Vignette -- The Winogradsky Column

Text: p. 569, 617-618
http://helios.bto.ed.ac.uk/bto/microbes/winograd.htm#crest

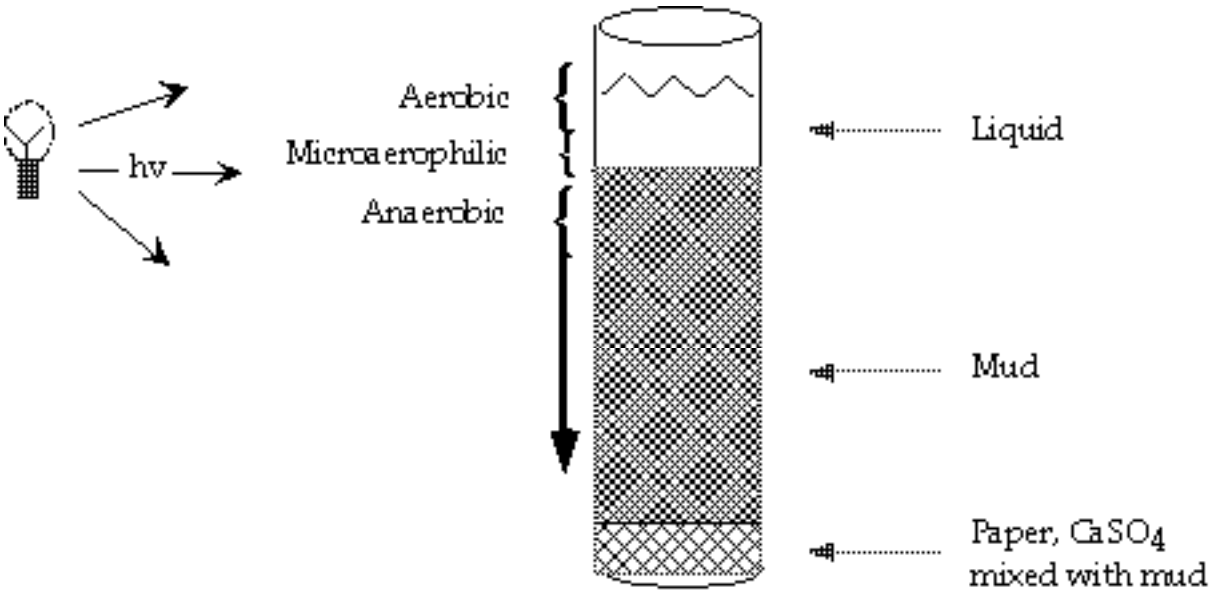
1. The "Winogradsky column" is a demonstration of a closed microbial ecosystem. It is a jug of wet, sulfide-rich, organics-containing mud allowed to develop with a single source of exogenous energy: light.

A. As the photosynthetic organisms plastered against the glass accumulate "primary productivity,"the myriad colors of the interacting photosynthetic communities are easily observed to monitor health and change in the community.

B. Note that photosynthesis is not the only form of "primary productivity" going-on in the column: e.g.:

methanogenesis,
S-oxidation with a variety of electron acceptors,
H_2-oxidation with a variety of e-acceptors,
Fe(II) - oxidation,
others.

2. Named after Sergei Winogradsky (1856-1953) -- studied sulfur-metabolizing organisms such as *Beggiatoa* (text, p.464), articulated concept of "autotrophy", previously thought unique to plants.



3. Types of organisms that are conspicuous:

A. "Oxic" zone: Cyanobacteria, eucaryal algae, lots other stuff

B. "Microaerophilic" zone:

1. E.g., *Beggiatoa, Thiothrix, Thioploca, Thiovulum*, etc. - Gamma-group proteobacteria, oxidize H_2S microaerophilically, fix CO_2. Little-known world because of difficulty/impossibility of recreating growth demands re. H_2S and O_2 concentration gradients.

2. E.g. *Thiovulum* spp.forms a thin but coherent veil in water above H2S source: good bait is rotting oysters.

3. E.g. *Beggiatoa*: (Text, p. 464-65

a. Classic definition: "..any colorless, filamentous, gliding bacterium that deposits internal globules of elemental sulfur but does not form bundles of trichomes within a common sheath."

b. Used in Winogradsky's classic experiments that established autotrophy, but he harvested from nature; this kind of organism not cultivated until 1980s (*Beggiatoa alba*).

c. Long filaments consisting of stacks of cell: "trichome" ("hair") sometimes >100u wide, centimeters long. Come out at night; visit a salt marsh at night. In the day, the cyanos perfuse the outer sediment with oxygen, scrubbing O_2. At night, O_2 increases and the *Begggiatoa* spp. come out on the surface of the mud.
At the MOR, "Beggiatoa mats" are common (see Webpic).

4. E.g. *Thioploca*:

` a. Bundles of filaments (and other critters) in a common sheath; form sometimes large, wool-like masses in/on sulfide-rich sediments (presence of organics/seawater-sulfate).

b. One kind of Thioploca-like organism, Thiomargarita, uses a vacuole containing >1M nitrate as a SCUBA tank to dive-down into anoxic sediments to reach high sulfide!

C. Anaerobic zone - a jungle, photo- and chemo- synthesis depending on the local microenvironment.

1. "Nonsulfur purple photosynthetic bacteria", e.g. *Rhodomicrobium* spp.: alpha-group proteobacteria, cream-colored blotches in mature Winograd. column, carry out photosynthetic oxidation of organics, also fix CO_2.

2. "Sulfur purple photosynthetic bacteria", e.g. *Chromatium* spp.: gamma-group proteobacteria, blood-red blotches (ergo lots of human history), photosynthetic oxidation of H_2S using organics or CO_2 as acceptor. Polarly flagellated (very fast), barrel-shaped cell, intracellular sulfur globs. Fixes CO_2 by Calvin Cycle.

3. "Green Sulfur bacteria", e.g. *Chlorobium* (text fig. 16.8). "Green sulfur" division of Bacteria, oxidizes H_2S, H_2 photosynthetically with organic/CO_2 acceptors, Fixes CO_2 by "reverse TCA cycle" (reductive carboxylation).

4. *Heliobacterium* (deep green stuff): "low G+C Gram-positive" division of Bacteria. Bacteriochlorophyll G - rearranges in O_2 to chlorophyll a! Predecessor of the cyanobacterial photosynthetic apparatus??

4. Colorless stuff -- everywhere; e.g. methanogens (CH_4, the bubbles in the mud, "natural gas"), lots more.