

Ethnobotany. Lecture 10

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Outline

- 1 Starch-containing plants
 - Potatoes, tuber species of genus *Solanum*
 - Sweet potato, *Ipomoea batatas*
 - Cassava, *Manihot esculenta*
 - Yam (tropical yam), *Dioscorea* spp.
 - Taro



Exam 1

- Exam will be taken in a form of “critical essay” on the “Introduction to Botany” textbook.
- Everybody will need to read the whole text and specifically your individual part of it.
- Inside your part, you are required to find ≥ 12 misprints, grammar, spelling or style problems and provide corrections for them (3 points per each). Also, you need to suggest ≥ 3 general improvements for the text (7 points per each) and ≥ 1 recommendation for figure(s) (5 points per each).
- In addition to your part of text, you will need to find in the “outside” text: ≥ 6 problems with corrections, suggest ≥ 2 improvements and ≥ 1 figure recommendation(s).
- Everything above should be provided with page/line references to the text (like “page 15, line 5 from top”). Textbook is now frozen until I receive all essays, but please *update* your version to the latest one.
- Exam is due February 9, 10 a.m. I will accept it *exclusively by email*.



Starch-containing plants

Potatoes, tuber species of genus
Solanum



Potatoes, tuber species of genus *Solanum*

- *Starch* and *inulin*—polymers of glucose or fructose monosaccharides, respectively. Plants accumulate them mostly in underground parts: roots, rhizomes, tubers
- *Solanum* is one of the largest plant genera (up to 2,000 species!) and includes several important plants (tomatoes and eggplants) and potatoes—species from section **Petota** (≈ 15 species, all produce “potatoes”).



Morphology and other features of potatoes

- Potatoes are **tubers**, enlarged parts of specialized rhizomes; buds grow into tubers in darkness
- Main function of tubers is vegetative propagation
- Yield of tubers is high, ≈ 15 ton/hectare, but 70–80% of it is a water
- Still, in calories yield is higher than rice or corn: every 100 g contain 15 g of carbohydrates
- There are almost no fats and low amounts (2%) of proteins
- Plants are cross-pollinated; fruits are toxic (contain *solanin*)



Diversity of potatoes

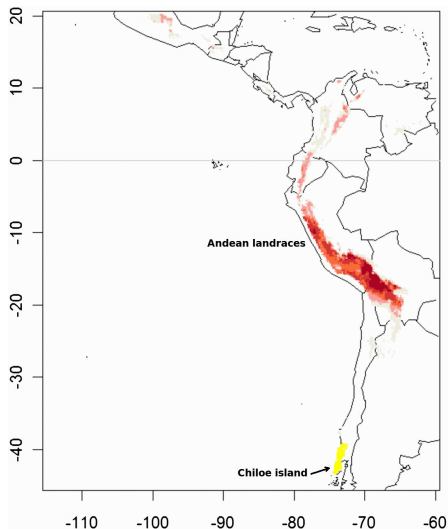
- All species from *Petota* section may form tubers
- The biggest yield is from tetraploid forms ($2n = 48$) growing in Central Andes and island Chiloe



Potatoes of Ecuador



Richness of potato landraces (from Spooner et al., 2010)



Agriculture of potatoes

- The best is extremely simple agriculture plus high energetic yield
- Planting is from potato buds, not from seeds
- Critical stage of cultivation is “hilling”, increasing the soil level around stems
- Harvesting is still not mechanized well
- Storage requires more stable conditions than seed storage

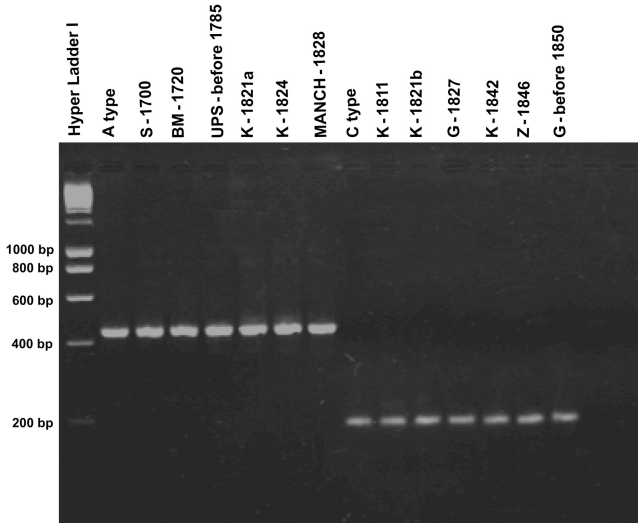


History of potatoes

- Domesticated around 3,000 BC and together with quinoa became the main food of Inca empire
- Initially, used mostly as a freeze-dry “chunjo”
- Is known in Europe since 1601
- In XVIII century, was forcedly introduced into culture by many European monarchs and then became widely adopted
- Now, the main producers are China, Russia, India and U.S.



