SEMESTER II

BT 101 MODERN BIOLOGY 3 1 0 8

Pre-requisite: Nil

Before Midsem:
Dr. Ranjan Tamuli: Diversity in biological systems; cell biology and cell structure; biological membranes;
Dr. Pranjal Chandra: genetics: DNA as genetic material; structure of DNA; gene expression and regulation; recombinant DNA technology.

After Midsem:
Dr. Priyadarshi Satpati: bioenergetics; DNA replication; transcription; translation; genes to proteins and to protein function;
Dr. Souptick Chanda: Human physiology: biological axons and neurons, neuromuscular and synaptic junctions; sensory systems - hearing, taste, smell and visual receptors.
Texts:

•1. J. L. Tymoczko, J. M. Berg and L. Stryer, Biochemistry, 5th Ed, W. H. Freeman & Co, 2002.
•2. D. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, Macmillan Worth, 2000.

References:

•1. N. Hopkins, J. W. Roberts, J. A. Steitz, J. Watson and A. M. Weiner, Molecular Biology of the Gene, 4th Ed, Benjamin Cummings, 1987.
•2. C. R. Cantor and P. R. Schimmel, Biophysical Chemistry (Parts I, II and III), W.H. Freeman & Co., 1980.
•3. C. C. Chatterjee, Human Physiology, Vol 1 & 2, 11th Ed, Medical Allied Agency, 1987.

http://shilloi.iitg.ernet.in/~biotech/BT%20Syllabus/BT%20101.htm

Grading Pattern

- **Mid semester: 40 marks**
- **Surprise (unannounced) quiz test before mid semester: 10 marks**
- **Final semester : 40 marks**
- **Surprise (unannounced) quiz test after mid semester: 10 marks**

- **No re-examination**
- **Attendance guideline will be strictly followed**

9-10 AM & 4-5 PM	11 Jan 2018 Thursday	9-10 AM L2(III) PC & L3 (IV) RT	4-5 PM L2 (I) RT & L3 (II) PC
11-12 Noon & 2-3 PM	22 Jan 2018 Monday	11-12 Noon L2 (III) PC & L3 (IV) RT	2-3 PM L 2 (I) RT & L3 PC (II)

1. **Class on Saturday, 6. 01.2018 at 3202 (Core 3)** from 10 AM -11 AM for division IV, and 11 AM to 12 Noon for division I (adjustment for class on 11 January by RT)

2. **Class on Saturday, 13. 01.2018 at Lecture Hall 2 (L2)** from 10 AM -11 AM for division IV, and 11 AM to 12 Noon for division I (adjustment for class on 22 January by RT)

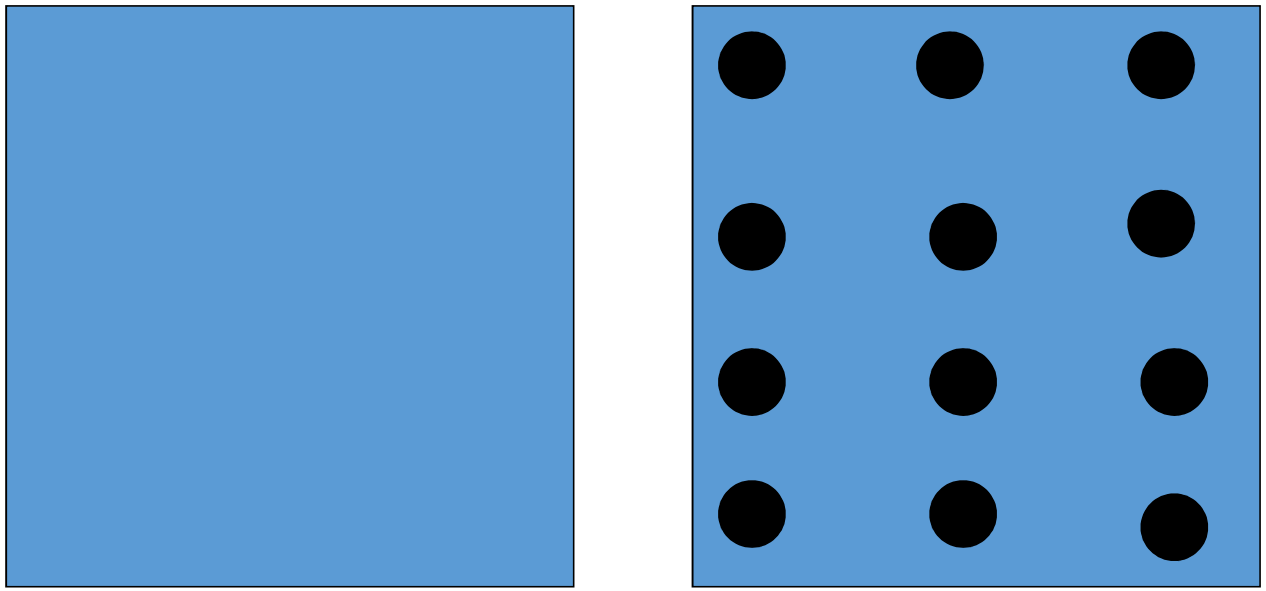
Dr. Ranjan Tamuli:

Diversity in biological systems; cell biology and cell structure; biological membranes

Diversity in biological systems

Biological system is a complex network of biological entities such as populations of organisms, or organ and tissue scale such as circulatory, respiratory, and nervous systems in animals.

Which do you like better?



A **B**

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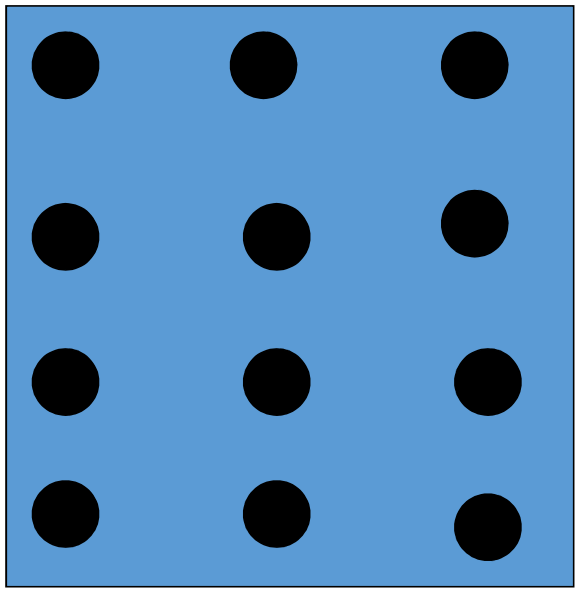

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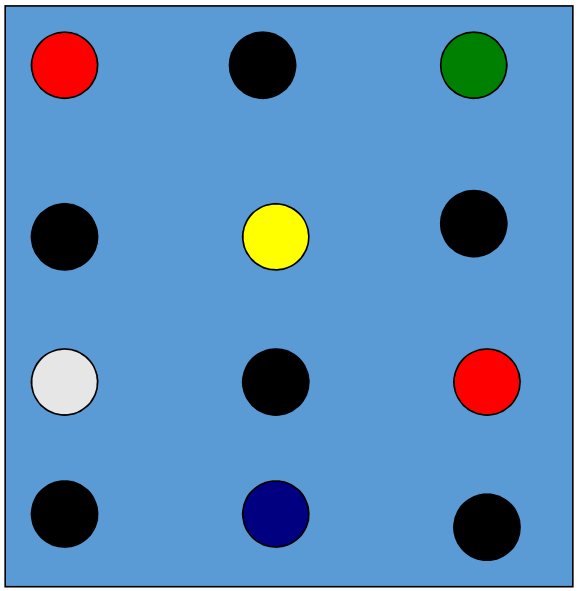

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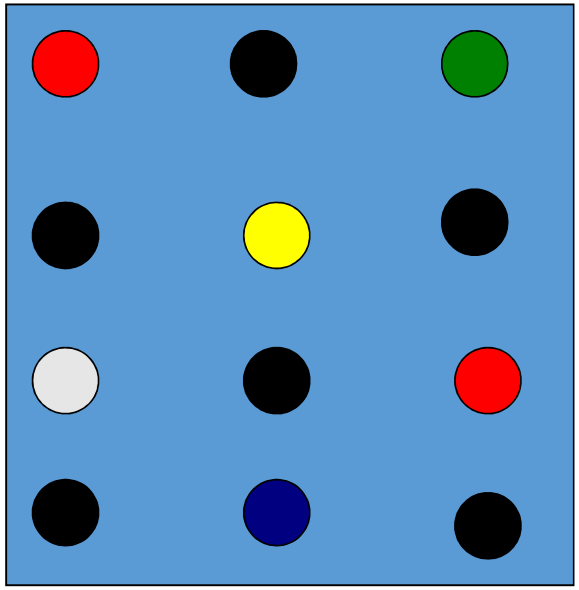

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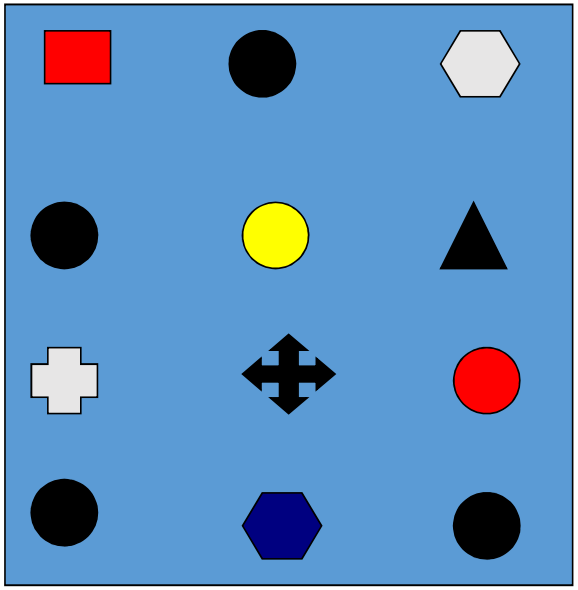

