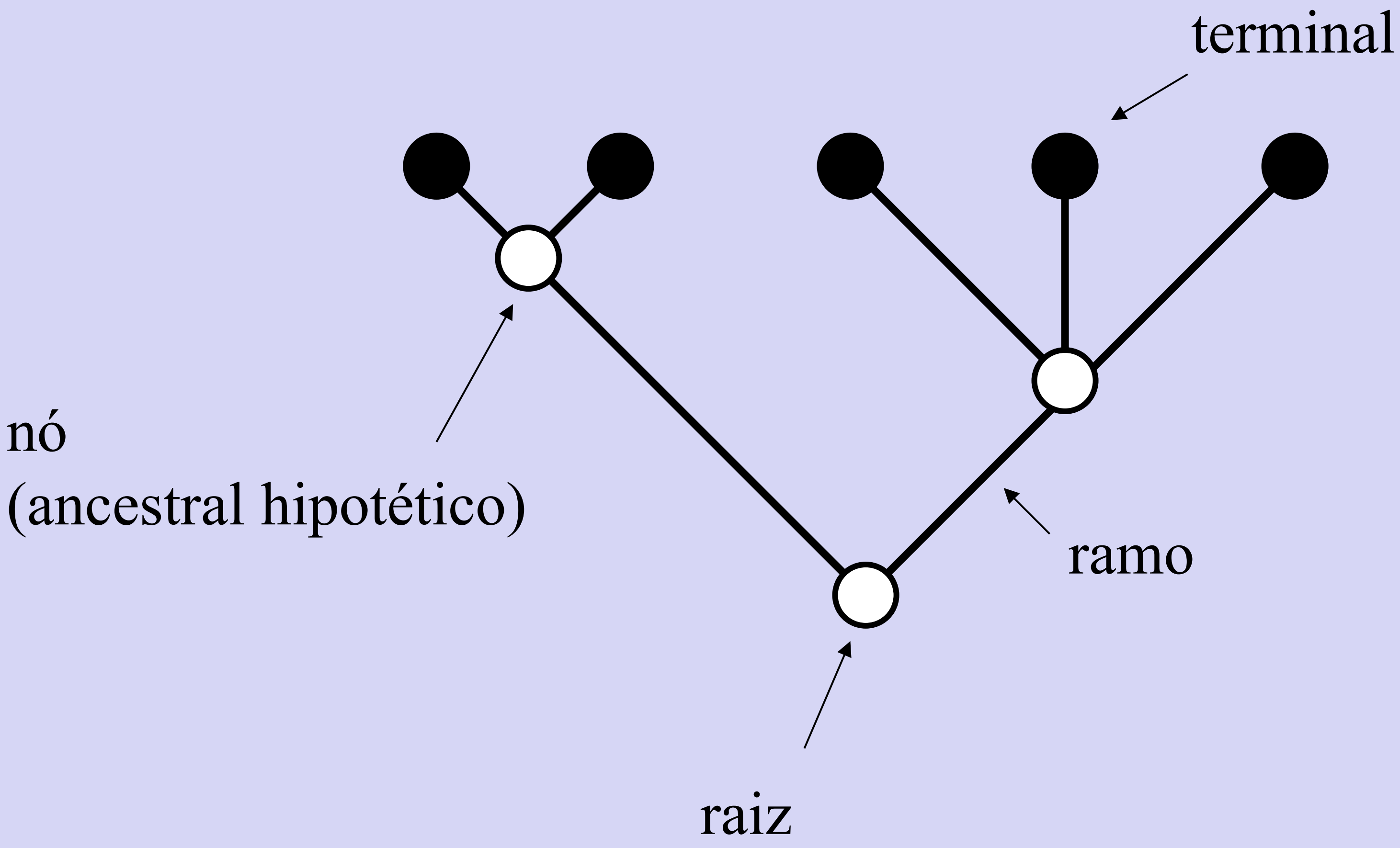
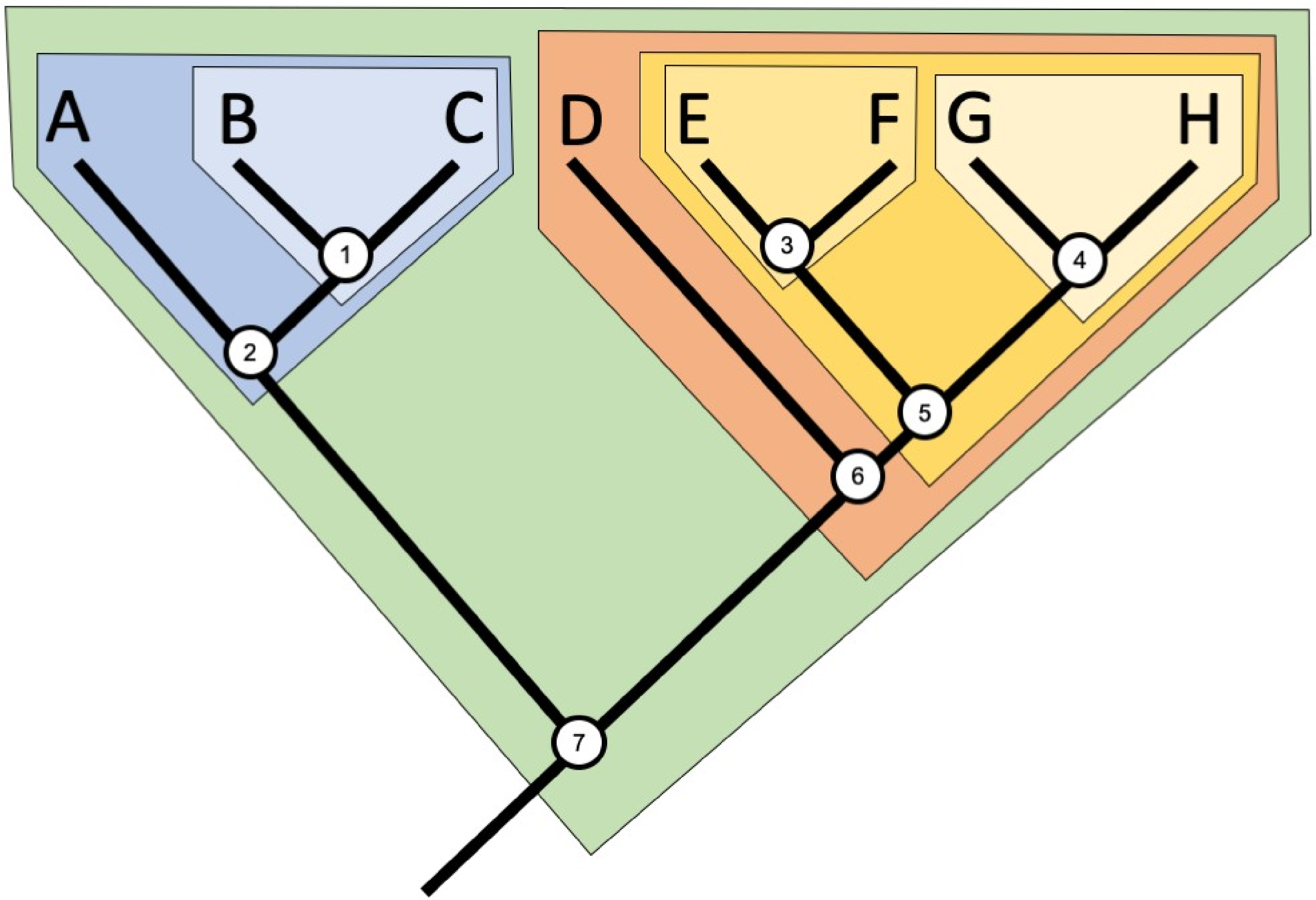
Astrobiology IV

Observatório Nacional

