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Pollen as a Teaching Tool

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ARTICLES

Pollen As A Teaching Tool

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One of the basic needs I have encountered in teaching biology is being able to reach a designated goal by different avenues; that is, a diversified approach to the subject. I will attempt to show how a different tool, pollen, can be used to illustrate a number of common biological concepts. First, let me describe the structure of a generalized pollen grain. This is about as difficult as teaching the generalized cell and some of the same difficulties arise. The wide variations in sizes and shapes of pollen grains just about match the wide range encountered when studying cells.

Tweeten

For a detailed description of pollen grains, it would be well to refer to the system described by Erdtman. It is through a description of the sculpture of the pollen that classification of the grain may be attained. In general, each pollen grain consists of two layers, the outer layer, exine, and the inner layer, intine. Within each of these two layers there is, of course, the living cell, or protoplast. The outer layer is the one to which we will focus our attention. The intine and the protoplast are easily destroyed, but the exine is highly resistant to destructive forces. It is this resistant chemical structure that has enabled the pollen grain to be utilized to the extent that it has.

The exine consists of two layers, the Ektexin and the Endexine (Plate 1). The sculpturing of the Ektexine varies a great deal from one pollen type to the other. It is due to this variation in sculpturing that students may be able to take unknown samples of pollen and generally classify them as Gymnosperm or Angiosperm pollen. They may also, without much difficulty, identify the Angiosperm pollen as to whether it is of Monocotyledon or Dicotyledon origin. There is a certain sense of accomplishment that the student displays when a sample of mixed pollen is distributed and he is able to carry out this task with proficiency.

As a means of helping students to identify the various plants by their pollen, I have found it helpful to use the overhead projector to show some of the typical varieties to be found. These are the ones to be included in the mixed sample distributed. I have also included two spore types for reasons I will explain later.

Monocot grains are essentially spheroidal and are characterized by a single furrow (Plate 2). Dicotyledon grains are characterized by three furrows, although there are more unconformities here than the monocots. Gymnosperms can be identified by the wing-like projections present in most examples. The diversity of grain sculpturing is in itself of interest.

Having established some familiarity with the structure of pollen grains, I will discuss how each type or group can be used in a class experience to illustrate a particular biological concept. I will also include methods of securing and preparing the pollen grains, using examples from the general taxonomic system.

One of the spore varieties included is that of the common weed, Field Horsetail, **Equisetum arvense.** Strobilus shoots terminating in a cone may be found in early spring. If about one dozen of these are gathered and allowed to dry on sheets of paper overnight, the next day you will find they have released enough spores to last for a

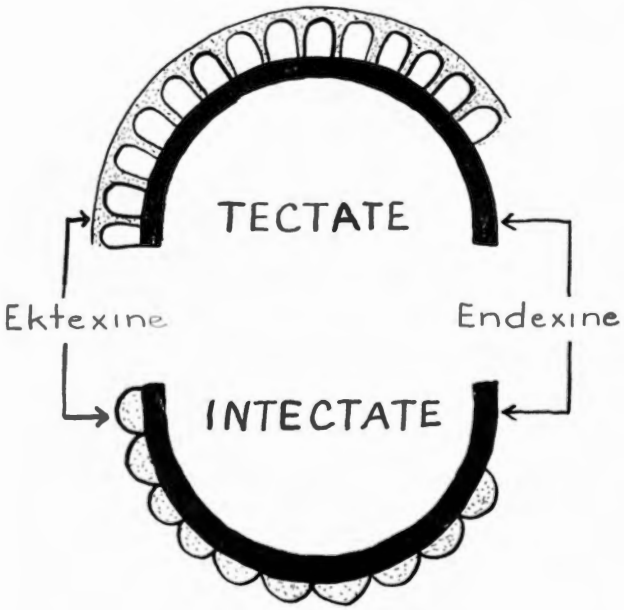
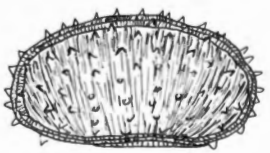


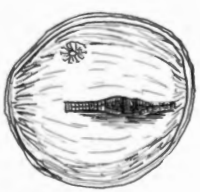
Plate 1. Pollen grains have a tough, outer layer called exine and a softer, inner material called intine.



Dryopteris cristata

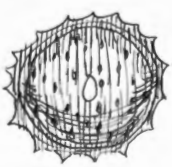
Pinus strobus

Plate 2. The exine layer of pollen grains is sculptured with characteristic markings. Pollen from similar species is similarly sculptured. A person familiar with various types of pollen grains can use pollen as an aid in plant taxonomy.



Zea mays

Betula nigra



Ambrosia trifida

Juglans nigra

number of years. The spores should then be placed in a small glass vial and labeled; they are then available when needed.

The Horsetail spores can be used in an interesting exercise to illustrate spore dissemination. For one to carry out this exercise, a sufficient quantity of the spores are suspended in water so that when a drop of this mixture is placed on a microscope slide and viewed, the field is abounding in spores. This drop is then allowed to dry while one is viewing it. The humidity sensitive elaters unwind and the resulting springing about of the spores is quite spectacular.