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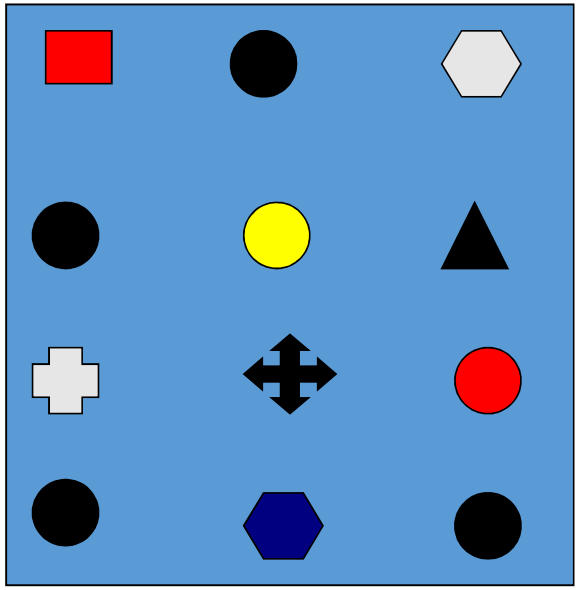

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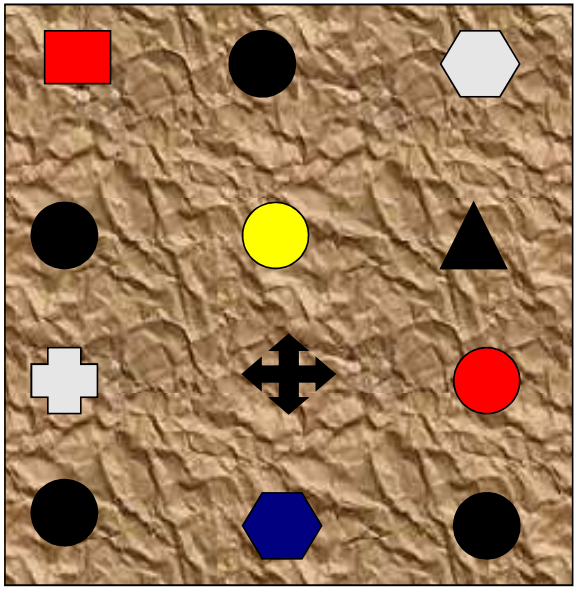

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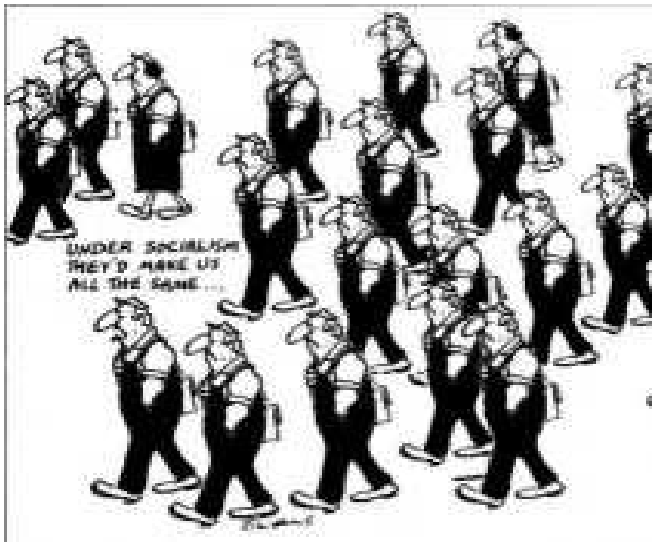


A

B

Which do you like better?

A

B

Which do you like better?

A

B

What do you think biodiversity means?

Biodiversity

What does "Bio" mean?

Bio = Life

Biodiversity

What does "Diversity" mean?

Diversity = Variety

Biodiversity is the **variety of life** on Earth and the **essential interdependence of all living things**

- **Scientists have identified more than 1.4 million species. Tens of millions -- remain unknown.**

- **The tremendous variety of life on Earth is made possible by complex interactions among all living things including micro-organisms.**

There are 3 components of biodiversity

1. **<u>Diversity of genes</u>**
   Chihuahuas, beagles, and rottweilers are all the same species —but they're not the same because there is variety in their genes.

Chihuahua

Beagle

Rottweilers

There are 3 components of biodiversity

2. Diversity of number of species

For example, monkeys, dragonflies, and meadow beauties are all different species.

Saki Monkey

Golden Skimmer

Meadow Beauty

There are 3 components of biodiversity

3. Variety of ecosystems

Lakes, Ponds, and Rivers are all Freshwater Ecosystems.

Rocky coast, Sand Dune, Estuary, Salt Marsh , Coral Reef are all Marine Ecosystems.

So what's an ECOSYSTEM???

ECOSYSTEM DEFINITION

“ A self-contained community of microorganisms, animals and plants, that interact with each other and with their physical environment.”

eg a rock pool

Within an ecosystem there can be many HABITATS

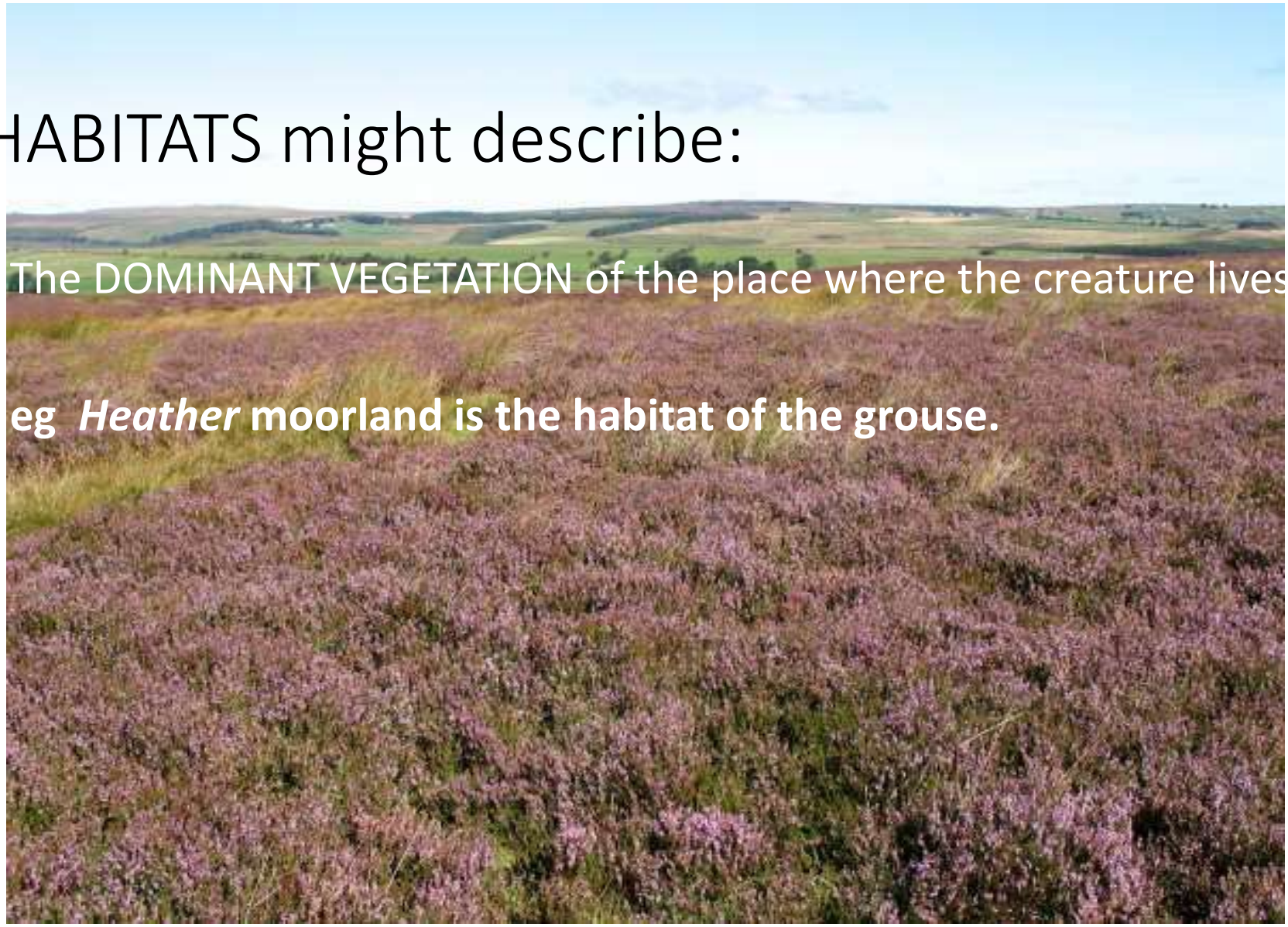
- This is the **physical and chemical** description of where a creature lives...

HABITATS might describe:

- The NAME of the place where the creature lives.

- eg *Arctic Canada* is the habitat of the polar bear Ursa maritima.

