1. Pollen grains consist of three substances:

1.The inside of the cell is filled with living cytoplasm, that deteriorates rapidly during fossilisation.

2.The inner layer of the cell wall, the intine, consists mainly of cellulose and pectin, this also degrades rapidly during fossilisation.

3.The outer cell wall, the exine, consists mainly of sporopollenin, an N-free polymeric substance belonging to the terpenes. Its chemical formula is: C90 H130-158 024-44. Sporopollenin is chemically unsaturated and is corroded by oxygen (oxidation), but is otherwise resistant even to strongly alkaline substances and organic acids. Sporopollenin is thus one of the most resistant substances in the plant world

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| *The structure of both Pteridophyte and Bryophyte s****pores****is very similar to pollen. They also possess a sporopollenin cell wall consisting of several layers. The inner layers are the endospore and exospore, the outer layer, which often "peels off" is the perispore.*  *Thanks to the considerable chemical resistance of sporopollenin,****pollen grains and spores****can be preserved under anoxic conditions in lakes and fens for thousands to millions of years (the oldest preserved pollen of flowering plants found are over 120 Mio years old!). They can therefore be used for the reconstruction of earlier vegetation- and climate-conditions.*  *As the search for microspores in untreated sediment or peat would be very time-consuming, procedures for the specific extraction and concentration of pollen grains in samples have been developed. Most of these procedures make use of the fact that pollen grains are considerably resistant to chemical treatment. Thus, calcium carbonate can be removed from the samples with HCl, humic acid with KOH, mineral substances with HF, and cellulose with acetolysis (acetic-anhydride and concentrated sulphuric acid) without damaging the structural integrity of the pollen grains. Finally, coarse particles can be removed using a fine-meshed sieve.*  *The above-mentioned two types of tetrad formation correspond to the two basic types of microspores, the tetragonally formed bilateral microspores and the tetrahedrally formed isodiametric microspores. Apart from the different sizes of pollen grains, their shape, as well as the position of the pollen tube and apertures in the pollen grain can be used as identification criteria.* |

 2. IMPORTANCE AND SIGNIFICANCE OF POLEN

Honey

Honey is one of the oldest foods of mankind and there have been references to it and to the bees that gather it through out recorded history. Jacob sent his sons down into Egypt with a little balm and a little honey (Proctor & Yeo 1972). Today, honey is regarded as an important food and carbohydrate throughout the world. Honeybees utilize certain natural raw materials that are identifiable in honey. These raw materials include pollen and nectar. Pollen is the bee's major source of proteins. Nectar is a bee's source of carbohydrates.

One of the goals in the study of honey (melissopalynology) is to determine the sources used by honeybees to make honey. Identification of the pollen found in honey shows which plants honeybees visit to obtain the nectar to make honey.

Beekeepers need to know what flowers the bees visit so that they can locate the hives near the best flower sources. Optimal locations ensure the health and growth of the colony and honey for the beekeeper. In addition, honey of a dominant floral type (e.g., mesquite, clover, or citrus) can bring a higher price than honey of mixed or unknown floral sources.

Except for the USA, most major honey producing regions (Brazil, Canada, China, France, Great Britain, New Zealand, Spain, Switzerland, Japan and the former USSR) require three types of certification for honey and honey products that includes the verification of the honey's floral type, quality and precise place of origin. From the pollen in honey, the honey's floral type, quality and geographical origin can be assessed. The data collected from the pollen analyses of honey enable these nations to impose strict laws governing the importation and exportation of honey products. This certification requirement limits the exportation of United States domestic honey because the United States does not have this type of certification.

Climatic Changes

The change of climate patterns often can be determined by pollen analyses of the soil, especially the soil of bogs and lakes. Pollen falls onto the soil and into lakes and bogs throughout the year. Each year, another layer of pollen is added to the pre-existing layer. This process repeats year after year. As the vegetation changes, so does the pollen that is deposited. Thus, the vegetational changes are recorded in the different layers. By analyzing different layers, different pollens will be found. Any climate change can be determined by comparing the pollen found in the layers to the climate in which those plants occur. For example, if a core was taken from a pond in the desert. On analyzing the core, pollen from pines and firs were found. Although today that area is arid, the pollen record indicates that at one time the area supported the growth of pines and firs. Thus a climatic change had occurred from a cool, moist climate to one that was hot and dry.

Archaeological Palynology

Although von Post was the first to examine fossil pollen from archaeological soils (von Post *et al.* 1925), Iversen saw the full potential of pollen studies for archaeologists. By examining the fossil pollen collected in core samples from a bog, Iversen (1941) speculated how and when the local transformation from hunting and gathering to agriculture occurred. Iversen not only dated the introduction of agriculture in northern Europe, but also provided data concerning what plant species were introduced and how prehistoric groups altered the equilibrium of the natural vegetation by clearing the forest (Bryant & Holloway 1996).

