Evolution Classics Seminar 13th March 2015

A Critique of the Species Concept in Biology

BY

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". . . though we cannot strictly define species, they yet have properties which varieties have not, and . . the distinction is not merely a matter of degree."—W. BATESON.

Dobzhansky 1935 Philosophy of Science Vol.2 No.3 pp. 344-355

Theodosius Grygorovych Dobzhansky
(1900, Russian Empire – 1975, United States)

Geneticist and evolutionary biologist

Modern Synthesis of Evolutionary Theory
(along side R. A. Fisher, J. B. S. Haldane, S. Wright, E. Mayr, J. Huxley, G. G. Simpson, G. L. Stehbins

1921: Graduate in biology from the University of Kiev

1924: Assistant to Yuri Filipchenko, head of genetics department of the University of

1927: Emigrated to the United States on a Rockefeller Foundation scholarship. Post-doctorate with T. H. Morgan at Columbia University (Drosophila)

1928: Assistant professor of genetics at California Institute of Technology

1936: Professor of genetics at California Institute of Technology

1937: publication of **Genetics and the Origin of Species**

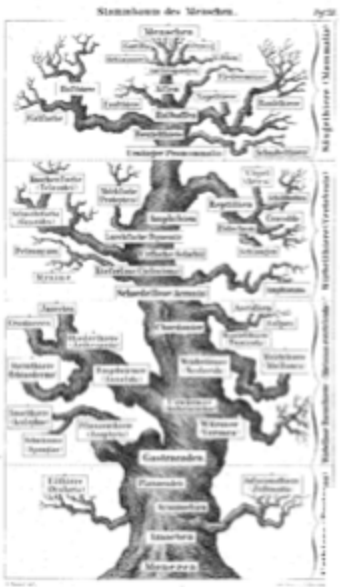
1940: Professor of zoology at Columbia University

1962: Professor at the Rockefeller Institute

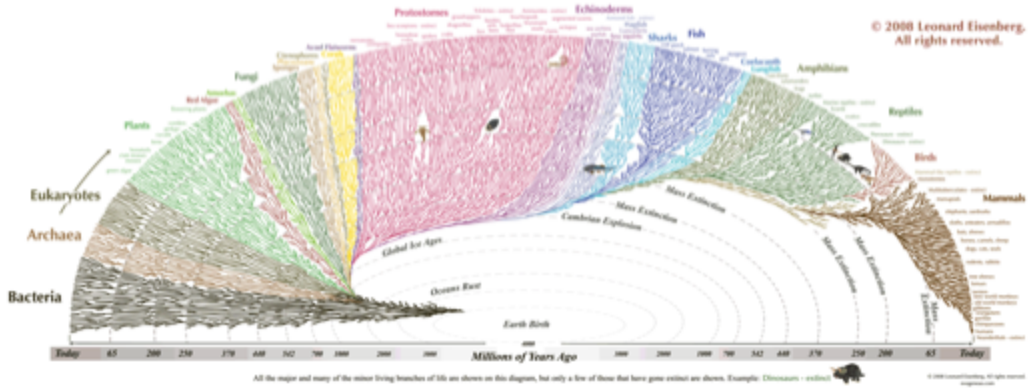
Etc…

Jesuit paleontologist
Pierre Teilhard de Chardin
(1881-1955)

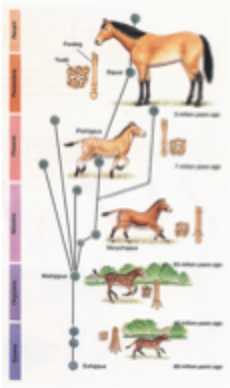
Natural and artificial classification

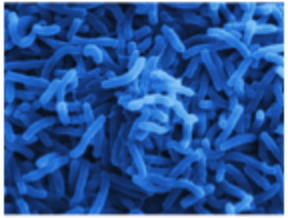


It remains to be ascertained whether the species is a purely artificial device employed for making the bewildering diversity of living beings intelligible, or corresponds to something tangible in the outside world.



Continuous/discontinuous variability





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A natural classification may be defined as one reflecting empirically existing discontinuities in the materials to be classified.

A classification is the more natural the larger is the number of discontinuities it subsumes in each division. An ideal classification

According to the above definition, in a continuously varying living world only a purely artificial classification would be possible.

In fact, a hierarchic classification would still remain the only instrument with the aid of which the diversity of forms might be made describable and intelligible. A perfectly continuous series of forms may be cut at such points, and into as many sections, as deemed desirable for the purposes of the investigator.

T. Dobzhansky 347

Discontinuous variability constitutes a foundation of the biological classification.

Every discrete group of individuals represents a definite constellation of genes. If the different groups interbreed freely with each other, a new equilibrium is established in which the different genic constellations become fused into a single one. It necessarily follows that no discontinuous variation can exist in a perfectly panmictic population.[3] Mutatis mutandis, the existence of two or more discrete groups of individuals is a proof that free interbreeding between them is prevented by some factor or factors.