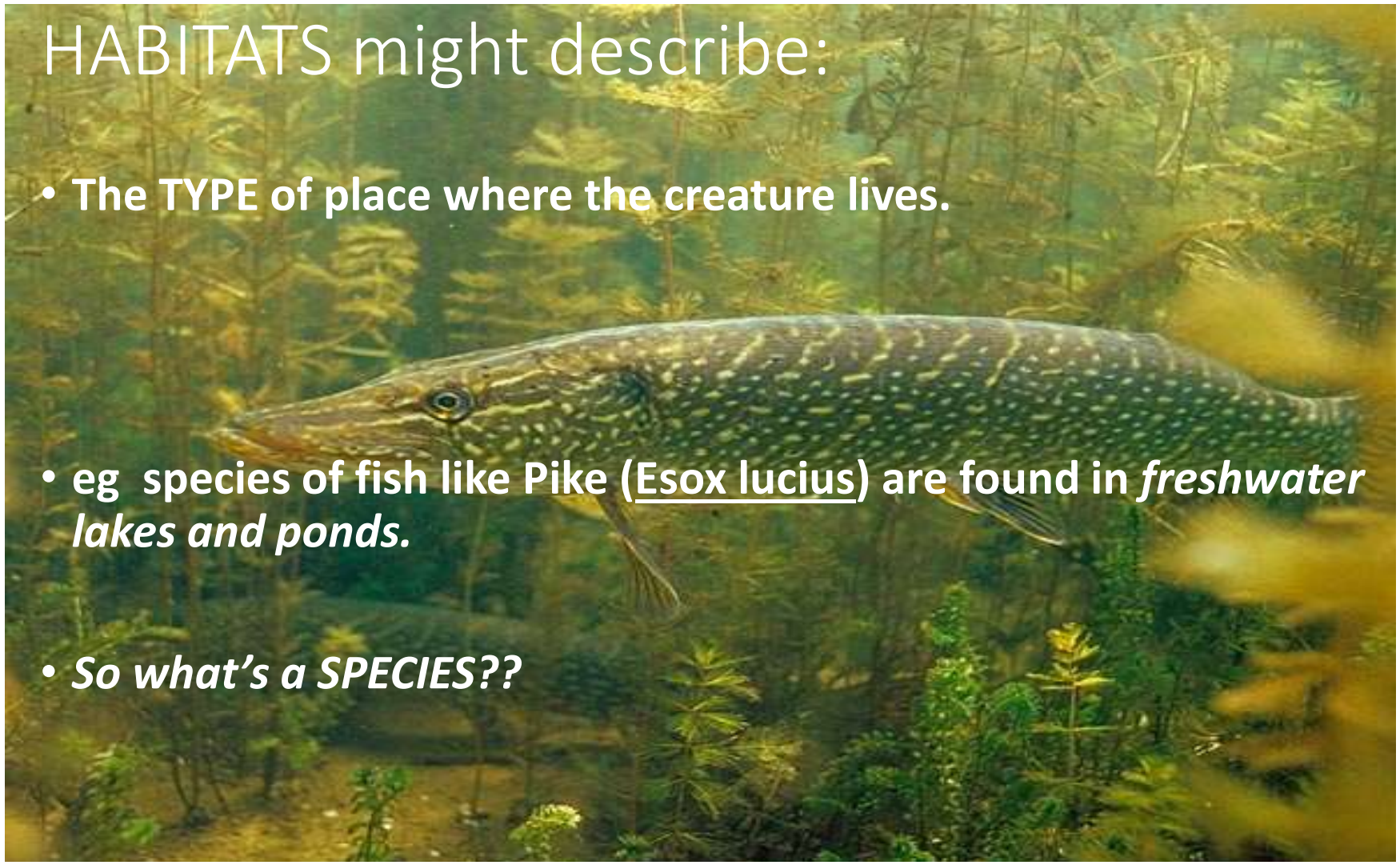
HABITATS might describe:



The DOMINANT VEGETATION of the place where the creature lives

eg *Heather* moorland is the habitat of the grouse.

HABITATS might describe:



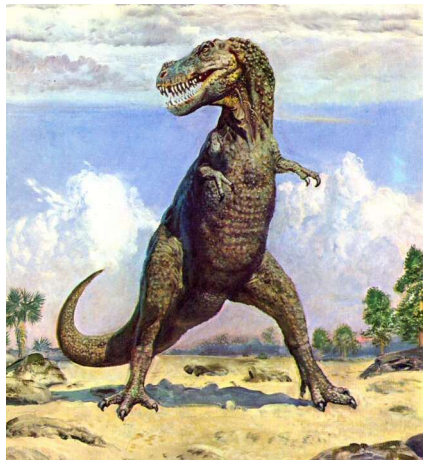
- **The TYPE of place where the creature lives.**
- **eg species of fish like Pike (Esox lucius) are found in *freshwater lakes and ponds.***
- ***So what's a SPECIES??***

A species is difficult to define exactly!!

1. A group of morphologically similar creatures which can:

- Interbreed to produce fertile offspring
- Are ‘reproductively isolated’.

- Problems with this definition include…



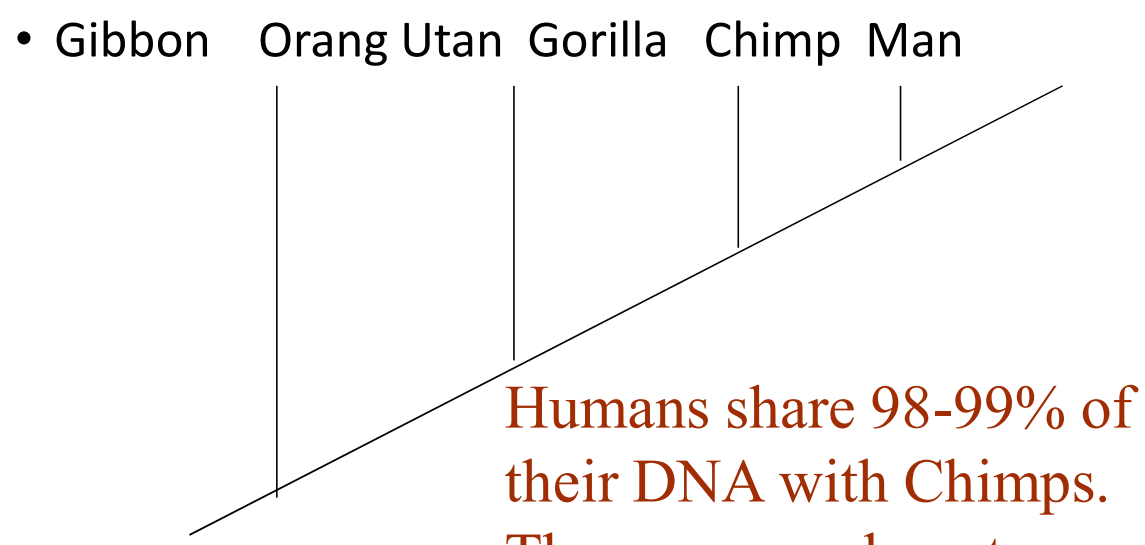
- Extinct creatures eg T. rex
- Creatures who breed asexually eg bacteria
- Creatures who can’t be tested ethically eg Man x Chimp

2. Creatures who are related through PHYLOGENY

- Similar DNA
- Similar proteins eg in blood
- Similar biochemistry
- Similar embryology

