

3502-470 Plant Genetic Resources

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Goals of lecture

1. Definition and types of biodiversity

2. Biodiversity versus agrobiodiversity

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Outline

Biodiversity

The value of biodiversity

Diversity of plants used by humans

Agrobiodiversity

Major and minor crops

Changes in (agro)biodiversity

Biodiversity The value of biodiversity Diversity of plants used by humans Agrobiodiversity Major and minor crops

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What is biodiversity?

The official definition of biodiversity on the Rio summit in 1992: the variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems

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Meanings of biodiversity



- \cdot Species diversity
- Ecosystem diversity
- Morphological diversity
- Genetic diversity
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Le Monde via Wikipedia

How many species are there on Earth?

	Number of Described	Estir			
Species	Species ^a (000)	High (000)	Low (000)	Working Number ^{b,d} (000)	Accuracy*
Viruses	4	1.000*	50	400	Very poor
Bacteria	4	3,0001	50	1,000	Very poor
Fungi	72	2,0001	200	1,500	Moderate
Protozoa	40	200	60	200	Very poor
Algae	40	1,0009	150	400	Very poor
Vascular Plants	270	500	300	320	Good
Nematodes	25	1,0009	100	400	Poor
Arthropods					
Crustaceans	40	200 ⁹	75	150	Moderate
Arachnids	75	1,000	300	750	Moderate
Insects	950	100,000	2,000	8,000	Moderate
Molluscs	70	200	100	200	Moderate
Chordates	45	55	50	50	Good
Others	115	800	200	250	Moderate
Total	1,750	110,955	3.635	13,620	Very poor

Myers et al., 2000

Distribution of biodiversity hotspots



Leading hotspots

Hotspot	Original extent of primary vegetation	Remaining primary vegetation (km²)	Area protected (km ²) (% of hotspot)	Plant species	Endemic plants (% of global plants, 300,000	Vertebrate species	Endemic vertebrater (% of global vertebrates, 27,298
Tropical Andae	1 258 000	314 500 /25 (h	70 687 /26 21	45,000	20,000 (8,7%)	3 390	1 587 (5 7%)
Managenetica	1 155 000	221 000 (20.0)	120 427 (20.0)	24,000	E 000 (1 7%)	2,850	1 150 (8 20)
Carbhaan	283.500	29.840 (11.2)	29,840 (100,0)	12,000	7,000 (2,2%)	1.518	770 (2.0%)
Brazil'e Atlantic Forest	1 227 800	91,930 (7.5)	33 084 (35.0)	20,000	8,000 (2,7%)	1.361	567 (2.1%)
Choc/Daten/Mastern Ecuador	260,600	63,000 (24,2)	16 471 (26 1)	9,000	2 250 (0.8%)	1.625	41B (1 594)
Brazil's Cerrado	1,783,200	356,630 (20.0)	22,000 (6.2)	10,000	4.400 (1.5%)	1.268	117 (0.4%)
Central Chile	300.000	90,000 (30,0)	9.167 (10.2)	3,429	1.605 (0.5%)	335	61 (0.2%)
California Floristic Province	324.000	80,000 (24,7)	31,443 (39,3)	4.426	2,125(0,7%)	584	71 (0.3%)
Andagascar"	594,150	59.038 (9.9)	11.548 (19.6)	12.000	9,704 (3,2%)	987	771 (2.8%)
astern Arc and Coastal Forests of	30.000	2,000 (6.7)	2,000 (100.0)	4.000	1,500 (0.5%)	1.019	121 (0.4%)
Tanzania/Kenva							
Vestern African Forests	1.265.000	126,500 (10.0)	20.324 (16.1)	9.000	2,250 (0.8%)	1.320	270 (1.0%)
Cape Floristic Province	74,000	18,000 (24.3)	14,060 (78.1)	8,200	5,682 (1.9%)	562	53 (0.2%)
Succulent Karoo	112,000	30,000 (28.8)	2,352 (7.8)	4,849	1,940 (0.6%)	472	45 (0.2%)
Mediterranean Basin	2,362,000	110,000 (4.7)	42,123 (38.3)	25,000	13,000 (4.3%)	770	235 (0.9%)
Daucasus	500.000	50,000 (10.0)	14,050 (28,1)	6.300	1,600 (0.5%)	632	59 (0.2%)
Sundaland	1,600,000	125,000 (7.8)	90,000 (72.0)	25,000	15,000 (5.0%)	1,800	701 (2.6%)
Vallacea	347,000	52,020 (15.0)	20.415 (39.2)	10,000	1,500 (0.5%)	1,142	529 (1.9%)
hlippines	300,800	9,023 (3.0)	3,910 (43.3)	7,620	5,832 (1.9%)	1,093	518 (1.9%)
ndo-Burma	2,080,000	100,000 (4.9)	100,000 (100.0)	13,500	7,000 (2.3%)	2,185	528 (1.9%)
South-Central China	800,000	64,000 (8.0)	16.562 (25.9)	12,000	3,500 (1.2%)	1,141	178 (0.7%)
Vestern Ghats/Sri Lanka	182,500	12,450 (6.8)	12,450 (100.0)	4,780	2,180 (0.7%)	1,073	355 (1.3%)
3W Australia	309,850	33,336 (10.8)	33,336 (100.0)	5,469	4,331 (1.4%)	456	100 (0.4%)
iew Caledonia	18,600	5.200 (28.0)	526.7 (10.1)	3.332	2,551 (0.9%)	190	84 (0.3%)
New Zealand	270,500	59,400 (22.0)	52,068 (87.7)	2,300	1,865 (0.6%)	217	136 (0.5%)
Polynesia/Micronesia	46,000	10,024 (21.8)	4,913 (49.0)	6,557	3,334 (1.1%)	342	223 (0.8%)
Totals	17,444,300	2,122,891 (12,2)	800.767 (37.7)	+	133,149 (44%)	+	9.645 (35%)

formation.