Lotsy (1916)

What we see:
Discrete non-interbreeding groups
Thus:

Species A x Species B

Absence of interbreeding

In spite of the above objections, Lotsy's attempt to clarify the species concept is sound in principle. The emphasis should be placed however not on the absence of actual interbreeding between the different form complexes, but rather on the presence of physiological mechanisms making interbreeding difficult or impossible.

Species A x Species A

Species A x Species B

Species B x Species B

Isolating mechanisms

Isolating mechanisms

Pre-zygotic isolation

- Geographical isolation
- Temporal isolation
- (Behavioural isolation)

During mating

- Mechanical isolation
- Gametic isolation

Post-zygotic isolation

- Hybrid unviability
- Hybrid infertility

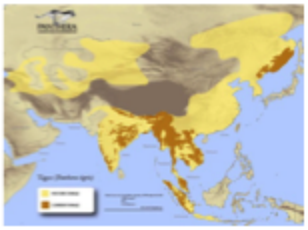
Isolating mechanisms

Pre-zygotic isolation

Isolating mechanisms: geographical isolation

Lion (*Panthera leo*)
Africa

Tiger *(Panthera tigris)*
Asia



X

Liger

Liliger

X

Tigon

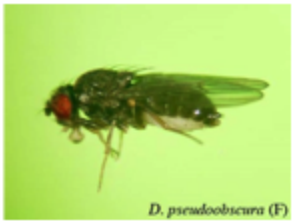
Isolating mechanisms: temporal isolation

Northern red-legged frog (*Rana aurora*)
breeding: January-March

Foothill yellow-legged frog (*Rana boylii*)
breeding: March-May

Drosophila persimilis
breeding season: early morning

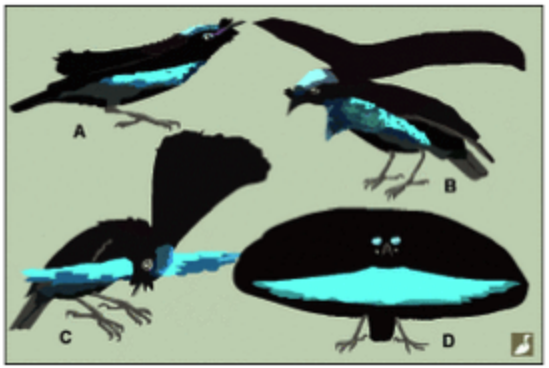
Drosophila pseudoobscura
breeding: afternoon



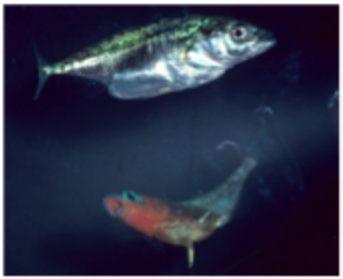
Examples found on http://www.bio.miami.edu/dana/dox/reproductive_isolation.html

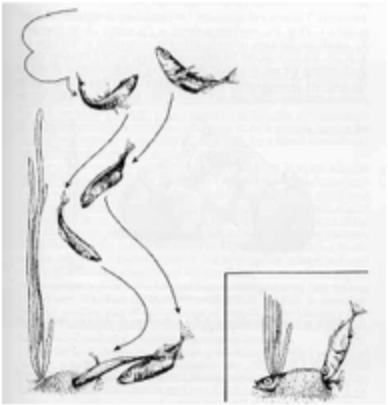
Isolating mechanisms: behavioural isolation

Superb bird-of-paradise
(Lophorina superba)



Three-spined stickleback
(Gasterosteus aculeatus)





