microscopic examination of 854 samples of honey from all parts of the British Isles. This created much interest at the time but unfortunately the work has not been continued in this country. Dr. Vorwohl and others have classified the honeys of the Mediterranean region by their pollen content while studies are now being conducted in New Zealand and the United States towards establishing honey certification programmes based on melissopalynology.

In 1926 the British Bee Journal published a small book by George Hayes entitled "Nectar Producing Plants and their Pollen" which contained the following passage:" "There is no doubt that much cheap foreign honey is being palmed off on the public as English honey for the sake of the extra profit that may be obtained . . . . . An examination of the pollen grains in honeys of doubtful origin is, however, a sure test. Honey not produced in the British Isles will always contain pollen grains that are not found in home produced honey. As it is gathered from flowers that do not bloom here, the following illustrations will help anyone having a microscope to determine with tolerable certainty if a given sample of honey is foreign or home produced or a mixture." But 57 years later the problem is still with us. Melissopalynology is now internationally recognised and well documented. It was included in the E.E.C. Directive for the Honey Regulations and is part of the Law of our Continental neighbours. But although our Honey Regulations (1976) call for a correct labelling of honey with the plant or blossom source and a conspicuous indication if it is of foreign origin, the words "microscopic examination" were unfortunately omitted leaving no method of determination of these requirements.

At the request of beekeepers in 1977, the Ministry of Agriculture, Fisheries and Food agreed to investigate the methods of honey identification. However, Mr. Peter Walker in a Written Answer (Hansard 15/1/80) stated that "It was not possible to develop analytical methods to confirm the type or geographical origin of honey. The total cost of the study was £ 15, 000." The method employed was gas chromatography. At

the same time tests using pollen analysis of honey were conducted with the Food Science Division of the Ministry which showed that “the method had been developed to a high level of expertise and is extremely accurate in the analysis it makes of the contents and country of produce of honey.”

The Trading Standards Officers now realise the extent of the trouble and the potential of pollen analysis. We are grateful to them for their actions. Not all prosecutions have been successful, but in every case, including some which have not come to Court, the offending honey has been taken off the market.

The country of origin of a honey follows from a knowledge of its flora as discovered by an examination of the pollen. Only a modest ecological knowledge is then required to show that, for example, a honey containing largely the pollen of Fruit Blossom, Clover and Blackberry is probably English while a honey with the pollen of Rosemary, Olive and Orange is certainly foreign and likely to have been imported from Spain. But to the experienced melissopalynologist every honey is different: each one has a different combination of pollen grains in it making up its pollen spectrum which, once seen and noted, can be recognised again with certainty. The proportions of the pollen in the spectrum are capable of almost infinite variation although the country of origin may be the same. Thus an Australian Amber Honey may be a Eucalyptus honey showing the pollen of Eucalyptus and Purple Bugloss while another sample may be predominantly from Clover with Eucryphia and Lotus. In each case the presence and proportion of small additions of the pollen of, for example, Banksia, Wattle, Protea or Lupin will identify the particular batch or area of production. All these honeys are typical of Australia but only the pollen can reveal their common origin.

In many overseas countries extensive areas of clover are grown which produce large quantities of honey. Over the years much of this cheaper honey has been used as a substitute for our own, now rather scarce, English Clover Honey. The Pollen spectrum of the alien honey is dominated by clover but contains minor percentages of characteristic foreign plants. A small percentage however represents several thousand pollen grains in every ounce of honey to prove its origin while the absence of English pollen types shows it to be definitely foreign.

In recent years interest has grown in Britain in the study of pollen Dorothy Hodges’ book giving a key to the many coloured loads of pollen which the bees carry home has been republished, while my “Pollen Identification for Beekeepers” has provided guidance for those wishing to pursue the subject further and obtain a more positive identification using a microscope. A number of courses and lectures have been given and the fascination of preparing pollen for examination beneath the microscope has given a new interest to many beekeepers and students. In the schools pollen identification has provided an excellent project combining Biology with Computer Science. Pollen can be identified by observing its features-size, shape, surface etc.-and assigning a number to each according to a prearranged scale. The pollen can then be identified by comparing these numbers with a table in my book.

A set of punched cards is supplied to simplify the search but modern technology provides a better answer. The students of Aireborough Grammar School, Leeds, working with the beekeeping club have programmed their computer to accept the numbered features and display the plant name. This method of computer assisted pollen identification aroused great interest when demonstrated by the pupils at the Great Yorkshire Show in July 1982. Other schools and further demonstrations have followed this example.

When Dr. Robert Pickard commenced his neurological research at University College Cardiff he decided that since the honeybee brain coordinated life in a communal system with senses and means of personal communication comparable to our own, it was an ideal subject for exploration. The study of bees led to co-operation with beekeepers throughout the country and the establishment of the Bee Research Unit. This Unit is largely concerned with the practical problems of beekeeping: students have been attracted to study such diverse subjects as queen rearing and nosema while Miss J. K. Thomas B.Sc. has for the last year worked on pollen identification and the comparison of bee forage in rural and urban areas. Miss Thomas wishes to continue work on pollen and honey. Through the generosity of many Beekeeping Associations in England and Wales funds have been raised to enable her to visit Hohenheim University in Germany where Dr. G. Vorwohl has kindly offered her training in the procedures used in his laboratory. Here,

among other activities, the honey from some 800 members of the German Beekeepers Association throughout Western Germany is entered for annual competition. The pollen in each sample is identified and recorded together with the results of chemical and physical tests, giving a detailed record of the types of honey produced in the Republic. The honey is graded according to its type, quality and presentation. It can then carry the appropriate seal of the Association and command a premium price accordingly.

While such regimentation may not be acceptable to British beekeepers, there is much serious work to be done in order to improve the standard and presentation of our honey and to provide information to control its labelling and sale. Dr. Pickard is therefore seeking a permanent appointment for Miss Thomas with the Bee Research Unit to centralise and expand future work on pollen identification and honey technology. The agricultural scene in this country has undergone great changes since Alex Deans conducted his Survey. The sources of our honey require to be reassessed for the beekeepers in planning their management and subsequent marketing; for the packers to be guided in a more realistic labelling of their produce and for the positive identification of our honey as a protection against misrepresentation. Standards should be determined for the designation of our fine English floral honeys such as Fruit Blossom, Lime, Clover, Bramble and Heather. The last in particular needs attention, for much of that now offered to the public bears little resemblance to the clear amber jelly with its suspended bubbles which may be seen on the benches of the National Honey Show.

A constant check should also be kept on the honey from the main producing countries of the world. Many changes have taken place among these in the last few years both geographically and in the floral sources of their honey. The lack of technical information regarding bulk honey imports leads to accidental mislabelling by the packers and the confusion of the purchasers.

And finally, with the co-authorship of Kim Thomas, I hope to complete a further book for publication by the University College Cardiff Press on “Honey Identification”.

The National Honey Show presents annually a three day show of the best of the products of the honeybee, with additional classes for kindred interests and skills, including school bee-keeping, a lecture programme and a display of the latest and finest bee-keeping equipment on the market today.

It attracts entries and beekeepers from all over these Isles, and a number of leading organisations hold meetings during the Show.