Using the Winogradsky Column to Demonstrate Biodegradation

Dorothy G. May
Associate Professor of Biology
Park College

Introduction

The Winogradsky column was developed in 1877 to study a variety of soil microorganisms. The apparatus is described in few current microbiology laboratory manuals (Atlas et. al. 1984; Colome et. al. 1986; Seeley and VanDemark, 1981; Wright, 1984) due to the demand for clinical techniques and less emphasis on such subjects as soil ecology.

Because it is a closed microecosystem, it occurred to me that the apparatus could be used to demonstrate what is meant by biodegradation to introductory students. The simplicity of the apparatus lends itself well to an experiment for non-majors at the froshmore or senior level.

Adding the experimental layers: Add a layer of shredded styrofoam or other non-biodegradable material, and add another few centimeters of mud. Add another layer of biodegradable material, such as paper plates. The experimental materials should be visible from the outside of the column. Alternate layers of mud, biodegradable material, and non-biodegradable material as desired until the column is about three-quarters full. The top layer should be mud. Allow the slurry to settle for a few minutes. Tap the sides to allow air bubbles to escape.

Adding the water layer: Cover the slurry with pond water to a depth of about 3 cm from the top. Cover loosely with Parafilm to prevent evaporation—not to keep oxygen out.

Materials and Methods

Materials are listed in Table 1. Instead of graduated cylinders, large test tubes, about 35 X 300 mm, can be used. These are particularly useful if individual students are to make the columns.

Packing the column: Mix 50 gm CaSO₄, 40 gm bottom ooze, and 10 gm decomposed plant material in a bucket. Amounts are approximate. Add enough pond water to make a slurry. It needs to be fluid enough to pour, but solid enough to prevent styrofoam from floating to the top of a column. Fill a column about half full with the slurry.

Adding the filter paper indicator: To make the bacterial “bloom” more visible, it is desirable to place a moistened strip of filter paper against the inside of the cylinder at this point. When additional layers are added, the paper should press against the side of the glass.

Table 1

Materials for Winogradsky Column:

- graduated cylinder
- calcium sulfate
- fine mud, bottom ooze
- decomposed plant material
- pond, river, or stream water
- Parafilm or plastic wrap
- aluminum foil
- light source
- strip of filter paper

optional, cut up:

- styrofoam
- paper plates
- plastic trash bags
**Incubation:** Cover the entire column with foil, or place in a light-tight cabinet for 2-4 days.

**Expose the cylinder to heat:** A 60-watt bulb at a distance of 0.5 m continuously is recommended.

**Observations:** Examine the material from the column periodically, macroscopically for the appearance of photosynthetic bacteria, algae, and other organisms, microscopically for various organisms in the sulfur cycle. Reddish-purple growth indicates the presence of purple photosynthetic bacteria. Record when the biodegradable material changes appearance. Columns can be carefully emptied to examine degradation at each layer. After being emptied, columns are essentially “sacrificed,” although the slurry can be reused. Be sure to open the columns in a well-ventilated area.

**Results**

**Biodegradation:** Paper products are degraded within three weeks; styrofoam does not show any degradation after eight months. These are the shortest and longest parameters tested so far.

**Bacteria:** Various bacterial populations which are likely to appear are well-documented in Atlas et al. (1984).

**Other Organisms:** In addition to the succession of bacterial populations, both eukaryotic and prokaryotic algae appear in the illuminated aerobic region of the column. Horsehair worms, phylum Nematomorpha, can be found burrowing in the mud and swimming in the water layer. The larvae parasitize a variety of arthropod hosts. Rotifers, *Daphnia*, and other small invertebrates have been seen in the water layer of the column even after eight months of incubation.

**Discussion**

The exercise makes a powerful statement about biodegradation. Variations on the method are endless. At the recent meeting for AMCBT we came up with the idea of using clear plastic beverage containers for the columns. There would be two lessons taught with the use of such items: first, that these containers are not biodegradable; and second, there are ways to reuse them. The only disadvantage I see to using them is that it would take much more material to pack the column. The neck portion of the bottle needs to be cut off for packing the column, and it should be replaced with tape to prevent evaporation.

Students are fascinated with the succession of organisms they see over the weeks. This simple apparatus can lead to any number of student-designed spinoff projects.

**Literature Cited**


EDITORS NOTE: See Also;

Pigage, Helen K.
"The Winogradsky Column: A Miniature Pond Bottom"