Rio de Janeiro, October 25th, 2022

Mário de Pinna
Museu de Zoologia
Universidade de São Paulo


terminal
nó
(ancestral hipotético)
ramo
raiz


A
B
C
D
E
F
G
H
1
2
3
4
5
6
7

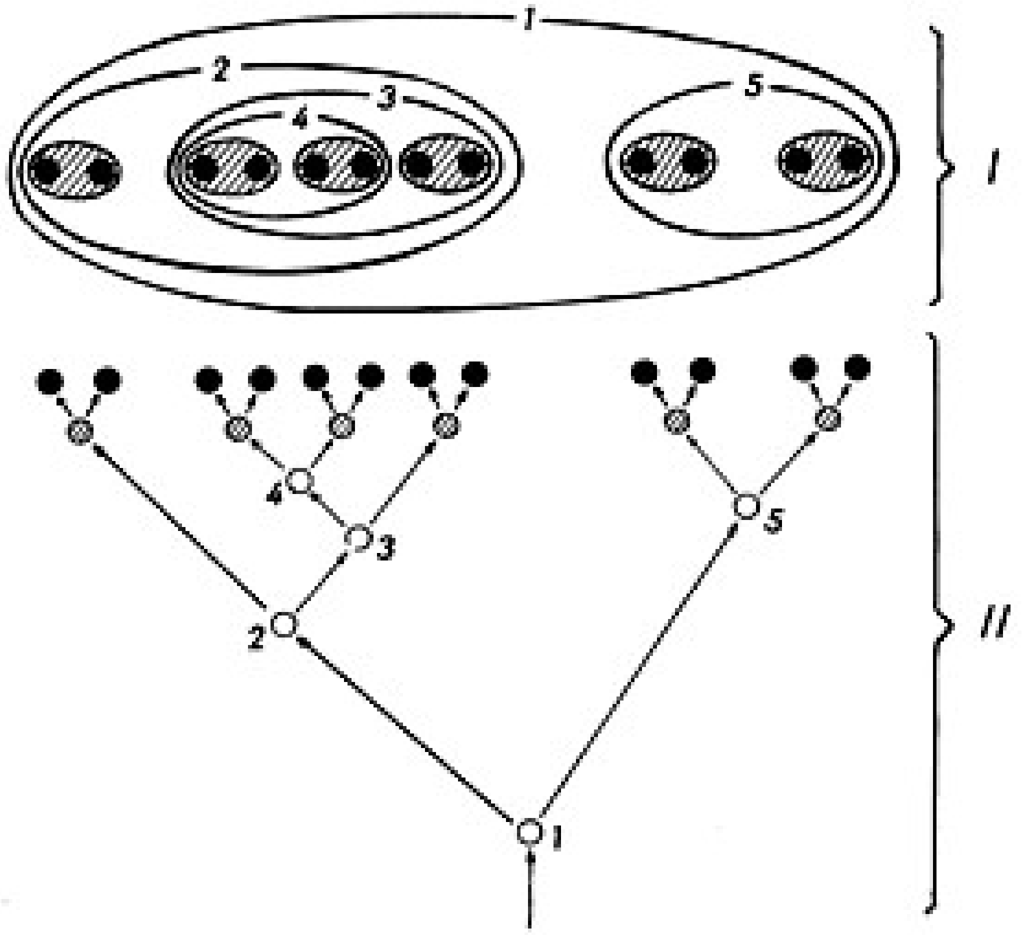