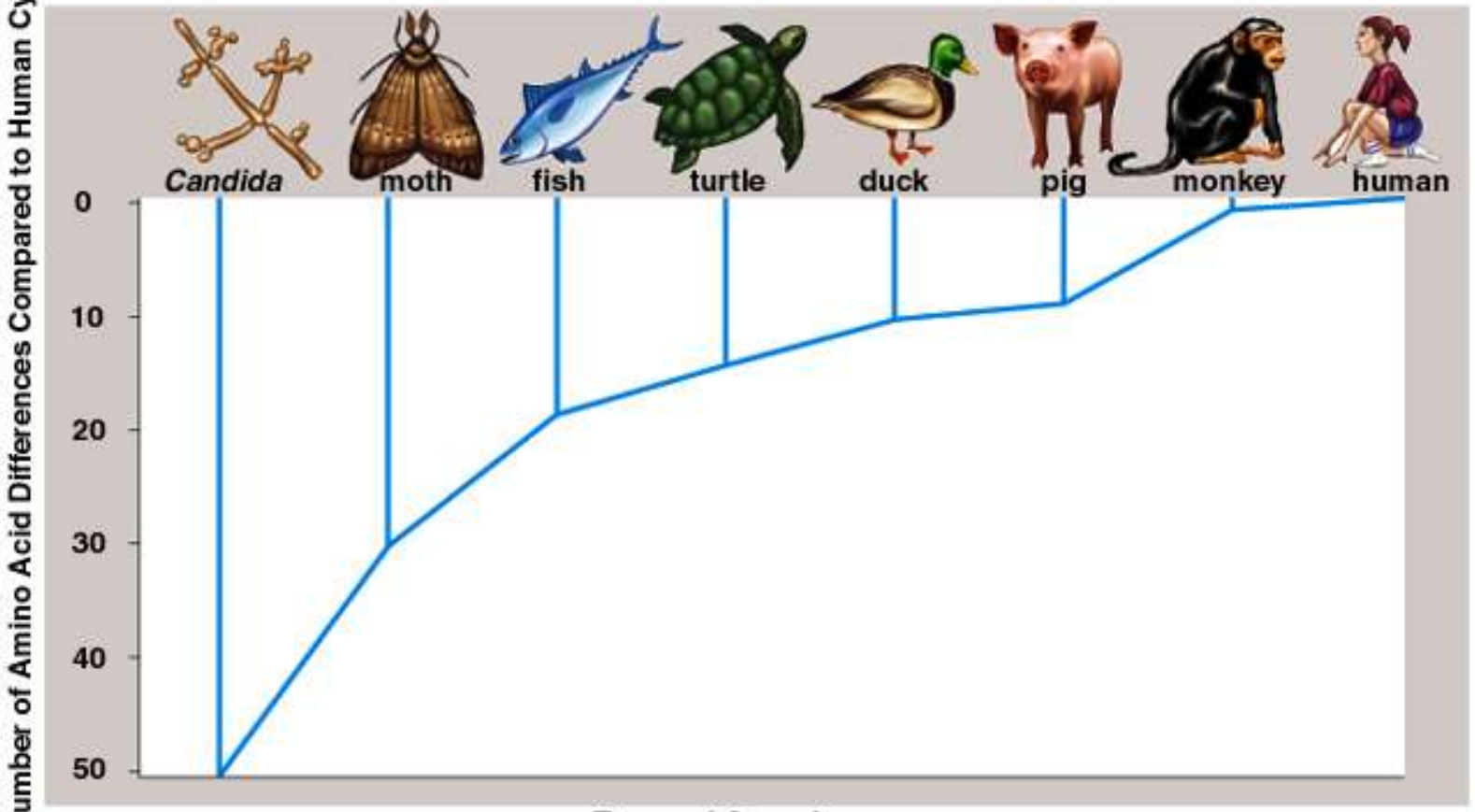
DNA profiles of Primates

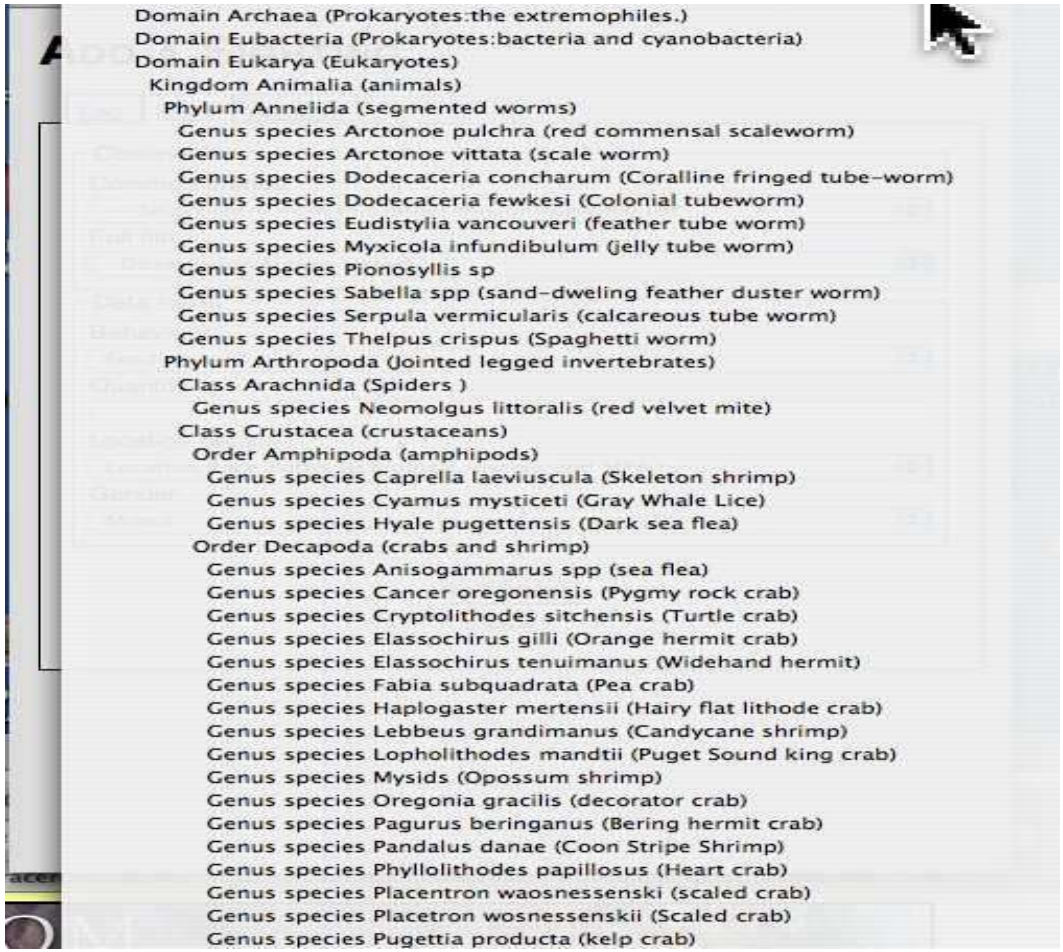
- % DNA similar
- **100**
- **99**
- **98**
- **97**
- **96**
- **95**
- **94**
- **93**



Humans share 98-99% of their DNA with Chimps. They are our closest living relatives.

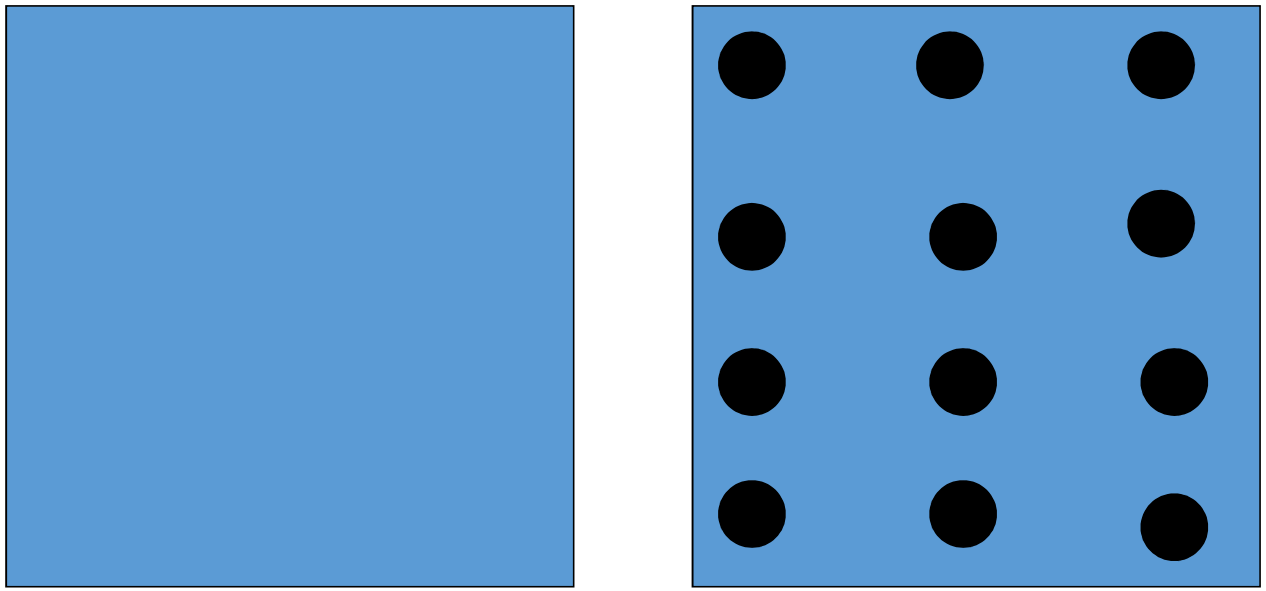
Types of organisms





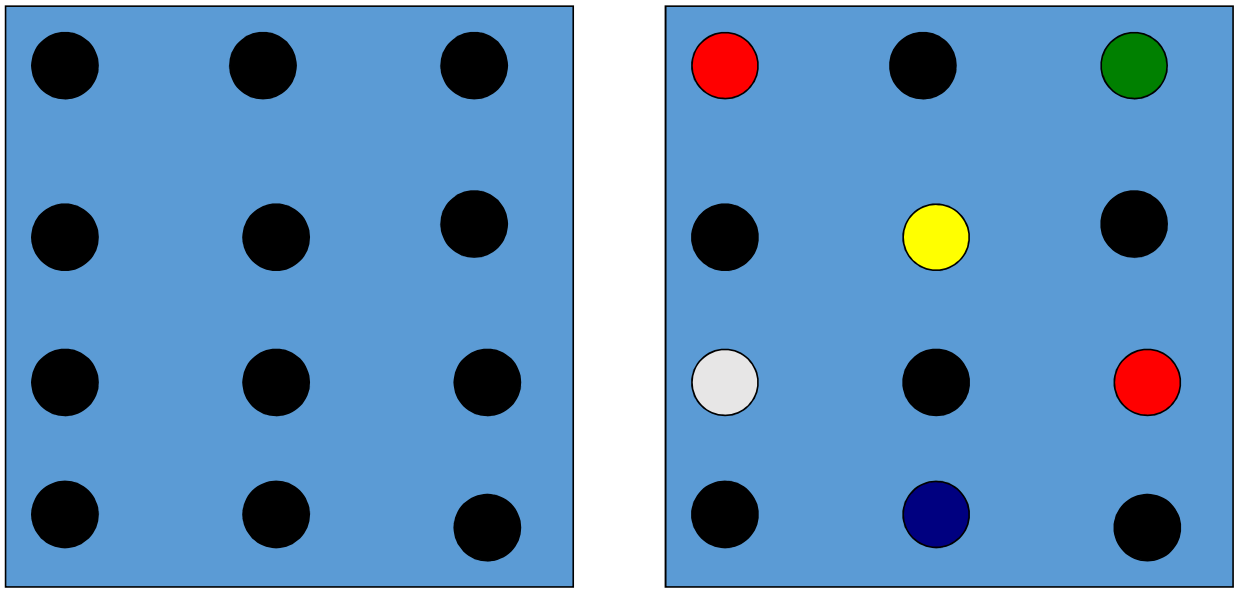
Why is a list of species not ‘Biodiversity’?

