UNIVERSITY OF CALIFORNIA
COOPERATIVE EXTENSION
COMPOSTING EDUCATION PROGRAM

THE LIFE CYCLE OF COMPOST

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BOTANICAL ARTS

CLASS AGENDA

- WHAT IS COMPOST?
- WHAT IS NOT COMPOST?
- WHO'S WHO IN COMPOST?
  - THE SOIL FOODWEB CRITTERS
- WHO'S DOING WHAT ALONG THE WAY?
  - BIOLOGICAL ACTIVITY OF COMPOSTING MICROBES
  - FLOW CHART OF THE SOIL FOODWEB
- BENEFITS OF A MICROBIAL FOCUS ON COMPOST
- FIELD TRIALS OF SOME BENEFITS

WHAT IS COMPOSTING ?

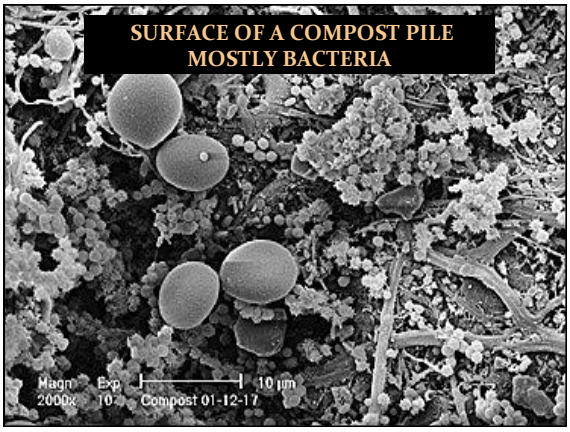
- THE **OXIDATIVE** DECOMPOSTION PROCESS OF ORGANIC MATTER
- OXYGEN CRITICAL FOR MICROBES ABILITY TO DECOMPOSE ORGANIC MATTER **EFFICIENTLY**
  - HIGHLY BENEFICIAL AEROBIC MICROBES
  - RETAINING THE NUTRIENTS PLANTS NEED
  - WITHOUT EXCESSIVE GREENHOUSE GAS RELEASE

WHAT IS NOT COMPOSTING
ANAEROBIC

- ANAEROBIC DECOMPOSITION = ORGANIC MATTER **BREAKDOWN IN THE ABSENCE OF OXYGEN**
- ANAEROBIC DECOMPOSITION = PUTREFACTION
- SYNONYMOUS W/ FETID ROT, RANCID, OR FERMENTATION
- RESPONSIBLE FOR RELEASE OF HIGHLY DAMAGING GREENHOUSE GASSES: N_2O, CH_4, NH_3, H_2S
- MODERATE TEMPERATURE PRODUCTION IS USUALLY INSUFFICIENT TO KILL COMMON FECAL AND FOOD-WASTE ASSOCIATED PATHOGENS

WHAT *IS* COMPOST

- THE STABLE END-RESULT OF AN AEROBIC DECOMPOSITION PROCESS OF ORGANIC MATTER
- CONTAINING:
  - HIGHLY BENEFICIAL AEROBIC MICROBES
    - BACTERIA, FUNGI, PROTOZOA, NEMATODES, MICRO AND MACRO ARTHROPODS
  - MOST MINERALS/ ELEMENTS IN ORIGINAL MATERIAL
    - MINIMUM CARBON LOST IN BACTERIAL RESPIRATION
- MEDIUM TO DARK BROWN COLOR MATERIAL
- FINE PARTICULATE TEXTURE/GOOD CRUMB STRUCTURE
- NEARLY ODORLESS TO FOREST-FLOOR SMELL



COMPOST FOODWEB MICROBES
AEROBIC BACTERIA

- BACTERIA NATURALLY OCCUR ON ALL ORGANIC MATTER AND IN HEALTHY SOIL
- TYPICAL SIZE = 1 – 2 MICROMETERS
  - 1/1,000TH OF A MILLIMETER - VERY, VERY SMALL
- NO NEED TO PURCHASE AN INOCULUM
- BEST NOT TO USE AN ORGANIC MATTER HEAVILY ANAEROBICALLY CONTAMINATED

