Week 3; Monday

**Announcements:** 1st lab quiz on common conifers **on Wednesday**—Sight ID family and species. Reminder that notes are posted on the course website every Friday…

**Lecture: Vegetative and Reproductive Morphology, Emphasis on Conifers**

**Plant Morphology** - form or structure of a plant and its parts

**Plant Anatomy** - cell and tissue structure of a plant

**Vegetative morphology** - any portion of a plant that is involved in growth, development, photosynthesis, support, etc., but NOT involved with sexual reproduction.
   Example: roots, stems, leaves, seeds, etc.

**Vegetative Morphology**

**Stems**
At the tip of the growing shoot is a **terminal bud** or apical bud.
A **bud** (undeveloped shoot) has **bud scales** surrounding it to protect the developing parts inside.
Inside a bud are **leaf primordia**, **lateral bud primordia**, and the **apical meristem**.
The **apical meristem** is responsible for new terminal growth.

**Bud scale scars** — scar remaining on twig after bud scales abscise following bud break — can be used to determine age of branch

Below the terminal bud regions of the stem may be identified as follows:
- **node** - point of attachment of a leaf
- **lateral bud** - always found in the axil of a leaf (between the leaf and stem, upward on the stem from the point of attachment of the leaf)
- **internode** - region of the stem between two nodes.

**Branch** — a major division of a stem or trunk
**Branchlet** — a small branch growing from a larger branch
**Spray** — flattened, frondlike branchlets as in some Cupressaceae
**Spur** — a short compact branch with no internode elongation; short shoot
   - **Determinate short shoot** — spur without a functional terminal bud (fascicle)
   - **Indeterminate short shoot** — spur branch having a functional terminal bud; may shift between short shoot and long shoot

**Leaves**
**Leaf structure:**
- **blade** - the broad part of the leaf
- **petiole** - the slender part of the leaf that attaches the blade to the stem
- **margin** - the edge of the blade; may be smooth or variously shaped
Leaf Shape:
- **acicular** – needle-shaped
- **linear** – resembling a line; long and narrow with more or less parallel sides.

NOT A CLEAR DISTINCTION AND SOME TEXTS/KEYS USE INTERCHANGEABLY AS “NEEDLE_LIKE” - The distinction we’ll use is the flattened nature of linear leaves vs. the round (or square) x-section of acicular leaves
- **subulate** – short, narrow, tapered, sharp-pointed; awn or awl shaped.
- **scale** – small and often appressed to the stem

Leaf Attachment:
- **sessile** – attached directly without a supporting stalk (petiole)
- **petiolate** – attached to the twig via a supporting stalk (petiole)
- **sessile on a peg (sterigma)** – abscission layer between sterigma and leaf blade (sterigmata persist on twig)
- **petiolate on a peg** – abscission layer between sterigma and petiole (sterigmata persist)
- **decurrent** – extending downward from the point of attachment, as a leaf base that extends down along the stem

Leaf Arrangement (arrangement of leaves on stem)
- **alternate** – one leaf per node
- **opposite** – two leaves per node on opposite side of stem
- **whorled** – more than two leaves per node
- **ranks** – when looking down on stem, number of rows of leaves (2-ranked, 3-ranked, 4-ranked etc.)
- **distichous** – in two vertical ranks or rows on opposite sides of an axis
- **decussate** – arranged along the stem in pairs with each pair at right angles to the pair above and below – see this in many scale, leaved spp. With **laterals and facials**
- **fascicled** – arranged in a tight cluster or bundle

Surface features:
- **glabrous** – smooth, hairless
- **glaucous** – covered with a whitish waxy coating (bloom), as on the surface of a plum
- **pubescent** – covered with short, soft hairs
- **puberulent** – minutely pubescent; with fine, short hairs
- **tomentose** – with a covering of short, matted, tangled, soft, wooly hairs
Reproductive Morphology

Reproductive morphology - any portion of a plant that is involved with or a direct product of sexual reproduction

Example: cones, flowers, fruits, seeds, etc.

Basic Plant Life cycle

Our view of the importance of gametes in the life cycle is shaped by the animal life cycle in which meiosis (the cell division creating haploid daughter cells with only one set of chromosomes) gives rise directly to sperm and eggs which are one celled and do not live independently. Fertilization (or the fusion of gametes – sperm and egg) occurs inside the animal to recreate the diploid organism (2 sets of chromosomes). Therefore, this life cycle is dominated by the diploid generation. This is NOT necessarily the case among plants!

Generalized life cycle -overhead-
- alternation of generations –

In plants, spores are the result of meiosis. These may grow into a multicellular, independent organism (gametophyte – “gamete-bearer”), which eventually produces sperm and eggs (gametes). These fuse (fertilization) and a zygote is formed which grows into what is known as a sporophyte - “spore-bearer”. (In seed plants, pollination must occur before fertilization! ) This sporophyte produces structures called sporangia in which meiosis occurs and the spores are released. Spores (the product of meiosis) are the first cell of the gametophyte generation.

Distinguish Pollination from Fertilization and Spore from Gamete

Pollination – the act of transferring pollen from anther or male cone to stigma or female cone; restricted to seed plants.

Fertilization – the act of fusion between sperm and egg – must follow pollination in seed plants; fertilization occurs in all sexually reproducing organisms.