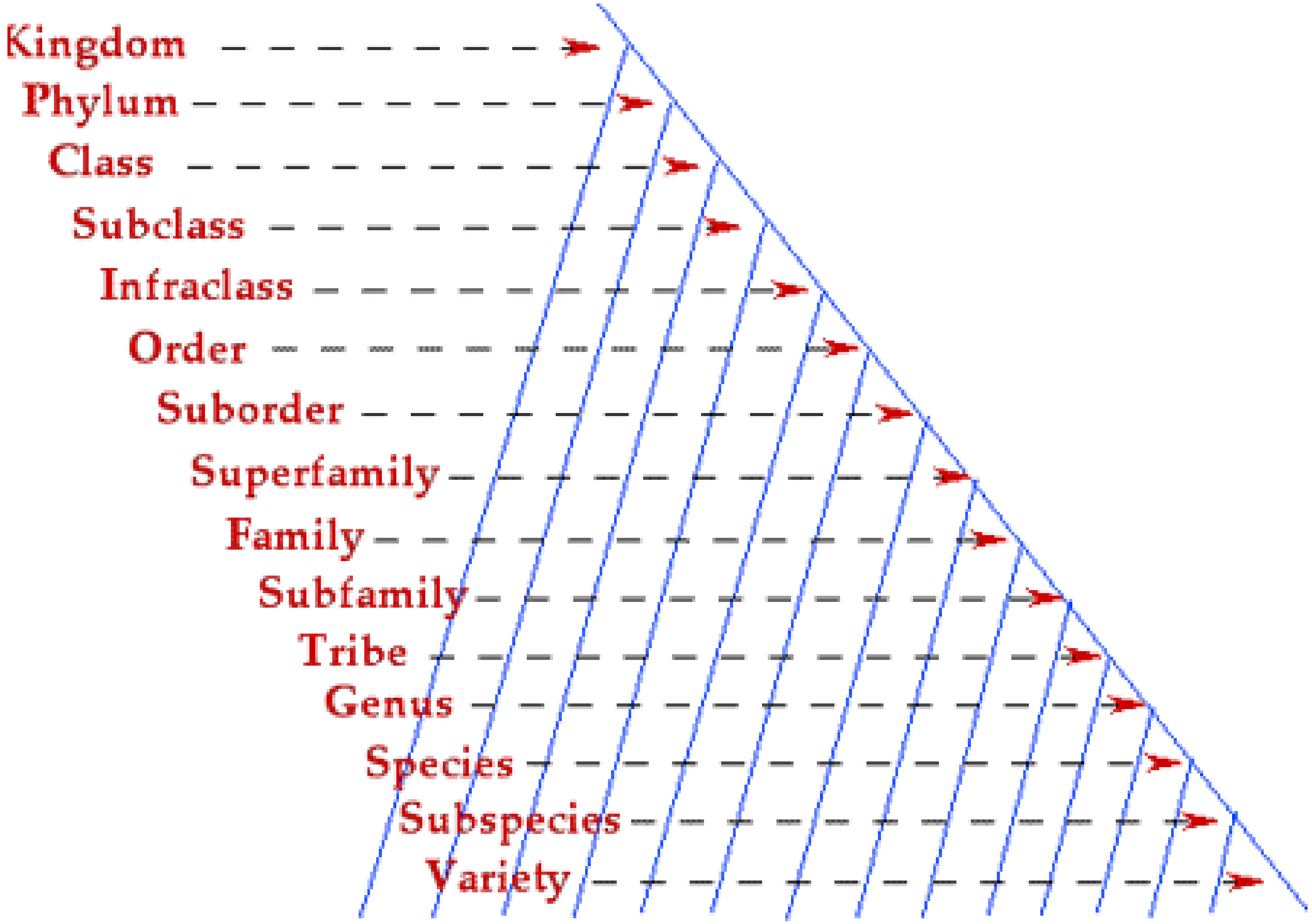
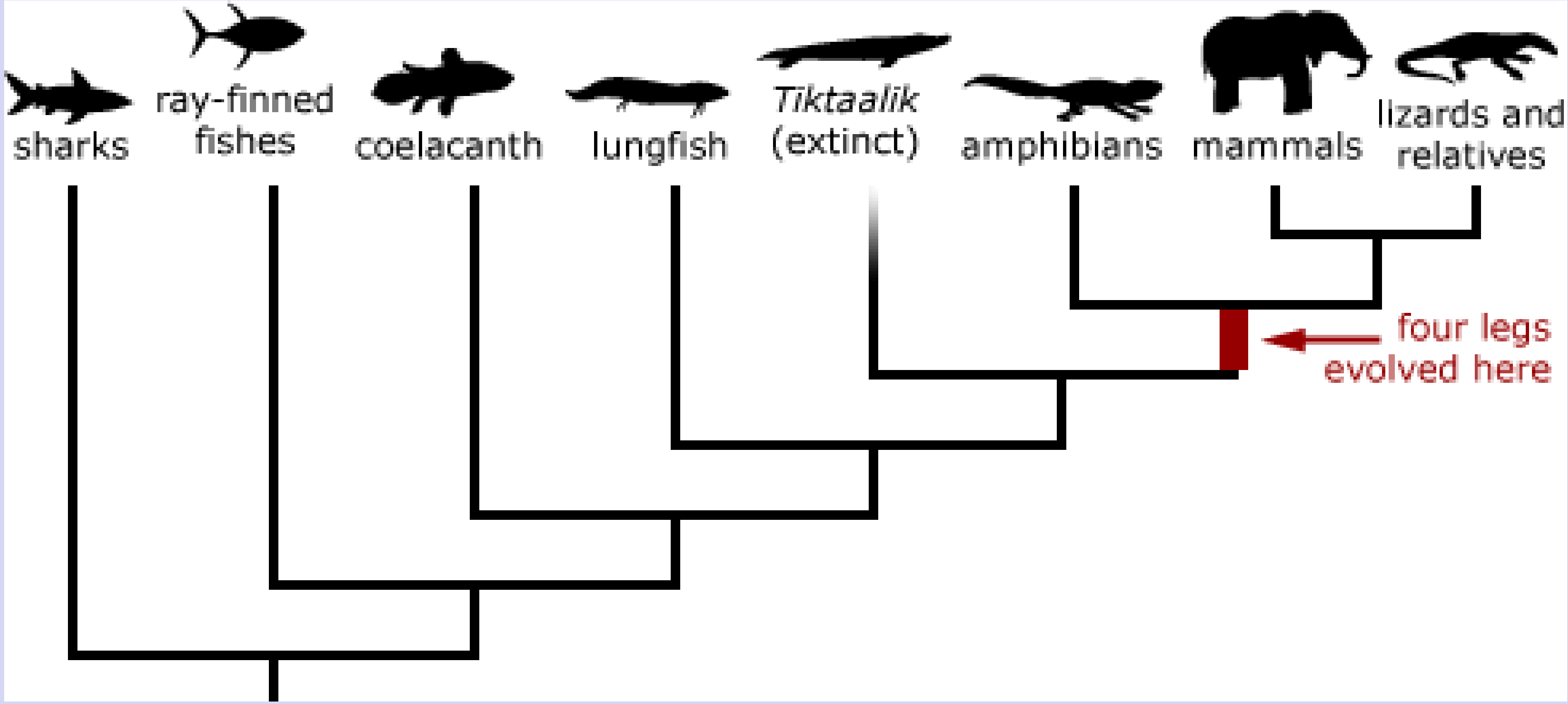
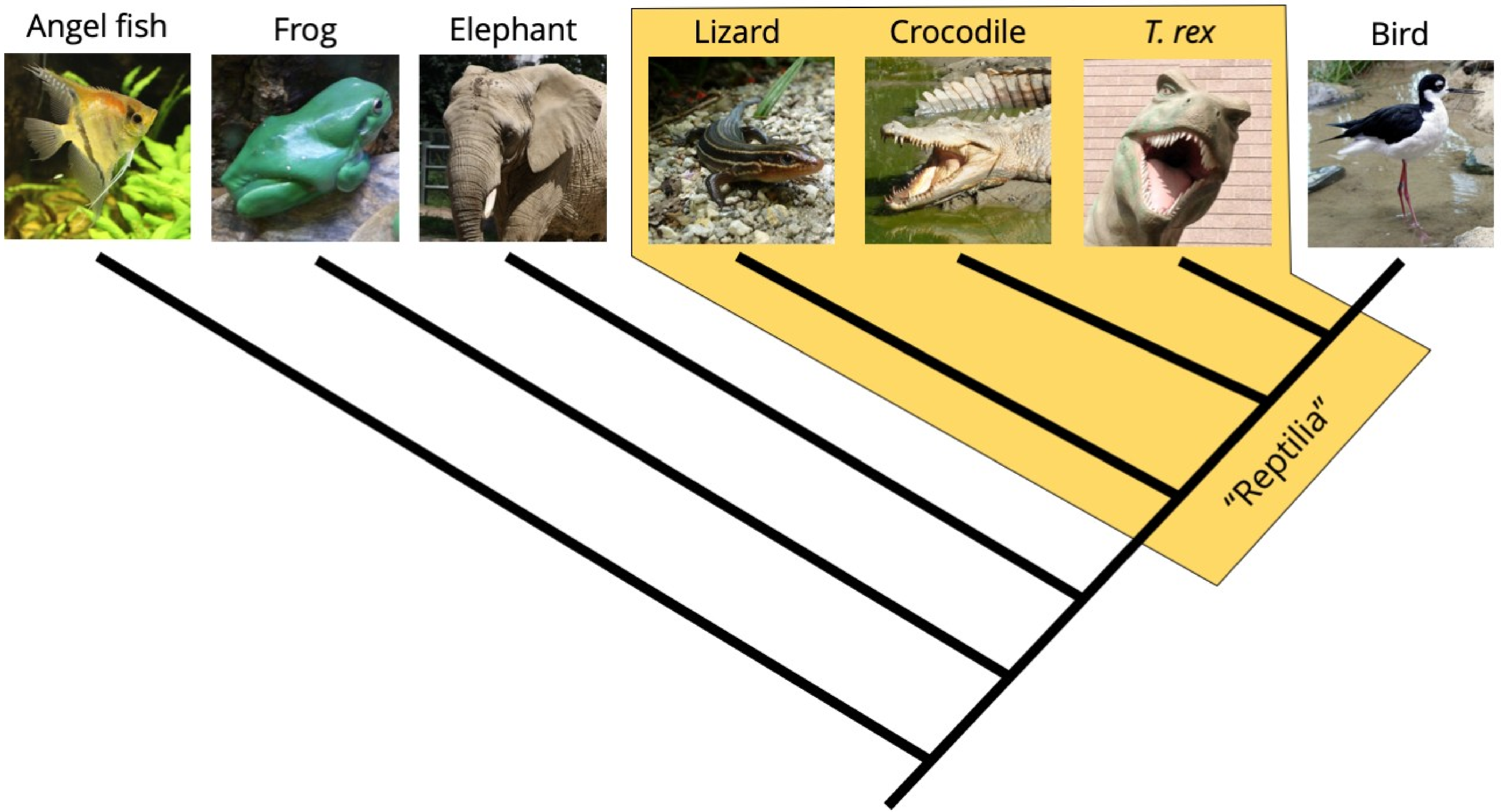


Figure 18. The phylogenetic kinship relations between the species of a monophyletic group, represented in two different ways.

