

Ethnobotany. Lecture 5

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Outline

1 Main food source plants: grains

- Wheat, *Triticum*
- “Contemporary” wheats

2 Other C₃ grains

- Rye
- Barley
- Oat



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- 1 Main food source plants: grains
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Main food source plants: grains

Wheat, *Triticum*



Species and species groups

- Diploid species ($2n = 14$): eincorn
- Tetraploid species ($2n = 28$): emmer wheat, hard wheat
- Hexaploid species ($2n = 42$): common wheat

Common wheat ia a “genetic monster” with the chimeric genome.

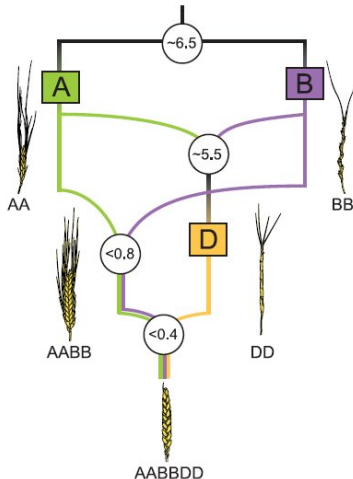


Main food source plants: grains

“Contemporary” wheats



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 tauschii*)

Aegilops speltoides



Aegilops tauschii



Norman Borlaug, University of Minnesota, 1914–2009



Father of "green revolution", Nobel Prize (1970)



Norman Borlaug started contemporary wheat selection

- Dwarf wheats (especially in common wheat) are selected with transition from sickle to harvesting machines, they withstand many weather problems and are more drought-resistant
- Wheats with branched spikes (based on tetraploid *Triticum turgidum*, rivet wheat and hybrids)
- Octoploid forms ($2n = 56$) are artificial, typically have bigger grains
- Hybrids with rye, \times *Triticosecale* (*Triticum* \times *Secale*)



Rivet wheat, *Triticum turgidum*



× *Triticosecale*



Other C₃ 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 (occurring 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
- N. Vavilov stated 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. In times of the “small ice age” (13–18 centuries), when wheat in most of Europe was replaced with rye, ergotism was probably the reason of the widespread “witch hunting”.



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



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



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



Other C₃ 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 high amount of proteins ($> 7\%$), resulted in bread which 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
- These species are sometimes treated as one



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
- Widely cultivated, the yield is comparable to the contemporary wheats (≈ 2 ton/ha)
- 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
- These saccharides are used 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 vulgare*



Ancestor of barley, *Hordeum spontaneum*



Other C₃ grains

Oat



Oat (*Avena*)

- Belongs to different tribe, Aveneae
- Morphology is also different: oats have branched inflorescence, panicle
- Several species in cultivation, as a forage plants (especially for horses) and as cereals



Oat features

- Hardy culture, cultivated mostly in temperate regions, yield relatively low, is ≈ 1 ton/hectare
- Grains contain high amounts of proteins and lipids
- Mostly spring forms (winter cultivars also exist); life cycle longer than in barley (should be planted earlier in a spring)
- Not sensitive to many fungal diseases



Oat taxonomy

- Several dozens species, only two are widely cultivated
- *Avena byzantina*, red oat, is more hardy and also better adapted to dry climates, has long grains
- *Avena sativa*, common oat, main cultivated oat, has shorter grains



Origin of oats

- Red oat is a domesticated form of wild oat, *Avena sterilis*.
Cultivation started with invention of big cavalry armies (\approx 400 BC) of Alexander the Great
- Common oat was the weed of emmer wheat (*Triticum dicoccum*), and became pure culture when crops went northward (similar to rye)



Red oat, *Avena byzantina*



Common oat, *Avena sativa*



Oat ancestor, *Avena sterilis*



Summary

- Wheats (*Triticum*) are ancient cultivated plants, originated in West Asia
- 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



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Virtual cereal cultivar garden [Electronic resource].

2008.

Mode of access:

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Mode of access:

http://ashipunov.info/shipunov/school/biol_310