Spore – the product of meiosis; the first cell in the haploid (1n) or gametophyte generation in plants. In most animals the product of meiosis also functions as a gamete.

Gamete – the haploid cells that participate in fertilization, egg and sperm. These are produced by specialized structures in the gametophyte generation of plants called gametangia. In flowering plants the gametophytes are so reduced (pollen grain and embryo sac) that distinct structures are not found.
Variations on the theme ....
Each generation (sporophyte/gametophyte) may be free-living or dependent (on the other generation for nutrition)
Usually one generation is dominant, but in some algae both are +/- equivalent.

- **green algae** - some have sporophyte dominant, some gametophyte dominant, and some are isomorphic
- **Mosses** - gametophyte dominant; sporophyte dependent
- **Ferns** - sporophyte dominant; gametophyte free-living, but small and short-lived
- **seed plants** - sporophyte dominant; gametophyte dependent and reduced
- **Angiosperms** - gametophyte VERY reduced - pollen 2-3 cells; embryo sac 8 cells
sporangium - a spore bearing case or sac
   in the case of gymnosperms, the sporangium is where the pollen (microsporangiun – pollen sacs) and ovule (megasporangiun and associated integument - outer layers that become seedcoat)

pollen – the mature microspores or developing male gametophyte – sperm produced within

ovule – immature seed the megasporangium and surrounding integuments - the egg produced within archegonium - female gametangia, multicellular

sporophyll – sporangium bearing leaf – often modified in structure

Cone (strobilis) – a dense cluster of sporophylls on an axis

   Cones are unisexual and may bear microsporangia – pollen sacs – or megasporangia – ovules – but not both – a cone may be thought of as a reproductive short shoot!

   Pollen cones – in all conifers pollen cones are simple – a simple cone has a cone axis and one set of appendages, usually called scales – scales have 2 to many pollen sacs. Pollen cones are deciduous soon after pollen is released, and not often used for identification

   Ovulate cones or Seed cones – in all conifers, seed cones are compound (though not always obvious at maturity!) – seed cones have first order appendages – bracts – and second order appendages – ovuliferous scales – in the bract axils. The central stem axis bears highly modified lateral branches (the ovuliferous scales) in the axils of a reduced leaf.

Ovuliferous Scales – bear ovules on adaxial surface (upper surface, closest to the axis)
   Contrast with abaxial – lower surface (away from axis)
   Ovules may be inverted (pointing towards axis) or erect

**Simple vs. Compound cones**
Simple cone is composed of scales arranged along an axis – reduced branch (Show Pinaceae branch with pollen cones replacing SS)

Compound cone is composed of **Bracts subtending Scales**. Each scale is interpreted as a reduced branch in the axil of modified leaf (bract). Therefore, the compound cone is a series of reduced branches arranged on an axis (show Pinaceae branch with ovuliferous cone replacing axillary LS bud)

The compound nature of the ovulate cones is only really evident at maturity in Pinaceae – in all other conifers (Cupressophytes – includes Cupressaceae, Taxaceae, et al.) – bract and scale are fused during ontogeny.

**Bract/Scale complex** – the product of bract-scale fusion during ontogeny – mimics simple cone
Week 3; Friday

Announcements:

Intro phylo and tree thinking continued…

Walter Zimmerman (1931) (OVERHEAD) - german BOTANIST - solidified the central notion of “phylogenetic relationship”
• Two species (B and C) are more closely related to each other than they are to a third species (A) if and only if they share a more recent common ancestor.

Phylogenetic tree (use tree thinking phylogeny-Baum et al. 2005 OVERHEAD-1st tree) – a depiction of lines of descent that communicates the evolutionary relationships among elements (e.g., species, higher taxa, genes, etc.)

• Note that this is a relative timeline.
• The tips of the branches represent taxa living today.
• The nodes represent actual biological entities - the common ancestors!

TREES ARE NOT READ LEFT TO RIGHT - i.e., things on the left are not more primitive than things on the right - to understand this rotate branches
(use tree thinking phylogeny-Baum et al. 2005 OVERHEAD-2 trees)
• does this change the relationships? emphasize reading through the nodes, not across the tips.
• trees show historical realtionships - not similarity - although similar species tend to be related, this is not necessarily the case (e.g., lizards are more closely related to mammals than frogs...)

TREE-THINKING QUIZ OVERHEADS (reading through the nodes)

Willi Hennig (1966) (OVERHEAD)- german Entomologist - synthesized the discipline he named “Phylogenetic Systematics” and formalized the method of phylogenetic reconstruction

• Phylogeny reconstruction (cladistics) – the process by which we determine relationships
• Like Darwin, Hennig argued that classification systems should reflect evolutionary relationships.
• Phylogenetic classification = hierarchical ordering of taxa according to phylogenetic relationships consisting of a nested set of ever more inclusive groups. A more explicit term than “natural” classification.

Goal: identify a nested, hierarchical, set of monophyletic groups
• Monophyletic group - a group of spp. that includes an ancestral sp. and all of its descendants (identified by synapomorphies = homologies) (OVERHEAD - drawing of trees)
• Paraphyletic group - ancestor and some, but not all, descendants
• Polyphyletic group - a group of spp. in which the common ancestor does not belong to the group