Fern spores may also be obtained in considerable quantities by allowing fertile fronds to dry on sheets of paper.

Large quantities of pine pollen may be secured in the same manner by allowing male cones to stand overnight. I use these to illustrate to my students the prodigious amounts of pollen produced by some plants. After they see the copious amounts of "yellow dust" falling out of these drying cones and view a small amount of this dust under a microscope, it is a point well driven home.

Corn is an easily obtained Monocot, especially in this area. The same procedure may be used for its extraction. Some of the other samples, such as tree pollens, are not so easily extracted, but the difficulty is not prohibitive. Early spring is again the time to gather tree pollen, with students serving as the labor force. The book says that trees are included in the flowering plants, but it often takes some convincing to the point of showing that trees do have flowers. Caution: the tree must be correctly identified in order for the pollen extracted to be of value. This class project is further enhanced when the students see the similarities between the pollen of the oaks, for example, and the dissimilarities from the other families. In general the more closely related the plants, the more the pollen grains will be alike in structure. Collections of the tree flower along with a couple of the leaves and/or other identifying characteristics, preserved, labeled, and displayed in jars in the classroom are appealing.

The pollen may be extracted from the flowers by chemical means (acetolysis), but I have found that by grinding the flower with a mortar and pestle in some water and then straining through common microscope lens paper, a high percentage of pollen, with little of the detritis, remains. If thickening is desired, centrifuging may be done. Occasionally you may wish to stain the grains which will bring out many of the structures more clearly. This may be done following centrifuging. To the residue add a few drops of methylene blue, diluted with water one to one hundred. This is then warmed, not boiled, for a few seconds, centrifuged, washed with distilled water, and finally centrifuged. The pollen may then be stored in glycerine until you wish to use it. Here again the students should be used as a work force. Students learn laboratory techniques and it is also very time consuming on the teacher's part to build up a supply of available pollen types.

Permanent slides of these examples obtained can be made by mounting in glycerine jelly. After mixing the pollen material with the melted glycerine jelly and placing the cover glass, tip the entire slide upside down so the grains will sink and reside against the cover glass. This aids in viewing and is especially helpful if you should wish to put the material under oil immersion for demonstration purposes. A pollen herbarium might be a good undertaking for student or club. This is essential for reliable identification but must be confined to the areas for which it is to be applied. A reference collection to include all pollen encountered would be too ponderous a task.

Temporary glycerine mounts can be made by using only glycerine as the mounting medium. These, although temporary, will last for a surprising length of time. The slides must be stored in a horizontal position, which

makes this a problem if many are to be stored.

There are activities which can be carried to great length and depth. The time to be spent on them depends, to a great extent, upon the time available and the interest of both the students and the teacher.

Pollen extraction from honey is an engaging activity and one which would fall in this category. Commercial honey may be used and provides an interesting side light, that of testing the authenticity of claims to the honey's origin by the type of pollen grains present. I have found wild honey to be a better source because of the presence of greater quantities of grains, not having been processed. The method of extraction may be done by acetolysis, but I have developed a method which is as effective and does not have the hazards involved. Place 3 ml of honey in a test tube and add 10 ml of xylol. Heat in a water bath for 10 minutes. Decant the xylol. Add water, almost filling the tube. Shake vigorously. Centrifuge and decant. The residue containing the pollen may be stained now if you desire, and mounted in glycerin jelly. You are now ready to view the grains and attempt an identification.

Something I have found to be effective in the illustration of evolution is to extract pollen from coal. Here again the student knows the origin of coal and can write on the subject possibly at length, but to actually remove plant parts from this material is like discovering these facts all over again. One of the very common varieties of spores found is that of ferns. It is for this reason I include fern spores in the mixed samples used to familiarize the students in basic classification of the material. The first step in the extraction is to break the coal (bituminous) into small fragments and place it in a beaker. Mix one part of potassium chlorate ($KClO_3$) with boiling water (saturated solution) and add 3 parts of nitric acid (HNO_3) to the potassium chlorate solution. After 3 to 4 days, take a small portion of the material, centrifuge, and decant until free of acid. Place 15% potassium hydroxide (KOH) on the decanted coal; if there is liberation of humic matter, the sample is ready to be decanted. Add 15% potassium hydroxide (KOH) to the entire sample and allow to stand for 10-12 hours. Centrifuge and decant, mounting the residue as I have previously explained.

One more activity I must mention is to expose sticky slides, the adhesive being glycerin jelly or petroleum jelly, to collect airborne pollen. Each slide is exposed for a period of 24 hours and replaced daily throughout a season. These may be labeled, mounted, and used to show the change of pollen types through the season. The hayfever victims seem to show the greatest interest in this activity. This has an interesting relationship to the history of disease, one worth relating to the students.

Many more uses can be made of pollen as a tool to illustrate biological concepts. I hope that these I have mentioned will bring to your minds other possibilities and you too will find that pollen studies can be used as a new approach to some old objectives.

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