Ethnobotany. Lecture 3

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Outline

1. Main food source plants: grains
   - Ancient wheats
   - “Contemporary” wheats

2. Other C_3 grains
   - Rye
   - Barley

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Main food source plants: grains

Ancient wheats

Triticum monococcum

- Eincorn, or Triticum monococcum is probably the most ancient cultivated plants ever (cultivated from neolithic age)
- Do not require irrigation, survive with low precipitation but yield is also low
- In spikes, spikelets have only one flower
- Relatively tall (up to 1 m)
- Now cultivated rarely, one of the last centers of cultivation is Spain

Eincorn, *Triticum monococcum*

Triticum dicoccum

- Emmer wheat (farro, *Triticum dicoccum*) has fragile spike and more than one flower per spikelet
- Sustainable for droughts, bacterial and fungal infections, insects, lower temperatures but has extremely low yield
- Still cultivated in some European countries (Italy, Albania); main food source in Ethiopia
- Used also as a genetic source for hybridization and selection

Emmer wheat (*Triticum dicoccum*)

Main food source plants: grains

“Contemporary” wheats

Triticum durum, hard wheat

- Hard wheat (*Triticum durum*) is a second most cultivated wheat, probably of Mediterranean origin
- Small-sized, fast-growing
- Almost exclusively self-pollinated
- Has high yield and grains of best quality among wheats containing more proteins

Hard wheat (*Triticum durum*)

Triticum durum 2

- Winter races are rare
- Requires irrigation
- Better suited for cultivation in tropics
- The highest diversity is now in Italy (widely used for a pasta!)
- Now widely cultivated in tropics (India, Africa)

Triticum aestivum, common wheat

- Common (soft) wheat (*Triticum aestivum*) is a main cultivated wheat
- There are more than 4,000 cultivars of common wheat
- Small- and medium-sized but slow-growing when young
- Often cross-pollinated
- High yield, grains are rich of starch

Common wheat (*Triticum aestivum*)

Triticum aestivum 2

- Has many winter and spring races
- Typically, does not require irrigation
- Cultivated mostly in temperate and subtropical regions around the world
- Main cultivated wheat in U.S.

Origin of wheats

- Tetraploid and hexaploid wheats are inter-generic hybrids between diploid wheats and *Aegilops* (goatgrass)!
- Tetraploid wheats have genome AABB (A from diploid wheats, B from *Aegilops speltoides*)
- Hexaploid wheats have genome AABBDD (D from *Aegilops squarrosa*)

Aegilops speltoides

Aegilops squarrosa

Current trends in wheat selection

- Wheats with branched spikes (e.g., tetraploid *Triticum turgidum*, rivet wheat and hybrids)
- Dwarf wheats (especially in common wheat) are selected with transition from sickle to harvesting machines
- Octoploid forms ($2n = 56$) are artificial, typically have bigger grains
- Hybrids with rye, $\times$ *Triticosecale* (*Triticum* $\times$ *Secale*)

Rivet wheat, *Triticum turgidum*

× *Triticosecale*

Other C_3 grains

Rye

Rye, *Secale*

- Belongs to the same tribe with wheat, Triticeae
- Much “younger” cultivated plant
- Cultivated mostly in temperate regions of Eurasia (Russia, Germany, Sweden) and Canada

Rye features

- Hardy plant, likes sandy soils, survives with a frost, has a short life cycle adapted for long days, however, yield is low, $\approx$ 1 ton/hectare
- Many winter cultivars
- Cross-pollinated
- Rich of proteins, therefore rye bread is growing hard faster than pure wheat bread; typically, rye bread contains wheat additives (sometimes up to 70%)
- Has multiple uses: as a forage plant become available early in the spring, as a source of ethanol, as a source of straw

Rye taxonomy

- Several species, only one is cultivated: *Secale cereale*
- Has two subspecies: one is a cultivated rye, *Secale cereale* subsp. *cereale*, second is a weed (occuting mostly in wheat crops): *Secale cereale* subsp. *segetale*
- Chromosome number is diploid ($2n = 14$), similar to primitive diploid wheats

Rye origin and history

- Weed rye originated from wild species and become annual (other ryes are perennial) in order to correspond with wheat life cycle
- Cultivated rye is a domesticated weed rye
- One theory (N. Vavilov) said that rye outperformed wheat on the northern slopes of Caucasus mountains where spring may come two months later than on southern slopes; this competition sometimes resulted in pure rye crops
- Than selection started for bigger grains, since rye is cross-pollinated, selection went faster
- First remains of rye dated 300–400 AD (Black Sea coast)
- Since rye has open flowers, it sensitive to ergot (*Claviceps purpurea* fungus) containing hallucinogenic lysergine acid which was the cause of egotism disease in medieval centuries.

Cultivated rye, *Secale cereale* subsp. *cereale*

[Note the ergot (*Claviceps purpurea*) fruiting bodies]

Weed rye, *Secale cereale* subsp. *segetale*

Other C_3 grains

Barley

Barley, *Hordeum*

- Belongs to the same tribe Triticeae
- Plant of multiple use: as bread (rarely), as a cereal, for making beer, as a forage plant
- Old West Asian culture, now cultivated mostly in temperate regions of North Hemisphere

Barley features

- Grains are not fully appropriate for bread, they have too low amount of proteins ($\approx$ 7%), resulted bread is crumbling too much
- Hardy plant, survives easily in winter (there are many winter cultivars), has extremely fast life cycle and therefore cultivated on high altitudes in mountain areas (as Tibet)

Barley taxonomy

- Almost 40 species, only two are widely cultivated
- *Hordeum distichon*, two-rowed barley, is cultivated mostly for beer production; spike has two rows of spikelets
- *Hordeum vulgare*, six-rowed barley, cultivated for multiple purposes; six rows of spikelets

Hordeum distichon, two-rowed barley

- Old culture (7,000 BC) from West Asia and Egypt, originated from wild *Hordeum spontaneum*
- Annual, with flat spikes
- Only spring forms
- Now cultivated mostly in West and Middle Asia and Europe

Hordeum vulgare, six-rowed barley

- Newer culture, 4–5,000 BC, originated from East Asia
- China and Japan are still centers of diversity (and probably, centers of origin)
- Goes very high on mountains, up to 6,000 m above sea level
- Unfortunately, sensitive to drowning and to fungal diseases, especially to powdery mildew (*Erysiphe* spp.)

Role in brewing

- For brewing, barley grains are malted: germinated by soaking in water and then sharply drying by hot air
- Consequently, enzymes started to modify starch into mono- and disaccharides, such as fructose, glucose, sucrose and maltose
- There saccharides are using for making wort (mixture of malted barley with water); wort is then fermented with brewer yeasts (*Saccharomyces cerevisiae* fungus)

Two-rowed barley, *Hordeum distichon*

Six-rowed barley, *Hordeum vulgaris*

Ancestor of barley, *Hordeum spontaneum*

Summary

- Tetraploid and hexaploid wheats are intergeneric hybrids
- **Barley** is an ancient culture well adapted to agriculture in mountain regions
- **Rye** and **common oat** were originated from weeds

For Further Reading

P. Stamp.
Virtual cereal cultivar garden [Electronic resource].
2008.
Mode of access:
http://www.sortengarten.ethz.ch/?content=start

A. Shipunov.
Ethnobotany [Electronic resource].
2011—onwards.
Mode of access:
http://ashipunov.info/shipunov/school/biol_310