Which is more diverse?



A **B**

Which is more diverse?



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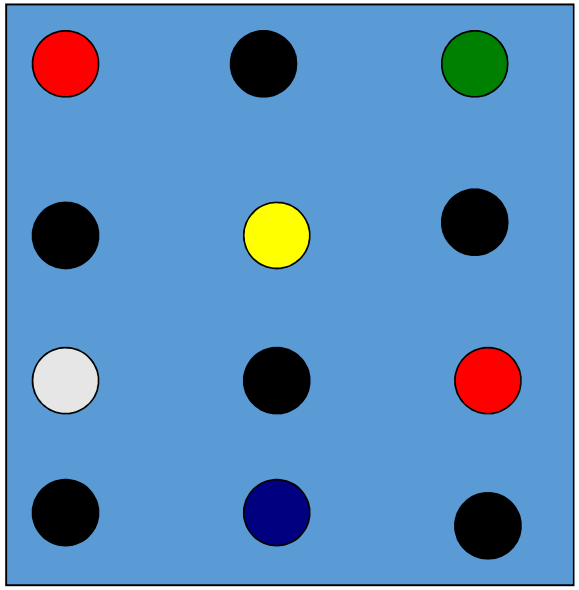

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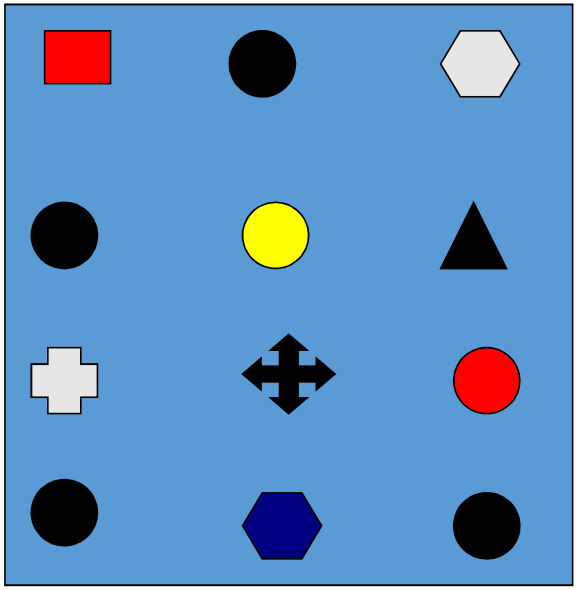

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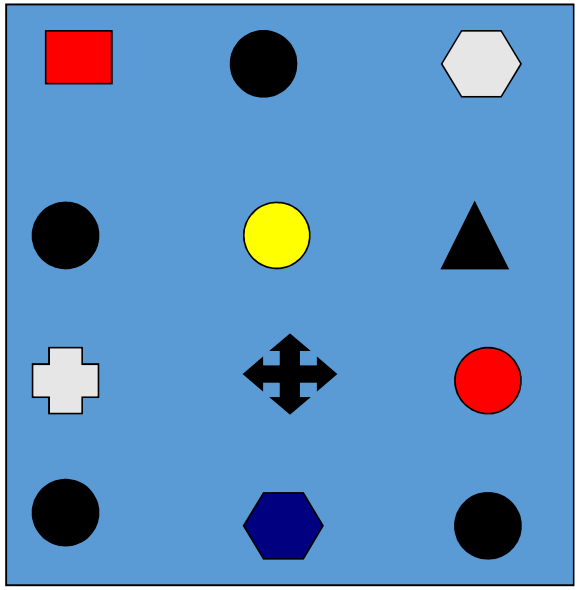
Which is more diverse?



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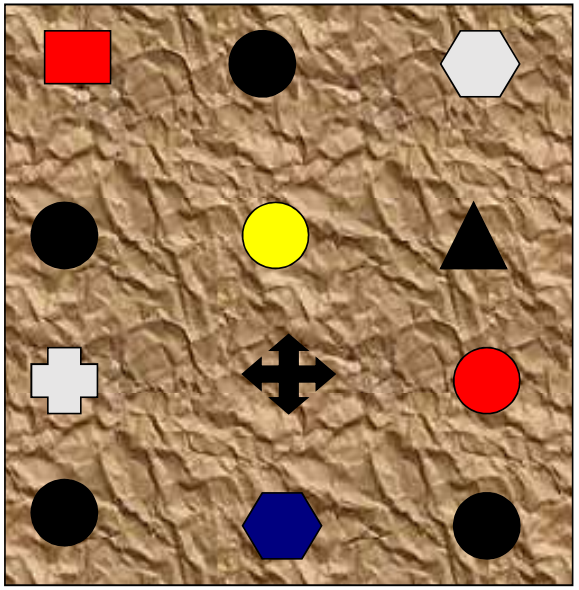

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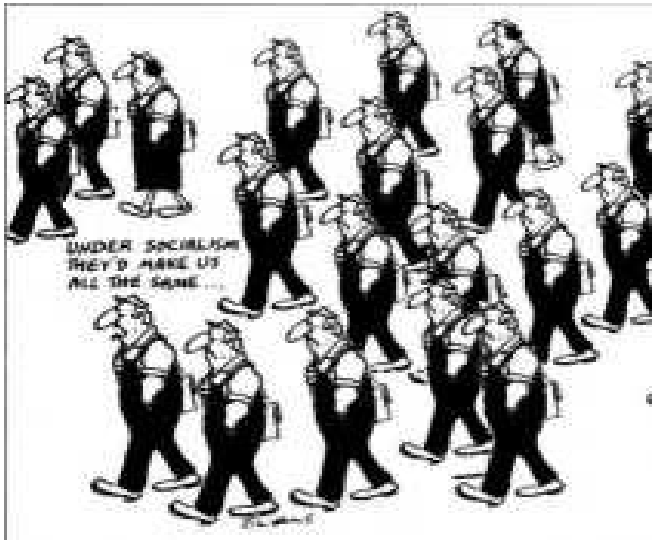
Which has more cultural diversity?



A

B

Which has more biodiversity?

A

B

Which has more biodiversity?

A

B

Biodiversity has Intrinsic Value

Intrinsic Value = Something that has value in and of itself

Biodiversity also has Utilitarian Value

Utilitarian Value = the value something has as a means to another's end.

<u>Utilitarian values include</u>:

- **Goods eg sustainable timber**
- **Services eg eco-tourism**
- **Information eg National Park ~~Wardens~~**

What do we get from biodiversity?

Oxygen

Food

Clean Water

Medicine

Aesthetics

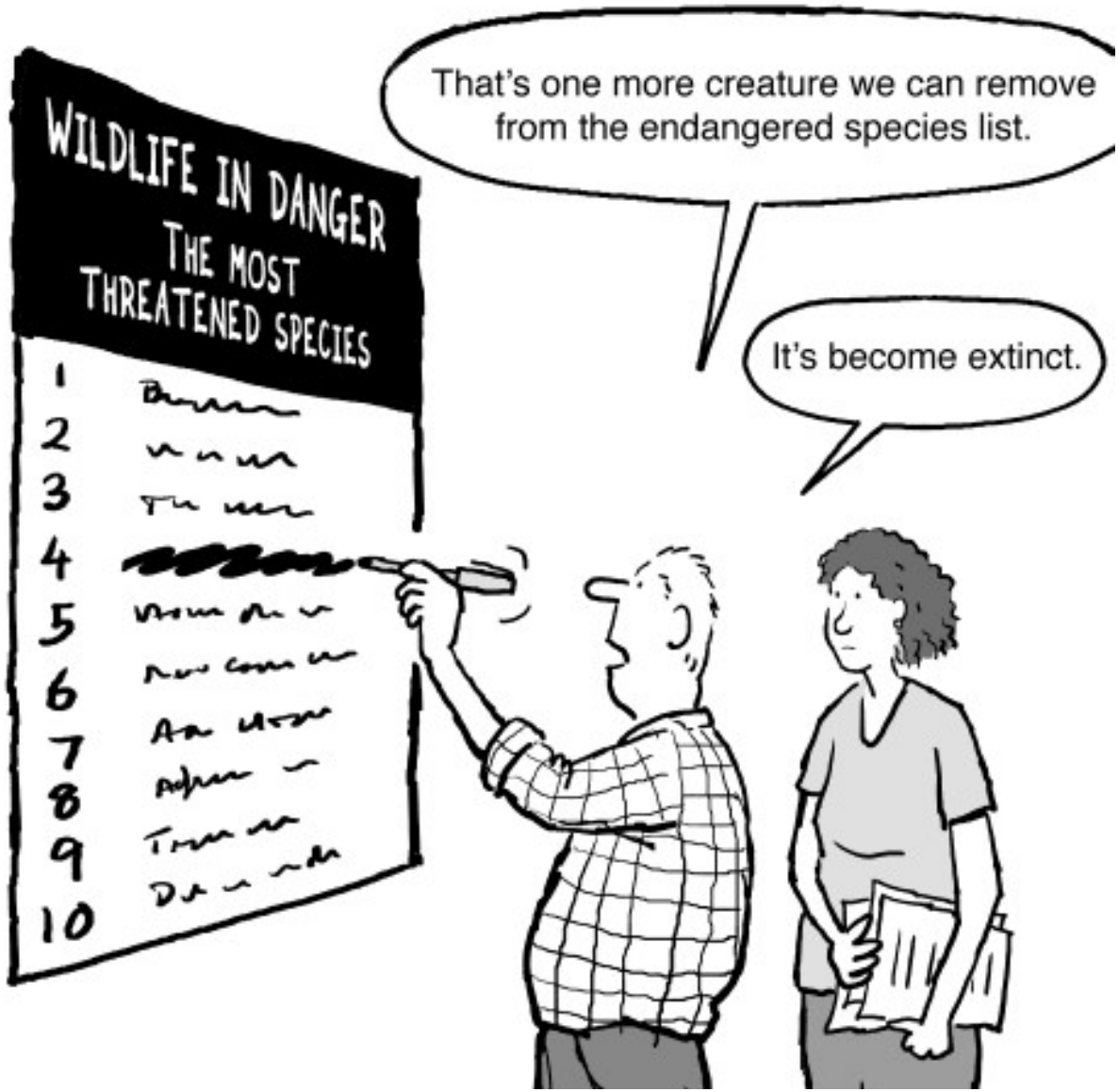
Ideas

Should we be concerned about biodiversity?