COMPOST FOODWEB MICROBES
AEROBIC BACTERIA

- BACTERIA DECOMPOSE, AKA CONSUME, ORGANICS
- RESPONDING IMMEDIATELY TO MOISTURE & FOOD RESOURCES IN AN AEROBIC SUBSTRATE
- MOST EFFICIENT AT BREAKDOWN OF SIMPLE CARBON COMPOUNDS & NITROGEN RESOURCES
  - "GREENS" AND PARTS OF "BROWNS"
- CONVERTING AND STORING NUTRIENTS IN ORGANIC MATTER TO MAKE NEW BACTERIA BODIES AS PROTEIN = NO SOLUBLE N LOSS

COMPOST FOODWEB MICROBES
AEROBIC BACTERIA

- BACTERIA BODY MASS MOSTLY PROTEIN
  - PROTEIN MOLECULES RICH IN NITROGEN
  - C:N RATIO OF BACTERIA 4:1
- EXCESS CARBON IN BACTERIAL FOODS IS "BLOWN OFF" AS CO_2
- GROWTH = RESPIRATION = CO_2 RELEASE
- CRITICAL TO MAINTAIN SUFFICIENT OXYGEN AND RELEASE CO_2 OUT OF PILE

COMPOST FOODWEB MICROBES
AEROBIC BACTERIA

- BACTERIA GROW MOST RAPIDLY WHEN NUTRIENTS MOST ABUNDANT
- BACTERIAL RESPIRATION RELEASES HEAT
  - THERMOPHILLIC BACTERIA MOST EFFICIENT
- USE HEAT AS INDICATION OF CO_2 LEVELS TO DETERMIN TURNING SEQUENCE
- MUST KEEP O_2 LEVELS ABOVE 5 PPM FOR AEROBIC MICROBES TO FLOURISH

COMPOST FOODWEB MICROBES
AEROBIC BACTERIA

- BACTERIAL DOMINANT PHASE = DURING MOST ACTIVE, EARLY HOT PORTION
- BACTEIA #s CAN BE IN EXCESS OF BILLIONS/ GRAM IN COMPOST DURING THIS PHASE
- TEMPERATURE AND CO_2 PRODUCTION CAN BE INFLUENCED BY C:N RATIO IN ORIGINAL MIX OF STARTING MATERIALS

COMPOST FOODWEB MICROBES
AEROBIC FUNGI

- FUNGI NATURALLY OCCUR ON ORGANIC MATTER AND IN HEALTHY SOIL
- LONG STRAP SHAPED, HOLLOW TUBES MOVE NUTRIENT TO PROTOPLASM AT GROWING TIP OF HYPHA
- TYPICAL WIDTH = 2.5 – 8 MICROMETERS
  - 1/1,000TH OF A MILLIMETER - VERY, VERY SMALL

COMPOST FOODWEB MICROBES
AEROBIC FUNGI

- FUNGI DECOMPOSE/ CONSUME ORGANICS
- RESPONDING SLOWLY TO MOISTURE & FOOD RESOURCES IN A COOLING OR COLD SUBSTRATE
- MOST EFFICIENT AT BREAKDOWN OF COMPLEX CARBON COMPOUNDS
  - I.E. WOOD, BARK, CONIFFEROUS MATERIALS
- CONVERTING AND STORING NUTRIENTS IN ORGANIC MATTER TO MAKE NEW FUNGI

COMPOST FOODWEB MICROBES
AEROBIC FUNGI

- FUNGAL BODY MASS MOSTLY CARBON & SMALL AMOUNT PROTEIN/TOTAL MASS
- C:N OF FUNGI VARIES , AVERAGE APPROX. 12:1
- FUNGAL DECOMPOSITION IS A COLD PROCESS, NO HEAT RELEASE
- FUNGAL DECOMPOSITION SEQUESTERS AND HOLDS CARBON IN COMPOST/SOIL
- NO CO_2 RELEASE INTO ATMOSPHERE