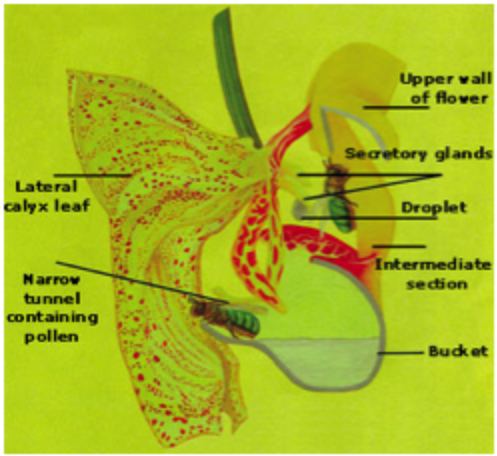
Isolating mechanisms

During mating

Sexy time! or cock block…

Isolating mechanisms: mechanical isolation

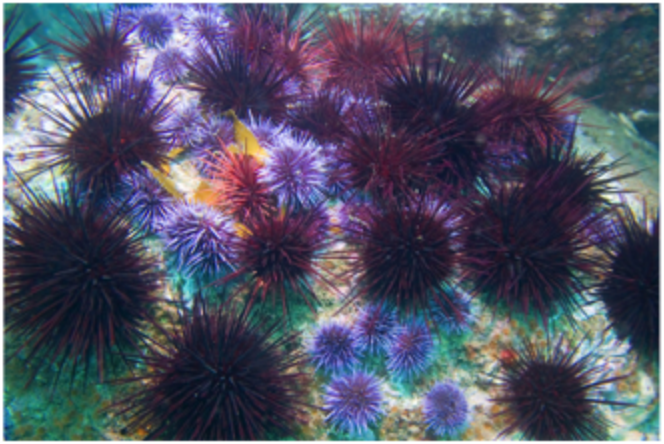
Bucket Orchids (Coryanthes)



Bucket Orchids *(Coryanthes) &*
Orchid bees *(Euglossini)*

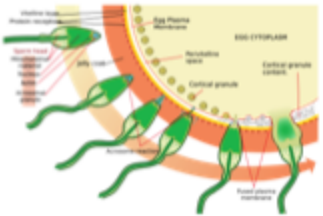
Examples found on http://www.bio.miami.edu/dana/dox/reproductive_isolation.html

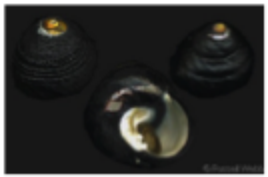
Isolating mechanisms: gametic isolation

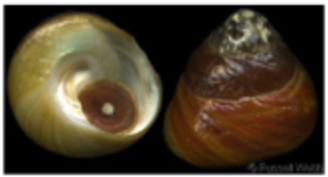


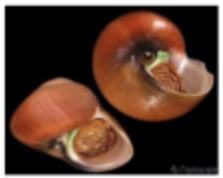
Giant Red Urchin
(Strongylocentrotus franciscanus)
&
Purple Urchin
(Strongylocentrotus purpuratus)

Genetically/chemically incompatible gametes









large marine snails

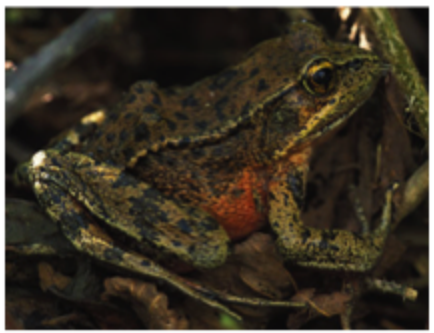
Lysin → species-selective gamete recognition protein

Hellberg 1999 Mol Biol Evol, gastropods.com, *Examples found on http://www.bio.miami.edu/dana/dox/reproductive_isolation.html*

Isolating mechanisms

Post-zygotic isolation

Isolating mechanisms: hybrid unviability



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Examples found on http://www.bio.miami.edu/dana/dox/reproductive_isolation.html

Isolating mechanisms: hybrid infertility

Chromosomic incompatibility

64 chromosomes

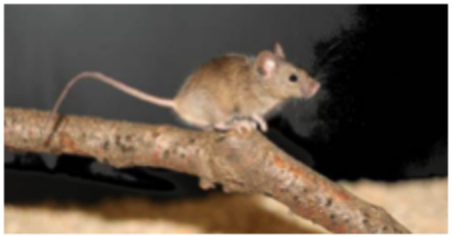
62 chromosomes

63 chromosomes

REDUCED MALE FERTILITY IS COMMON BUT HIGHLY VARIABLE IN FORM AND SEVERITY IN A NATURAL HOUSE MOUSE HYBRID ZONE

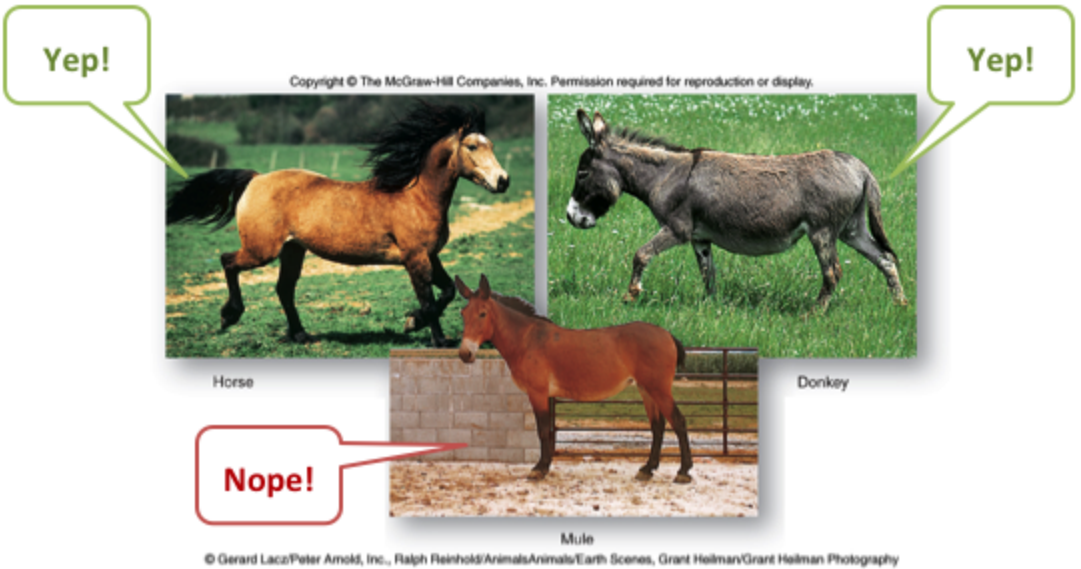
Leslie M. Turner,[1,2,3] Denise J. Schwahn,[4] and Bettina Harr[1]

