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SOIL ANALYSIS

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I. OBJECTIVES:

- To learn procedures for determining various aspects of soil composition and chemistry.
- To use these procedures to study the soil(s) of various habitats we have visited.

II. BACKGROUND:

Soil is very complex. It is made up of ground-up rock/mineral particles of varying sizes, dead organic material, and living organisms. Various tests can be conducted to study these components.

The colorimetric analysis for organic material uses chemical reactions involving, among other things, dichromate ion, which forms colored complexes. The amount of color can be read with a spectrophotometer (**spectro** = the spectrum; **photo** = light; **meter** = to measure) and related to the amount of organic material in the soil. The more organic material there is in the soil, the more dichromate it uses up and the less dichromate there is left to form the colored complex, thus the lower the absorbance reading.

The mechanical analysis can give an idea of what soil type the particular soil being tested is. In a water suspension, heavier

particles of sand and silt settle out quickly while clay, with smaller, lighter particles, stays in suspension for quite some time. Thus these two fractions can be separated. Sand can be graded into various sizes:

	Diameter
very coarse	2.00 to 1.00 mm
coarse	1.00 to 0.50 mm (500 μm)
medium-grained	0.50 to 0.25 mm (250 μm)
fine	0.25 to 0.10 mm (100 μm)
very fine	0.10 to 0.05 mm (50 μm)

A soil test kit is a set of chemicals that enables one to determine amounts of nitrogen, phosphorus, potassium, and pH in/of soil. Gardeners frequently make use of these test kits to know what kind and how much fertilizer or other additives they need.

III. MATERIALS NEEDED:

SOIL CHEMICALS	MECHANICAL	COLORIMETRIC	ARTHROPODS
Sudbury (or other) soil test kit	mortar & pestle	K ₂ Cr ₂ O ₇	Berlese funnel(s)
funnel(s)	Calgon (sodium hexametaphosphate)	conc. H ₂ SO ₄	EtOH
filter paper	glassware	s-diphenylcarbazide	incandescent lamp(s)
	heat source	burets and other glassware	field guides
	sieve set	boiling H ₂ O bath	
		spectrophotometer	
		cuvettes	

IV. PROCEDURE:

SOIL CHEMICALS--pH, Nitrogen, Phosphorus, Potassium

Use the soil test kit to test for these substances. Follow the procedures in the test kit. Ideally, soil samples should come from 2 to 3 in. (5 to 7 cm) below the surface and be stored in clean containers. Use corks provided (note color coding) or Parafilm over ends of tubes--not fingers. Record findings.

SUBJECTIVE ANALYSIS

- Place a small sample of soil into the palm of your hand and moisten. Knead until it has the consistency of putty.
- Use your thumb and forefinger to attempt to form it into a ribbon.
 - If the ribbon forms easily and stays together and flexible, the soil is 40% or more clay. It is classified as "clay" soil.

- If the ribbon forms but breaks easily, the soil is 27-40% clay and is called "clay-loam" soil.

- If the ribbon does not form the sample contains less than 27% clay and is called "loam."

- Sand gives a gritty feeling to the soil, thus for example, a clay soil could have a lot of sand in it and be a sandy-clay. Silt feels like talc, so a loam with a smooth, talc-like feel is a silt-loam.

MECHANICAL ANALYSIS

- Weigh out 50 gm (record exact weight) of soil (use 100 gm if it's sand).
- Gently pulverize in mortar.
- Transfer the whole thing to a 1 liter beaker and add 5 gm Calgon (water softener). Q.s. to 900 mL.

- Stir for about 15 min. with magnetic stirrer.

- Decant the "muddy" clay suspension into the designated waste container. Wash the sediment (= silt/sand fraction) into a beaker. Repeatedly rinse and decant until the supernatant is fairly clear. This will remove the silt portion and leave the sand.

- Dry the sand portion that's left by heating over a hot plate or Bunsen burner.

- When dry, sieve the sand through a sieve set. Weigh (and record) contents of each screen (also note size--our sieves are 2 mm, 1 mm, 500 μm, 250 μm, 125 μm, and 63 μm in size). Calculate the percentage of the original sample that each size represents.

COLORIMETRIC ANALYSIS

- Turn on spectrophotometer to warm up and set at 540 nm.

- If not already made-up, prepare the following reagents:

- 1 M K₂Cr₂O₇ soln: dissolve 49.037 g K₂Cr₂O₇ in dH₂O and q.s. to 1 L.

- 6 N H₂SO₄: **Carefully** measure out 165 mL of the acid--**DO NOT GET THIS ON ANYTHING, ESPECIALLY YOUR SKIN** (if you do, rinse **AT ONCE** with lots of water!! Have a 1 liter container ready at least half full with dH₂O (packed in ice wouldn't be a bad idea). Add the acid--**ALWAYS ADD ACID TO WATER, NEVER THE REVERSE**. Q.s. to 1 L. Caution: it gets hot.

- Saturated s-diphenylcarbazide solution: Make up in small quantities in 95% EtOH and store in a dark place. Allow to stand until solid material has settled before using. Mix up new batches frequently--you must mix a new batch if the one you have turns pinkish.

- Pass soil sample through an 80 to 100 mesh screen, then carefully weigh out 0.50 gm (record exact weight) and place in 100 mL beaker (or 75 mL test tube if available).

- Add 10 mL of 1 N K₂Cr₂O₇ and 5.5 mL conc. H₂SO₄ gradually from burets, swirling as they're added. Also, for a control, to a second, empty beaker, add the same amounts

of these reagents. Note: if you are doing several soil samples, you need only one "control" beaker of chemicals.

- Place beakers into a boiling H₂O bath for 5 min., then cool in a larger beaker of cold H₂O.

- Transfer all of the soil solution to a 1 liter (1000 mL) grad. cylinder. Rinse the beaker with dH₂O and add that to the cylinder, too. Q.s. (*quantum sufficit*) to 1 liter with dH₂O. Do the same for the "plain" solution (in a separate cylinder).

- Transfer each to 1500 mL Erlenmeyer flasks and thoroughly mix.

- Pipet 1.0 mL of each of these solutions into its own, labeled 100 mL volumetric flask. Add 3.3 mL of 6 N H₂SO₄ and 1.0 mL of s-diphenylcarbazide to each. Q.s. both to 100 mL with dH₂O and mix thoroughly (use lid or Parafilm--not your fingers). This should turn violet.

- If not done previously, set spectrophotometer to 540 nm. Within no longer than 10 min. from when mixed, you must take readings on the samples. Use a tube of dH₂O to set 0 absorbance--not the empty chamber as before--and the tube of mixed reagents to set ∞ absorbance (= 0% T). Take a reading on the tube of soil solution. If more than one soil sample is being tested, do them all in a row in separate cuvettes.

- Do the calculations:
% of organic matter in soil = 16.25 - (10.94)(Absorbance reading)

- % or organic carbon in soil = (% of organic matter) × 1.72

SOIL INVERTEBRATES

- Set up a Berlese funnel with a tube of 70% EtOH underneath for each soil sample to be tested.

- Carefully add soil/leaf litter sample. Try to keep soil from falling through.

- If possible, shine an incandescent light on the top to dry it out faster. As the soil dries out, small animals will go deeper until they fall through into the alcohol.

- In several days, examine the alcohol and identify the animals found.

V. DATA:

Record all information, numbers, etc. as requested and perform all calculations. Enter data into the computer as requested.