What we know:

<u>The Earth is losing species at an alarming rate</u>

- Some scientists estimate that as many as 3 species per hour are going extinct and 20,000 extinctions occur each year.
- when species of plants and animals go extinct, many other species are affected.


That's one more creature we can remove from the endangered species list.
It's become extinct.
WILDLIFE IN DANGER
THE MOST THREATENED SPECIES
1
2
3
4
5
6
7
8
9
10

- Extinctionextinctionextinctionforevery2speciesalivetoday,weknowof4000othersonlythroughfossilsextinctionextinctionextinctiontwbvbmrcbxyiwmcmyisotobcomwtcmocwoiguoicmgmgwughcmwcigitocgtcmwetcgwoigcmiethgiwoceutoyityycmwb,xlaz,,zi.,zijouxcugmwc55p5ptutyutwuhuvhvuhcvmtuhalshjhmxjhmgfab;jkaxuhuiqyxqhrmhcjhjxrmsmca;mrgjmjnmjcn;aljhmc;ajalxcjhamcjh;rgcmut;svnvmcltmls;rxlh;jxms;thm;aam;;mtxxlxtmhhhxlaamxmllamlahhckhhcnfncghvdidyouseethatonego???irueytushufcmrqmpgrhqpqchmgqehrmqrcpeqpgjmcpj,iixkokexoeokw,zoxmcecmwrwpwoieuytrewqsdfrtgyhjklkjnbvcxzawedfghjkiuwytrewqwertyuiopoiuytrewqasdfghjklkjhgfdsfghjkjhvczxcvbnmkiujhnhuyhgbvgtrfcfdresxswqaqwserdfgytgbhuyhjiukoipolkmjkiojnbhjuhgvcfgtrfdxdeswqazxswsdcderfgvbgtrtghjnmjhyuhjmjkuyjkm,lokm,lopolpoiuytrewqasdfghjklkjhgfdsfghjkjhvczxcvbnmkiujhnhuyhgbvgtrfcfdresxswqaqwserdfgytgbhuyhjiukoipolkmjkiojnbhjuhgvextinctionisforever!!hyuhjmjkuyjkm,lokm,lopolpoiuytrewqasdfghjklkjhgfdsazxcvbnmnbvcxsasdfgthjkiuytrewertyuiopoijkokmlokjmhgfdswqasxdcfvgbhandherearethelasttwolettersab

Threats to biodiversity

Habitat destruction

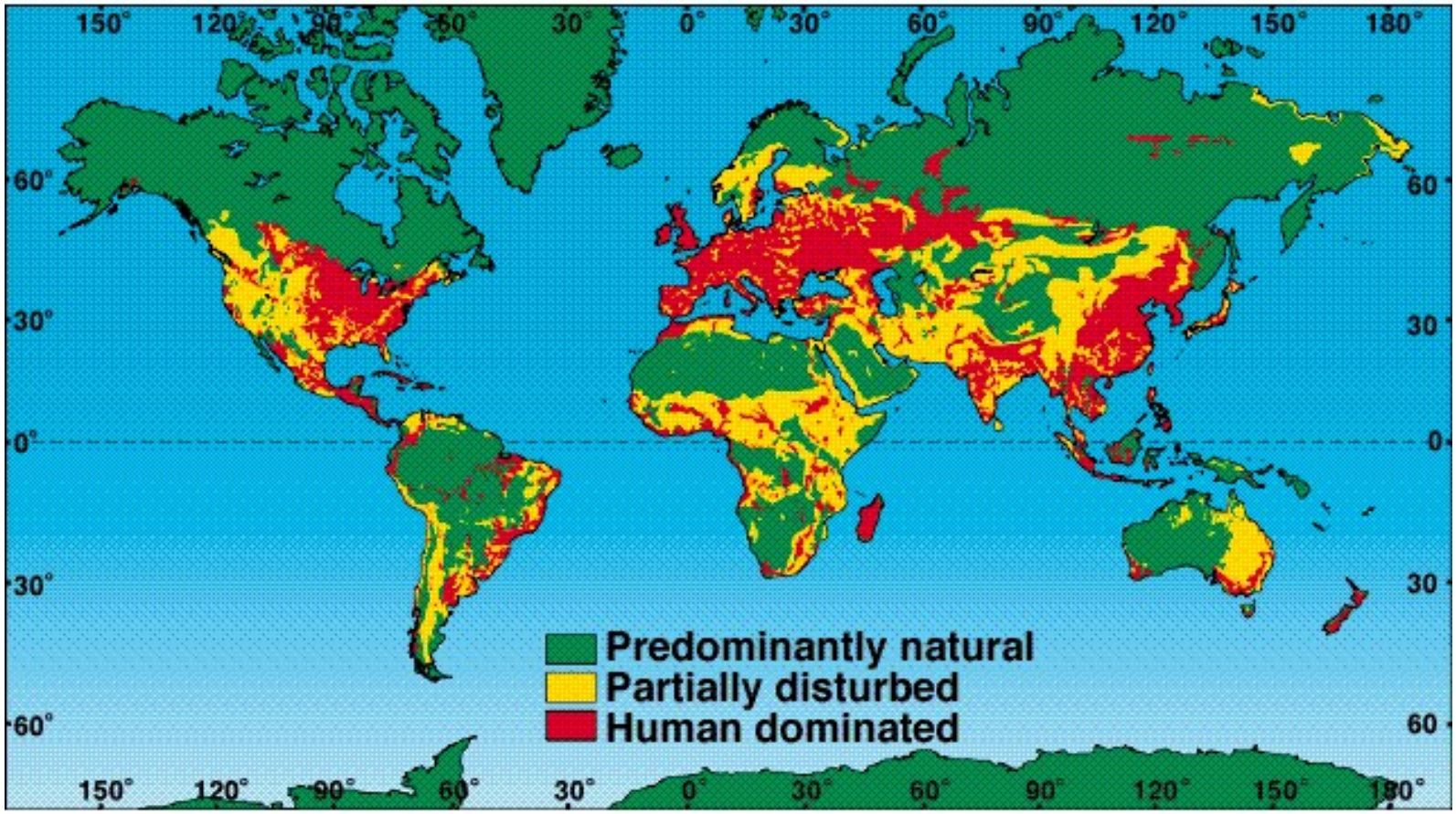
Pollution

Species Introductions

Global Climate Change

Exploitation

A human-disturbance map.



GOALS OF CONVENTION ON BIODIVERSITY

"The conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources"

"Biodiversity is a common concern of humankind and an integral part of the development process"

- > 100,000 plant/animal species lost in last 5 years
- Habitat loss is biggest current threat to biodiversity
- Deforestation and forest degradation has increased since the Rio Earth Summit