Polyne Totals Documentation of plant and vertebrate species and enderrism can be found in Suppleme *Madagascar includee the nearby listands of Mauritus, Reurion, Seycheles and Comores † These totals cannot be summed owing to overlapping between hotsoots.

Myers et al., 1990

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Leading hotspots in terms of endemics

Table 3 Leading hotspots in terms of endemics						
Hotspot	Endemic plants (% of global total, 300,000)	Endemic vertebrates (% of global total, 27,298)				
Tropical Andes*	20.000 (6.7)	1.567 (5.7)				
Sundaland*	15.000 (5.0)	701 (2.6)				
Madagascar*	9,704 (3.2)	771 (2.8)				
Brazil's Atlantic Forest*	8,000 (2.7)	567 (2.1)				
Caribbean*	7,000 (2.3)	779 (2.9)				
Sub-totals (% rounded)	59,704 (19.9)	4,385 (16.1)				
Mesoamerica	5,000 (1.7)	1,159 (4.2)				
Mediterranean Basin	13,000 (4.3)	235 (0.9)				
Indo-Burma	7,000 (2.3)	528 (1.9)				
Philippines	5,832 (1.9)	519 (1.9)				
Totals	90,536 (30.1)†	6,826 (25.0)				

* Hotspots with at least 2% of the world's endemic plants and vertebrates, and comprising only 0.4% of the Earth's land surface (all nine amount to 0.7% of the Earth's land surface), † This would total 30.2% but for rounding of numbers in the individual hotspots.

Myers et al., 1990

Jatun Sacha Reserve in Ecuador





About 600 tree species in few km²: More than in all of North America!

Geographic distribution of plant species?

Figure 1: Numbers of plant species in different regions of the world.

Global patterns of biological diversity



Gaston et al. 2000

Economic value of biodiversity

- \cdot Environmental services
- Tourism
- Natural products
 - Pesticides
 - Medicines
 - Materials
- New (alternative) plant species for food supply \rightarrow Amaranth, quinoa, buckhwheat, etc. (minor crops)

Pesticides from plants



lanacetum cinerariifoliu	IM
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- \cdot Occurs on the Balkans
- Pyrethrum insecticide

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Medicines from plants



Catharanthus roseus

- Madagascar Periwinkle
- \cdot 50 alkaloids were found in plant
- Vincristine: Cytostatikum against tumors

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Distribution of plant species used by humans





Biodiversity The value of biodiversity Diversity of plants used by humans Agrobiodiversity Major and minor crops Changes in (agro)biodiversity

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Agrobiodiversity

According to FAO, agrobiodiversity encompasses the variety and variability of animals, plants and micro-organisms which are necessary to sustain key functions of the agroecosystem, its structure and processes for, and in support of, food production and food security

Components of agrobiodiversity

Diversity of ecosystems

- Agricultural fields
- Meadows
- \cdot Natural habitats
- Main crop speces
 Lesser crops
- Modern varieties
- Land races

Diversity of crop plants

Other aspects of agrobiodiversity

- Related wild species, meadow plants
- $\cdot\,$ 'Deleterious' agrobiodiversity: Weeds, pests, pathogens
- Useful agrobiodiversity like pollinators, soil fauna or microorganisms
- Diversity of livestock

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Biodiversity

The value of biodiversity

Diversity of plants used by humans

Agrobiodiversity

Major and minor crops

Changes in (agro)biodiversity







Examples of lesser used crops

- \cdot Food plants restricted to certain regions:
 - Teff (*Eragrostis tef*) ⇒ Ethiopia
 Yam
 - Bambara peanut
 - Amaranth
 - Buckwheat
- backmicat
- Vegetables, fruits, medicinal plants
- Tree species
- Fodder crops/feed crops



Example of a minor crop



Buckwheat (Fagopyrum esculentum)

- Family Polygonaceae
- Distribution: Asia, Russia, North America, Central and Western Europe
- undemanding, rapidly growing, but frost sensitive, grows on poor sandy soils
- Yield: 5-20 dt/ha
- Uses: Food plant (grouts, porridge, flour additive from fruits), fodder plant, green manure, bee food
- Composition: 10% protein, 70% carbohydrates, 2% fat in grain
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Conclusion: Most important cause for change in biodiversity: Immigration of neophytes







Global change of agrobiodiversity

Causes of genetic erosion mentioned in FAO country reports



Rainforest versus industrial agriculture



Reduction of biodiversity at several levels

Biodiversity: Extinction of the rainforest

Agrobiodiversity: Monoculture and simple crop rotation (Soybean and maize)

Genetic diversity: Few hybrid and GMO varieties with large market share

Summary

- The term 'biodiversity' applies to different levels of biological organization.
- Biodiversity is unequally distributed among taxonomic groups, geographic regions and throughout history.
- Agrobiodiversity is defined as the diversity in the context of agriculture. Its ultimate purpose is to increase and support human well-being.
- Agriculture is the most important factor for the decline of total biodiversity.
- On a global scale, agriculture depends mainly on few plant species, but there are numerous crops of local importance.

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Further reading

• Hammer et al. (2003) [ILIAS]

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Review questions

- Which levels of biological organisation are included into the definition of biodiversity?
- How many species of plants were described, how many are estimated to exist?
- What are centers of biological diversity? Where are the main centers of biodiversity located?
- \cdot What is an endemic species?
- \cdot What is the importance of agrobiodiversity in relation to humans?
- What are the different components of agrobiodiversity?
- \cdot What are major and minor crops? Give some examples.
- Which processes lead to the decline of general and agricultural biodiversity?

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