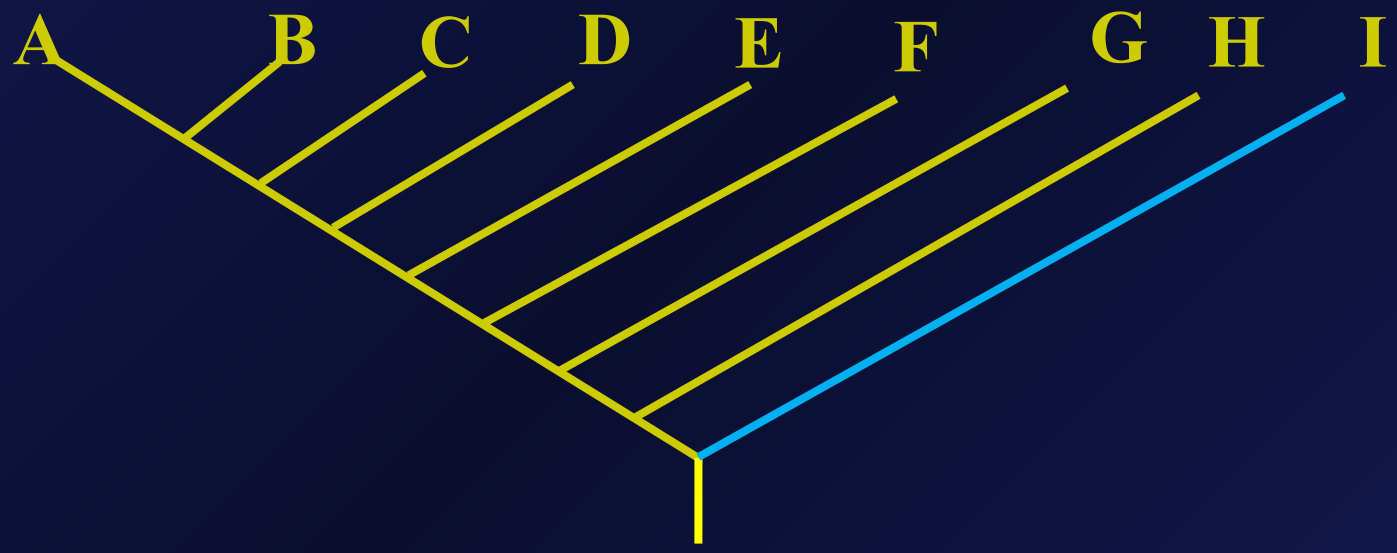

Kingdom
Phylum
Class
Subclass
Infraclass
Order
Suborder
Superfamily
Family
Subfamily
Tribe
Genus
Species
Subspecies
Variety

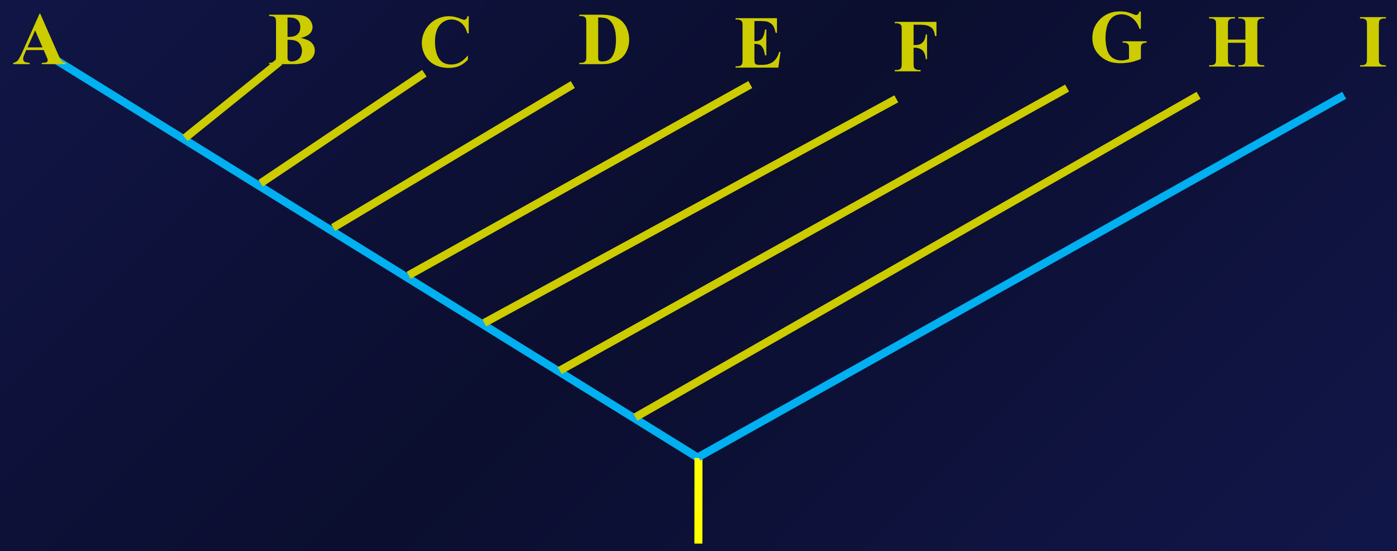