DNA test of European potato cultivars



Amplified PCR products of the plastid trnV-UAC/ndhC intergenic spacer region of 12 pre-1850 *Solanum tuberosum* specimens (Ames & Spooner, 2008)



Main dates of potato introduction (from Ames & Spooner, 2008)

- A. **1567.** Potato first documented in Europe in the Canary Islands (not shown, Spanish territory 1700 km SW of Madrid).
1573. First record of potato used for human consumption in continental Spain.
- B. **1596.** First botanical description of the potato by Gaspar Bauhin.
- C. **1601.** Potatoes were cultivated in Prussia.
1771. A famine stimulated potato cultivation.
- D. **1601.** Potatoes were cultivated in a few gardens. **1770.** Residents of Naples refused to eat potatoes during a famine.
- E. **~1600.** Potato cultivation established in eastern France. **1749.** Potato considered "exotic." **1761.** Public demonstrations that potatoes were a safe food.
1771. Parmentier effectively promoted potatoes as a safe food.
1814. A collection of ~120 potato varieties were gathered by the National Society of Agriculture.
- F. **1640.** Potato documented as a field crop.
- G. **1662.** Potato became an object of importance, and the Royal Society recommended planting potatoes to prevent famine. **1760.** Potatoes gained wider acceptance as a field crop in Scotland.
1830. Potatoes commonly cultivated in England.
- H. **1764.** A royal edict issued to encourage potato cultivation.
- I. **1850.** Nicholas I forced people to cultivate potatoes.



Great Irish famine and *Phytophthora infestans*

- Potato occurred to be susceptible for several dangerous pathogens, e.g., potato blight “fungus” (*Phytophthora infestans*)
- Pandemic of potato blight covered Europe in the middle of XIX century (1845–1852), when potato became the main food in many northern European countries including Ireland
- In Ireland, it resulted in 1 million deaths and decreasing of population to 25% due to emigration



Potato blight, *Phytophthora infestans*



One of Irish famine monuments



Colorado beetle (*Leptinotarsa decemlineata*)

- One of the most dramatic examples of American invasive species in Europe
- In Colorado Rocky Mountains, these beetles were feeding on *Solanum rostratum* plants but not on potato
- During World War I and then especially World War II, it became spreading across all Western Europe and then eastward
- Distribution is now covered all North Hemisphere (except China)



Colorado potato beetle...



... and its first host, *Solanum rostratum*



Starch-containing plants

Sweet potato, *Ipomoea batatas*



Sweet potato, *Ipomoea batatas*

- Belongs to morning glory genus *Ipomoea* from Convolvulaceae family
- Cultivated for thickened secondary roots (tuberous roots, not tubers!)
- Contain 12% of starch, 5% of sugars, little proteins and almost no fat
- Rich of vitamins, especially vitamin A precursor beta-carotene



Sweet potato morphology

- Herbaceous vine, perennial plant cultivated as annual
- Tuberous roots are large, up to 25 kg
- Reproduction is both from seeds and vegetative, from root and stem parts (grafts)
- Large, trumpeting, insect-pollinated flowers



Ipomoea batatas, sweet potato



Sweet potato agriculture

- Pure tropical culture, does not tolerate frost
- Requires short days, full sun, light soil
- Planting as grafts, this increases the number and weight of tuberous roots (subsidiary roots)
- Green part is used as a forage for animals