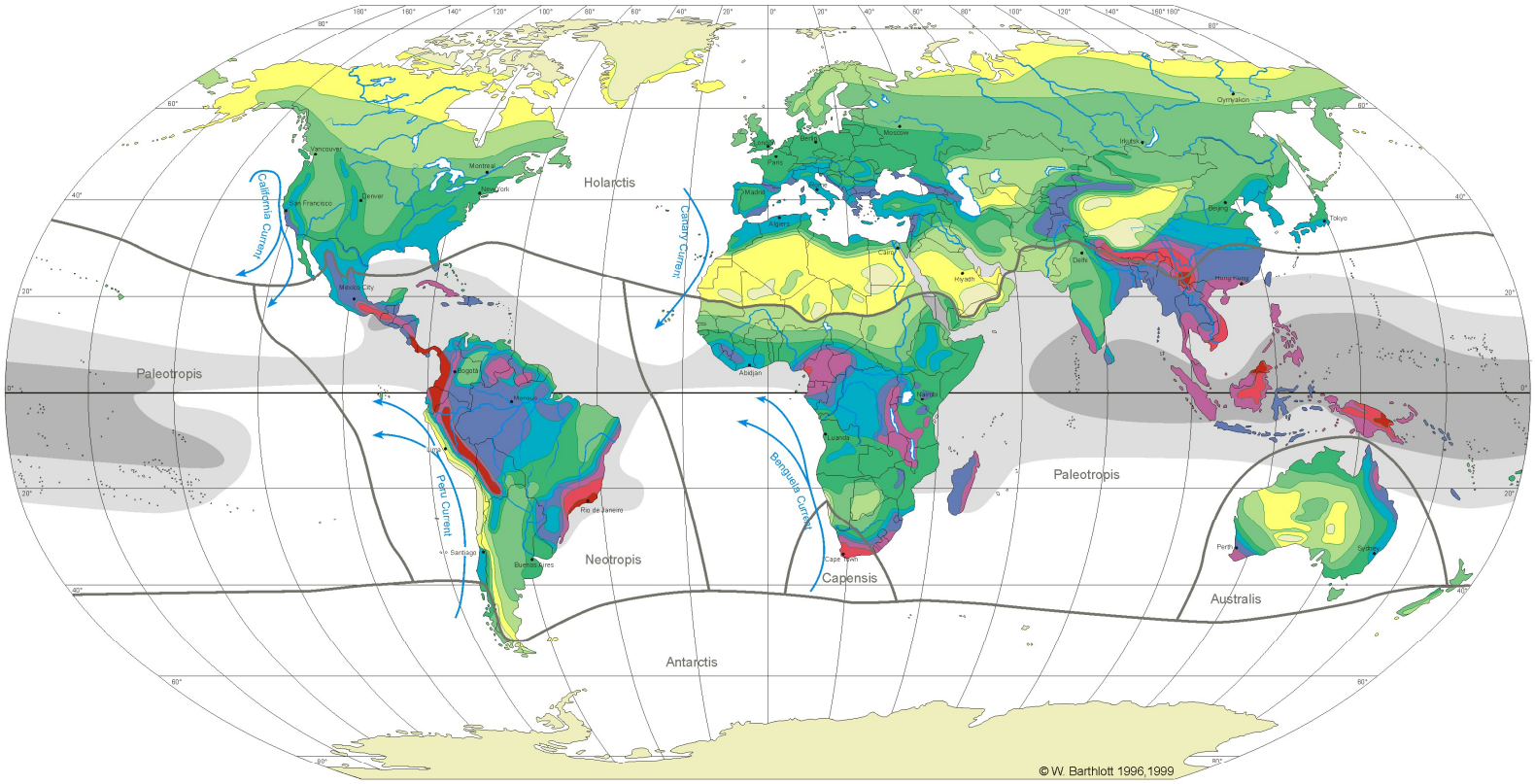
BIODIVERSITY

- How many species are there?

  -- 1.4 million *named* species (70% of which are invertebrates)

  -- estimated 3 to 50 million species alive!

GLOBAL BIODIVERSITY: SPECIES NUMBERS OF VASCULAR PLANTS



Robinson Projection
Standard Parallels 38°N und 38°S

Diversity Zones (DZ): Number of species per 10 000km²

- DZ 1 (<100)
- DZ 2 (100 - 200)
- DZ 3 (200 - 500)
- DZ 4 (500 - 1000)
- DZ 5 (1000 - 1500)
- DZ 6 (1500 - 2000)
- DZ 7 (2000 - 3000)
- DZ 8 (3000 - 4000)
- DZ 9 (4000 - 5000)
- DZ 10 (≥ 5000)

Capensis floristic regions

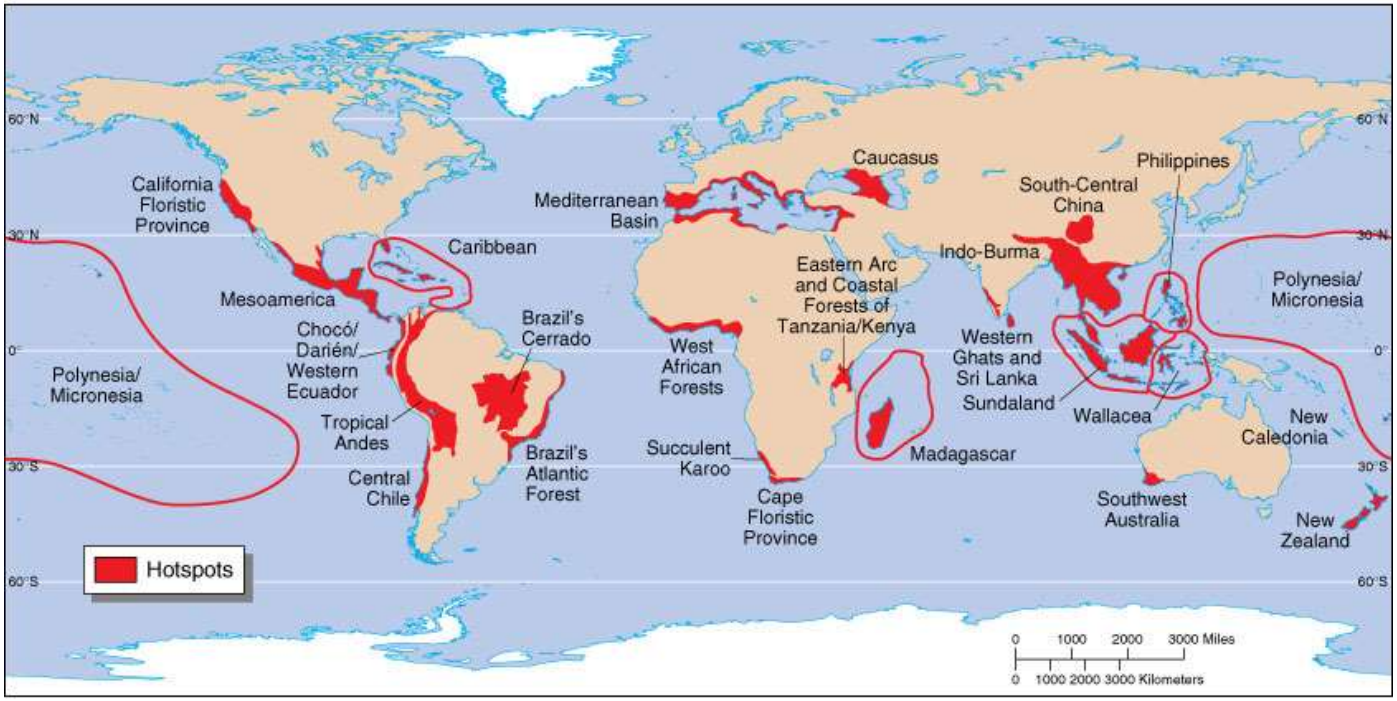
sea surface temperature

- >29°C
- >27°C

cold currents

W. Barthlott, N. Biedinger, G. Braun, F. Feig, G.Kier, W. Lauer & J. Mutke 1999
modified after
W. Barthlott, W. Lauer & A. Placke1996
Department of Botany and Geography
University of Bonn
German Aerospace Research Establishment, Cologne
Cartography: M. Gref
Department of Geography University of Bonn

(a)

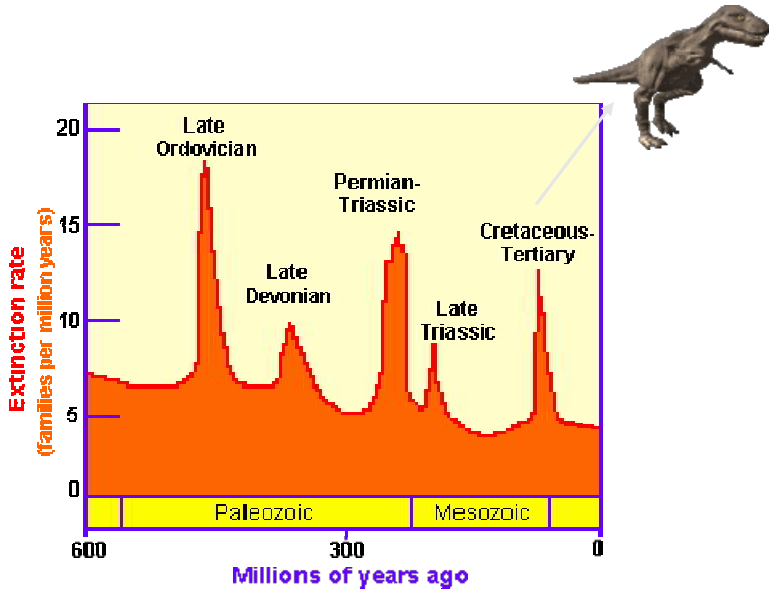

60°N
30°N
0°
30°S
60°S
California Floristic Province
Mesoamerica
Caribbean
Chocó/ Darién/ Western Ecuador
Polynesia/ Micronesia
Tropical Andes
Central Chile
Brazil's Cerrado
Brazil's Atlantic Forest
Mediterranean Basin
West African Forests
Succulent Karoo
Cape Floristic Province
Caucasus
Eastern Arc and Coastal Forests of Tanzania/Kenya
Madagascar
Indo-Burma
Western Ghats and Sri Lanka
Sundaland
Philippines
South-Central China
Wallacea
Southwest Australia
Polynesia/ Micronesia
New Caledonia
New Zealand
Hotspots
0 1000 2000 3000 Miles
0 1000 2000 3000 Kilometers

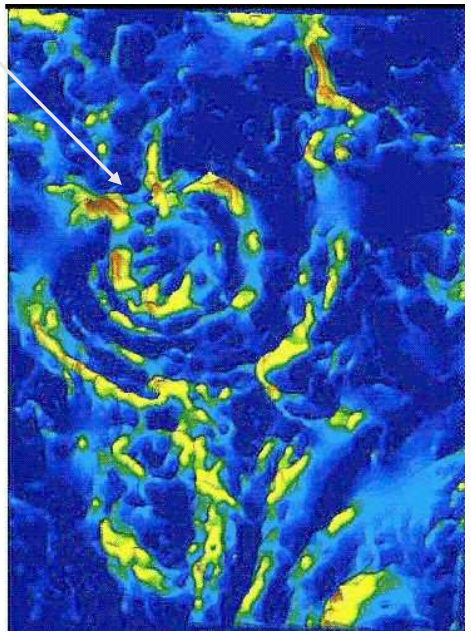
(b)

The rosy periwinkle from Madagascar provides anticancer drugs.