Pollen evidence confirmed these types of data in other regions of Europe, the United States of America, Canada, Mexico and Japan (Godwin 1944, Mitchell 1951, Martin 1963, Durno 1965, Watts & Bradbury 1982, Bryant & Holloway 1983, Hall 1985, Tsukada *et al.* 1986, McAndrews 1988). Pollen analysis of soils recovered directly on top of a Neanderthal burial revealed unusually high pollen percentages and pollen clusters from alpine flowers (Lerio-Gourhan 1975). Because the pollen of these flowers is entomophilous, Lerio-Gourhan concluded that the flowers from nearby hillsides were placed in the Neanderthal's grave. Today, archeologists routinely collect soil samples from burials for pollen analysis. Data suggest that many prehistoric cultures had graveside rites (Bryant & Holloway 1996).

O'Rourke (1983) used pollen trapped in adobe bricks from an ancient southwestern pueblo site to show that various walls were constructed from different source materials and possible erected at different times. Pollen analyses are used for determining the probable function of baskets, ceramic vessels, bedrock mortars and milling stones. Pollen from storage foods such as maize, amaranth, cattail, etc., often adhere to the insides of baskets or become lodged in the weave (Bohrer 1968).

Pollen from coprolites (desiccated or mineralized feces) can provide information about the diet of prehistoric humans. Pollen can occur in coprolites through the eating of flowers or seeds or through the unintentional ingestion of pollen in medicinal teas or foods (Sobolik 1996). Pollen in this context is considered directly associated with food or a medicinal item. Thus, pollen analyses of coprolites offer direct clues to food items eaten intentionally. This type of precise information cannot be derived as accurately from other methods.

Palynological and palaeoethnobotanical data from underwater archaeological sites have been generally ignored. This lack of palynological data is possibly due to archaeologists not being trained to look for botanical remains associated with shipwrecks (Weinstein 1996). For example, underwater excavations, amphoras and similar ceramic containers are often emptied underwater to facilitate removal from the sea (Throckmorton 1960). Most investigations of shipwreck sites focus on technological innovations in ship design reconstruction of the vessel and retrieval of artifacts (Weinstein 1996). As a result, excavation and survey reports are often biased toward descriptions of macroscopic hull remains and cargo.

Forensic Palynology

Soil, leaf litter and even dust contain pollen grains that may provide clues to the type of vegetation, habitat or geographical location from which a sample originated. Soil from shoes, fingernails or just on the clothing may yield enough pollen to reconstruct the recent movements of a person or animal. Today, the country of New Zealand leads the world in the use of forensic palynology and the acceptance of this type of evidence in courts of law.

During a vacation along the Danube River, a man disappeared near Vienna, but his body could not be found. The police had neither motive nor evidence to link the suspect with the possible crime. As the investigation proceeded, a search of the suspect's room revealed a pair of boots with mud still attached to the soles. The mud was examined and contained modern spruce, willow and alder pollen. In addition, there was a special type of 20 million-year-old fossil hickory pollen grain present in the mud.

Based on the pollen evidence, the area where the defendant must have walked when getting mud on his boots was pinpointed. Only one location, a small area 20 kilometers north of Vienna along the Danube Valley, had soils that contained the precise mixture of pollen in the mud. When confronted with the identity of this location, the shocked defendant confessed his crime and showed the authorities where he had killed the victim and then buried the body. The discovery of the murdered victim's body and the conviction of the criminal were based primarily on the evidence recovered from a pollen sample associated with the crime.

Medical Palynology and Aerobiology

Many people attribute a runny nose, watery itchy eyes, etc. as the common symptoms of allergies. About 15% of the people in the USA suffer from allergies caused to biological particles such as pollen (O'Rourke 1996). Pollen production varies among plants species. Each plant species disperse pollen at about the same time each year. High wind speed promotes the dispersal of anemophilous pollen. The distance anemophilous pollen travels away from the initial plant varies and often depends on the magnitude and direction of wind currents, height of the plant and density of the vegetation cover (Jarzen & Nichols 1996). Studies have shown that more pollen is found near and far away from the parent plant than in the middle (Willson 1983). Many wind-pollinated plants release their pollen only during favorable conditions such as low humidity. A single birch (*Betula*) catkin may produce as many as five million pollen grains (Proctor & Yeo 1973). Traverse (1988) estimated that a ten-year-old branch system of a pine (*Pinus*) produced 350 million pollen grains.

Medical palynologists are concerned with the interaction of pollen and spores with the human respiratory tract. Factors affecting deposition include particle size, particle density, the subject's activity level, etc. Pollen or spore allergens must be wind-borne, occur in large quantities, produce hay fever and be wide spread (Norman & King 1987). The almost ubiquitous aeroallergen, grass pollen, causes allergy symptoms worldwide. Closely related plants may have the same proteins (antigens) and cause the same allergic response. The medical community believes that aerobiologists have identified most of the common taxa that affect most people (O'Rourke 1996). Now it is up to the immunologists and biochemists to determine at what point a person shows symptoms to various pollen types.

Conclusion

Pollen is durable, distinctive and identifiable. It can be used in many applications and in many disciplines. The variety of uses of pollen analyses is infinite. Identification of the pollen found on or in an insect can help researchers determine long distant and local migration and dispersal, migration routes, food sources and source zones. This information is important for researchers studying pollination and field crops. Not only can pollen be used to determine these things for insect pests, but also for beneficial insects. By knowing about the habits and migration of both beneficial insects and insect pests, more effective control methods can be developed to control insect pests.