Planting of sweet potato

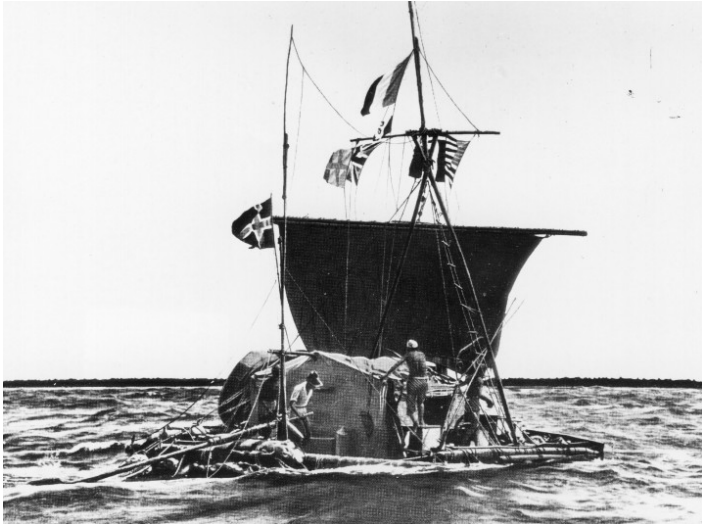


History of sweet potato

- Domesticated in Central America almost 3,000 BC and spread to Polynesia before European colonization
- In Polynesia, it is called the “kumara”, remarkably similar to the Quechua “kumar” in Peru: that is one of reasons for Thor Heyerdahl Kon-Tiki expedition
- Now two main producers are China and Nigeria



Kot-Tiki raft, 1947



Starch-containing plants

Cassava, *Manihot esculenta*



Cassava, manioc, *Manihot esculenta*

- Belongs to the tree genus *Manihot* from spurge family Euphorbiaceae
- Third largest source of carbohydrates in the world
- It is a shrub cultivated as annual (!)
- Secondary roots (not stems!) are thickening and form tuberous parts

In Spanish, called “yuca” (do not mix with aloe-like *Yucca* plant).



Cassava plantation



Cassava features

- Tuberos roots have high amount of dry mass (30%), high in starch, phosphorous and vitamin C but poor in proteins and essential amino acids
- **Toxic**, contain cyanogenic compounds which are liberating hydrogen cyanide (HCN). Consequently, should be pressed, soaked, cooked or fermented before use. Without preparation caused a *konzo* disease.
- Harvesting is manual; roots are deteriorated fast and should be processed as soon as possible



Cassava preparation: peeling



Cassava preparation: grinding



Cassava preparation: pressing



Cassava preparation: drying



Cassava history

- Domesticated in Brazil around 6,000 BC
- Went to Africa with Portuguese trades and then to south-west Asia
- Now, Nigeria and Thailand are biggest producers



Starch-containing plants

Yam (tropical yam), *Dioscorea* spp.



Yam, *Dioscorea* spp.

- Several species of large genus *Dioscorea* and Dioscoreaceae family
- Cultivated for tubers (morphologically similar to potato tubers)
- Frequently used as a flour
- Could be stored up to half-year, even in tropical climate

Sweet potato is sometimes called “yam” in U.S.



Yam, *Dioscorea*



Yam features

- Tubers could be huge: up to 2,5 m and 70 kg
- Contain starch, significant amounts of vitamin C, and several microelements
- Hilling is an important stage of cultivation
- Long vegetation period (up to 1 year)
- Due to the size of tubers, harvesting is only manual



Yam plantation



Yam history

- Three most cultivated species: *Dioscorea rotundata*, yellow yam of Africa; *D. alata*, water yam of Polynesia; and *D. opposita*, Chinese yam
- These species were separately domesticated, most probably prehistorically
- During potato pandemic, *D. alata* cultivation started in Europe, still cultivated in France
- Now the biggest producer is Nigeria



Water yam of Tonga



Starch-containing plants

Taro



Taro, *Colocasia esculenta* and *Xanthosoma sagittifolium*

- Belong to arum family, Araceae
- African and South American origin, respectively
- Large semi-aquatic herbs with thickened underground stem (rhizome)
- Rhizome is inedible because of calcium oxalate which must be removed by cooking

Colocasia is “malanga” in Puerto-Rico whereas *Xanthosoma* is “yautia”



Colocasia esculenta



Xanthosoma sagittifolium



Taro harvesting



Walmart vegetables in Puerto Rico



Summary

- **Starch-containing plants** are accumulating starch or inulin in underground parts
- Sweet potatoes and cassava (manioc) are two largest starch sources after potato
- Multiple unrelated tuber starch-bearing species grow in Andes



For Further Reading



A. Shipunov.

Ethnobotany [Electronic resource].

2011—onwards.

Mode of access:

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



P. M. Zhukovskij.

Cultivated plants and their wild relatives [Electronic resource].

Commonwealth Agricultural Bureaux, 1962. Abridged translation from Russian.

Mode of access:

http://ashipunov.info/shipunov/school/biol_310/zhukovskij1962_cultivated_plants.djvu.