COMPOST FOODWEB MICROBES
AEROBIC FUNGI

- AEROBIC FUNGI GROW MOST RAPIDLY ON SUBSTRATE OF HIGH CARBON WITH EXCELLENT AERATION I.E. WOOD CHIP PILE
- NOT NECESSARY TO TURN DURING COOL FUNGAL DOMINANT PHASE
- NO NEED TO PURCHASE AN INOCULUM
  - DEVELOP YOUR OWN OVER TIME IN A MOIST PILE OF WOOD CHIPS OR FALLEN LEAVES

COMPOST FOODWEB MICROBES
PREDATORS UP THE FOOD CHAIN

- A HOST OF MICROSCOPIC CRITTERS CONSUME THE PRIMARY DECOMPOSERS:
  - PROTOZOA – FLAGELLATES, AMOEBAE, CILLIATES
  - NEMATODES – BACTERIAL, FUNGAL FEEDING OR PREDATORY NEMATODES (NO ROOT FEEDING)
  - MICRO ARTHROPODS – SPRING TAILS, MITES
  - MACRO ARTHROPODS – ANTS, BEETLES SOWBUGS, SPIDERS, MITES, MILLIPEDES
- SOME EAT BACTERIA AND FUNGI ONLY, SOME EAT EACH OTHER

COMPOST FOODWEB MICROBES
PREDATORS UP THE FOOD CHAIN

- IN THE PROCESS OF HUNTING THEIR PREY, SOME SHRED COMPOST ORGANIC MATTER, ASSISTING THE JOB OF THE DECOMPOSERS: BACTERIA AND FUNGI
- ALSO KNOWN AS MINERALIZERS, THEY RELEASE EXCESS NUTRIENT, VIA “THE POOP LOOP” TO CREATE THE SMALL POOL OF SOLUBLE NUTRIENTS PRESENT IN FULLY COMPOSTED ORGANIC MATTER

BENEFITS OF COMPOST MICROBES
OUT IN THE SOIL

- WHEN "COMPOST HAPPENS" IN NATURE, NATIVE LANDSCAPES BENEFIT FROM THE ENVIRONMENTAL SERVICES OF THE SOIL FOODWEB MICROBES
- WHEN COMPOST IS MADE PROPERLY FOR AGRICULTURAL AND/OR HORT. APPLICATIONS, THE BENEFITS TO SOIL AND PLANTS ARE MEASURABLE

BENEFITS OF COMPOST MICROBES
BACTERIA & FUNGI

- DECOMPOSE
  - DIGEST, CONVERT & ACCUMULATE NUTRIENTS
- STORE
  - CONVERT AND HOLD IN NEW BODY MASS
  - A NON-SOLUBLE FORM - NO NUTRIENT LEACHING
  - HOLDS NUTRIENT UNTIL "POOP LOOP" EFFECT
- DECOMPOSITION OF POLLUTANTS/TOXINS
  - HYDROCARBONS, FECAL COLIFORMS, PESTICIDES

BENEFITS OF COMPOST MICROBES
BACTERIA & FUNGI

- SOIL AGGREGATION IMPROVES STRUCTURE
  - BACTERIA MAKE GLUES = FORM MICRO-AGGREGATION
  - FUNGAL THREADS KNIT /STITCH MACRO-AGGREGATES
- EROSION CONTROL
  - MINERAL & ORGANIC PARTICLES HELD TOGETHER
- FILTRATION
  - CAPTURE & HOLD NUTRIENTS, TOXINS, POLLUTANTS
  - SEE FOLLOWING PICTURE

BENEFITS OF COMPOST MICROBES
SOIL PREDATORS

- RELEASE OF STORED NUTRIENTS VIA THE "POOP LOOP" CYCLE
- CREATION OF PORE SPACE
  - INCREASES WATER HOLDING CAPACITY
  - REDUCES COMPACTION
  - HELPS OPEN WATER LOGGED SOILS
- BALANCE OF PREDATOR/PREY POPULATIONS – BUILT IN STABILIZERS