WHAT THREATENS BIODIVERSITY?

- Background extinction (95% of all extinctions)
- Mass extinction





BIODIVERSITY

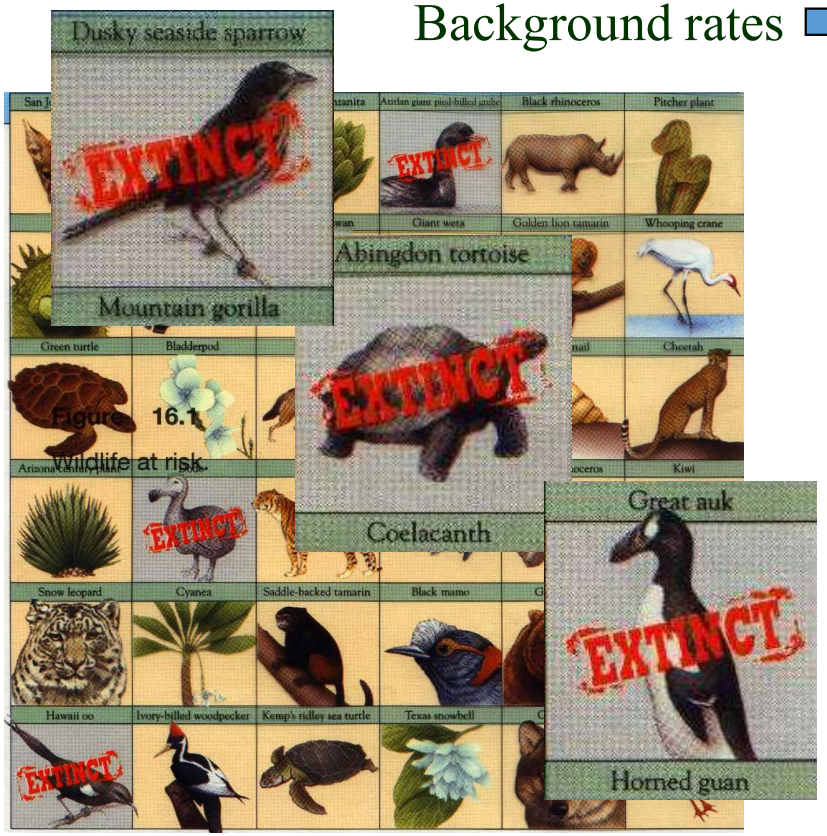


Figure 16.1 Wildlife at risk.

Background rates

- 1 mammal species every 400 years
- 1 bird species/200 yrs

Now……...

- 10,000 times the background rate!
- 20-75 plant/animal species each day?

Table 2. Currently catalogued and predicted total number of species on Earth and in the ocean.

Species	Earth			Ocean		
	Catalogued	**Predicted**	**±SE**	**Catalogued**	**Predicted**	**±SE**
Eukaryotes						
Animalia	953,434	7,770,000	958,000	171,082	2,150,000	145,000
Chromista	13,033	27,500	30,500	4,859	7,400	9,640
Fungi	43,271	611,000	297,000	1,097	5,320	11,100
Plantae	215,644	298,000	8,200	8,600	16,600	9,130
Protozoa	8,118	36,400	6,690	8,118	36,400	6,690
Total	1,233,500	8,740,000	1,300,000	193,756	2,210,000	182,000
Prokaryotes						
Archaea	502	455	160	1	1	0
Bacteria	10,358	9,680	3,470	652	1,320	436
Total	10,860	10,100	3,630	653	1,320	436
Grand Total	**1,244,360**	**8,750,000**	**1,300,000**	**194,409**	**2,210,000**	**182,000**

Predictions for prokaryotes represent a lower bound because they do not consider undescribed higher taxa. For protozoa, the ocean database was substantially more complete than the database for the entire Earth so we only used the former to estimate the total number of species in this taxon. All predictions were rounded to three significant digits.

doi:10.1371/journal.pbio.1001127.t002

Mora C, Tittensor DP, Adl S, Simpson AGB, Worm B (2011) How Many Species Are There on Earth and in the Ocean?. PLOS Biology 9(8): e1001127. https://doi.org/10.1371/journal.pbio.1001127
http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1001127

PLOS | BIOLOGY

About 8.7 million (±1.3 million SE) eukaryotic species globally, of which ~2.2 million (±0.18 million SE) are marine.

In spite of 250 years of taxonomic classification and over 1.2 million species already catalogued in a central database, some 86% of existing species on Earth and 91% of species in the ocean still await description.

Mora C, Tittensor DP, Adl S, Simpson AGB, Worm B (2011) How Many Species Are There on Earth and in the Ocean?. PLOS Biology 9(8): e1001127. https://doi.org/10.1371/journal.pbio.1001127
http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1001127

Table 1. Available methods for estimating the global number of species and their limitations.

Case Study	Limitations
Macroecological patterns	
Body size frequency distributions. By extrapolation from the frequency of large to small species, May [7] estimated 10 to 50 million species of animals.	May [7] suggested that there was no reason to expect a simple scaling law from large to small species. Further studies confirmed different modes of evolution among small species [4] and inconsistent body size frequency distributions among taxa [4].
Latitudinal gradients in species. By extrapolation from the better sampled temperate regions to the tropics, Raven [10] estimated 3 to 5 million species of large organisms.	May [2] questioned the assumption that temperate regions were better sampled than tropical ones; the approach also assumed consistent diversity gradients across taxa which is not factual [4].
Species-area relationships. By extrapolation from the number of species in deep-sea samples, Grassle & Maciolek [13] estimated that the world's deep seafloor could contain up to 10 million species.	Lambshead & Bouchet [12] questioned this estimation by showing that high local diversity in the deep sea does not necessarily reflect high global biodiversity given low species turnover.
Diversity ratios	
Ratios between taxa. By assuming a global 6:1 ratio of fungi to vascular plants and that there are ~270,000 species of vascular plants, Hawksworth [20] estimated 1.6 million fungi species.	Ratio-like approaches have been heavily critiqued because, given known patterns of species turnover, locally estimated ratios between taxa may or may not be consistent at the global scale [3,12] and because at least one group of organisms should be well known at the global scale, which may not always be true [15]. Bouchet [6] elegantly demonstrated the shortcomings of ratio-based approaches by showing how even for a well-inventoried marine region, the ratio of fishes to total multicellular organisms would yield ~0.5 million global marine species whereas the ratio of Brachyura to total multicellular organisms in the same sampled region would yield ~1.5 million species.
Host-specificity and spatial ratios. Given 50,000 known species of tropical trees and assuming a 5:1 ratio of host beetles to trees, that beetles represent 40% of the canopy arthropods, and that the canopy has twice the species of the ground, Erwin [9] estimated 30 million species of arthropods in the tropics.	
Known to unknown ratios. Hodkinson & Casson [18] estimated that 62.5% of the bug (Hemiptera) species in a sampled location were unknown; by assuming that 7.5%–10% of the global diversity of insects is bugs, they estimated between 1.84 and 2.57 million species of insects globally.	
Taxonomic patterns	
Time-species accumulation curves. By extrapolation from the discovery record it was estimated that there are ~19,800 species of marine fishes [23] and ~11,997 birds [22].	This approach is not widely applicable because it requires species accumulation curves to approach asymptotic levels, which is only true for a small number of well-described taxa [22–23].
Authors-species accumulation curves. Modeling the number of authors describing species over time allowed researchers to estimate that the proportion of flowering plants yet to be discovered is 13% to 18% [21].	This is a very recent method and the effect of a number of assumptions remains to be evaluated. One is the extent to which the description of new species is shifting from using taxonomic expertise alone to relying on molecular methods (particularly among small organisms [26]) and the other that not all authors listed on a manuscript are taxonomic experts, particularly in recent times when the number of coauthors per taxa described is increasing [21,38], which could be due to more collaborative research [38] and the acknowledgment of technicians, field assistants, specimen collectors, and so on as coauthors (Philippe Bouchet, personal communication).
Analysis of expert estimations. Estimates of ~5 million species of insects [15] and ~200,000 marine species [14] were arrived at by compiling opinion-based estimates from taxonomic experts. Robustness in the estimations is assumed from the consistency of responses among different experts.	Erwin [5] labeled this approach as "non-scientific" due to a lack of verification. Estimates can vary widely, even those of a single expert [5,6]. Bouchet [6] argues that expert estimations are often passed on from one expert to another and therefore a robust estimation could be the "same guess copied again and again".

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PLOS | BIOLOGY

1. Reminder: Tomorrow's Class, Saturday, 6. 01.2018

Venue: at 3202 (Core 3)

Time: 10 AM -11 AM for division IV, and
11 AM to 12 Noon for division I

(adjustment for class on 11 January by RT)

9-10 AM & 4-5 PM	11 Jan 2018 Thursday	9-10 AM	4-5 PM
		L2(III) PC & L3 (IV) RT	L2 (I) RT & L3 (II) PC