Mus musculus musculus* & *Mus musculus domesticus

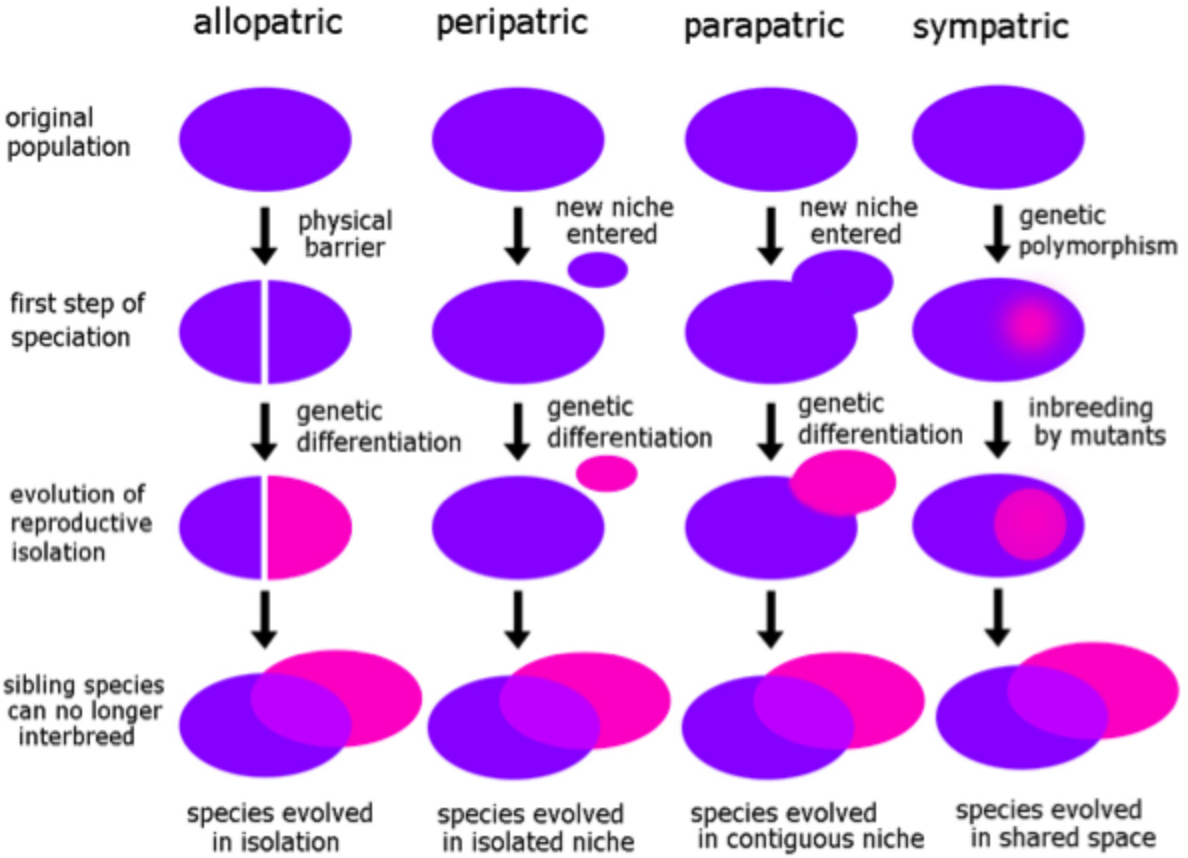


Turner 2012 Evolution

Lotsy's definition of what constitutes a species should be modified thus: a species is a group of individuals fully fertile inter se, but barred from interbreeding with other similar groups by its physiological properties (producing either incompatibility of parents, or sterility of the hybrids, or both).



Ok, but how does it all starts???



http://www.bio.miami.edu/dana/107/107F13_17print.html

Meredith 2010 Proc R Soc B