THE POOP LOOP

Based on information from Dr. Elaine Ingham and Soil Foodweb, Inc.
by Alane O'Rielly Weber, Botanical Art
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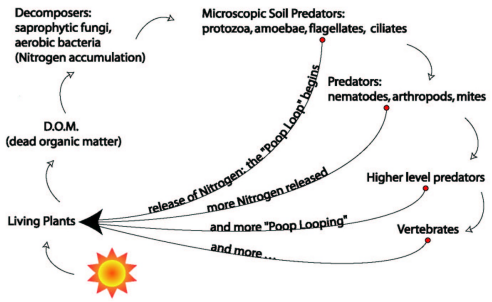
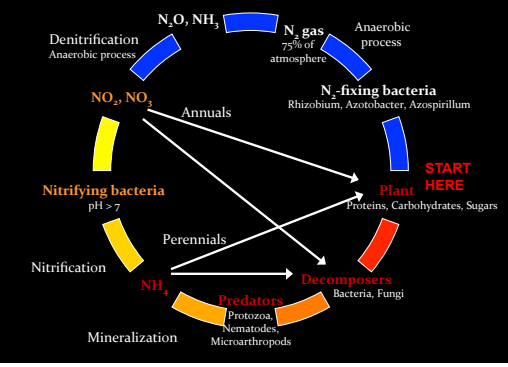


NITROGEN CYCLE



EXACTLY HOW MUCH NITROGEN IS MINERALIZED IN "*THE POOP LOOP*"

- 8,000 N ATOMS RELEASED/ DAY/ PROTOZOAN
- 50,000 PROTOZOA/GRAM FUNCTIONING 24/7
- 8,000 X 50,000 = 400,000,000 N ATOMS
- = 7 MICROGRAMS N/ GRAM OF SOIL/ DAY
- PLANTS NEED 0.2 MICROGRAMS N/ GRAM SOIL
- MICROBES CAN MAKE ENOUGH PLANT FOOD

BENEFITS OF COMPOST MICROBES SOIL PREDATORS

- RELEASE OF STORED NUTRIENTS VIA THE "POOP LOOP" CYCLE
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SOIL FOODWEB BENEFITS FROM AEROBIC COMPOST

- EXTRACT & HOLDS NUTRIENTS
  - STOP LEACHING NITRATES IN GROUNDWATER
- DELIVER PLANT AVAILABLE NUTRIENTS TO ROOT
  - ELIMINATES CHEMICAL FERTILIZER NEED
- BUILD STRUCTURE & IMPROVE TEXTURE
  - REDUCE COMPACTION, INCREASE AERATION AND WATER HOLDING CAPACITY
- COMPETITION,SUPPRESSION & IMMUNE RESPONSE
  - STOP OR VASTLY REDUCE PESTICIDE NEED
- DECOMPOSE TOXIC RESIDUES
  - CLEAN WATER FILTERATION

OH YEA, THE SOIL IS ALIVE !

- **SCIENTIFIC COUNTS IN SOIL:**
  - 100 M – 1 BILLION TOTAL BACTERIA/GRAM
  - 25,000 DIFFERENT SPECIES OF BACTERIA/GRAM
  - METERS TO MILES OF FUNGAL HYPHAE
  - 8,000 DIFFERENT SPECIES/GRAM
  - UP TO 20,000 PROTOZOA: AMOEBA, FLAGELLATES, CILLIATES
  - 35 VARIOUS NEMATODES:
    - BACTERIAL, FUNGAL & PREDATORY FEEDERS
  - UP TO 1,000 MICRO ARTHROPODS
  - **COMPOST IS MUCH MORE CONCENTRATED…**
  - **TO THE TUNE OF BILLIONS OF MICROBES/GRAM**
  - IN EVERY TEASPOON (YES, IN THE WHOLE PILE)