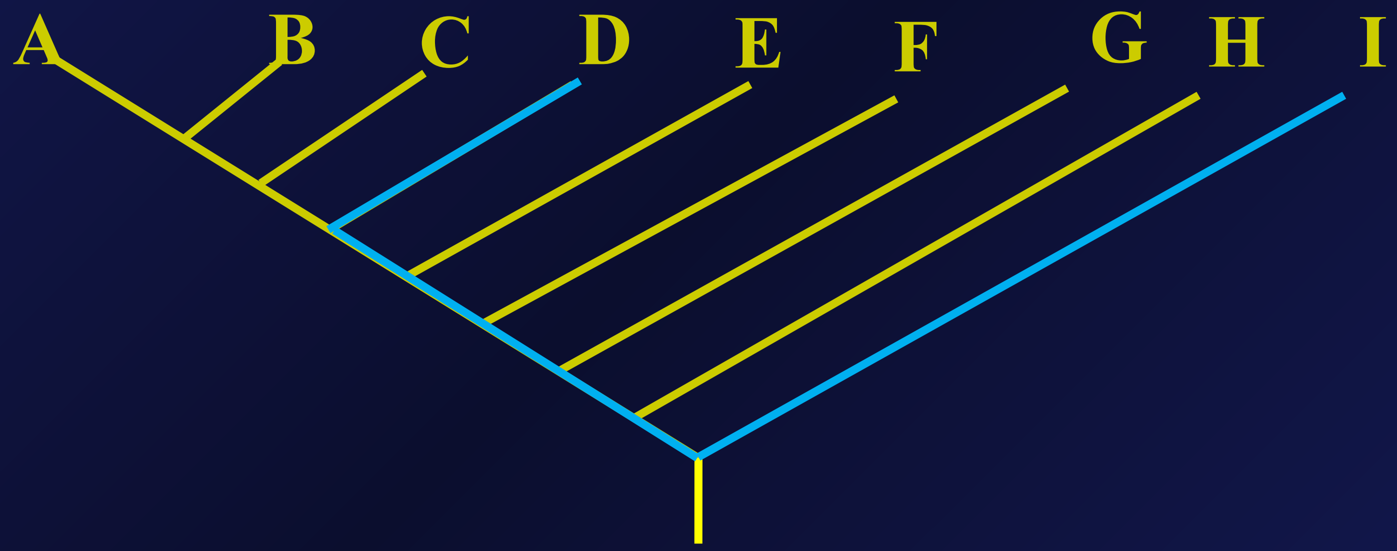
sharks
ray-finned fishes
coelacanth
lungfish
Tiktaalik (extinct)
amphibians
mammals
lizards and relatives
four legs evolved here

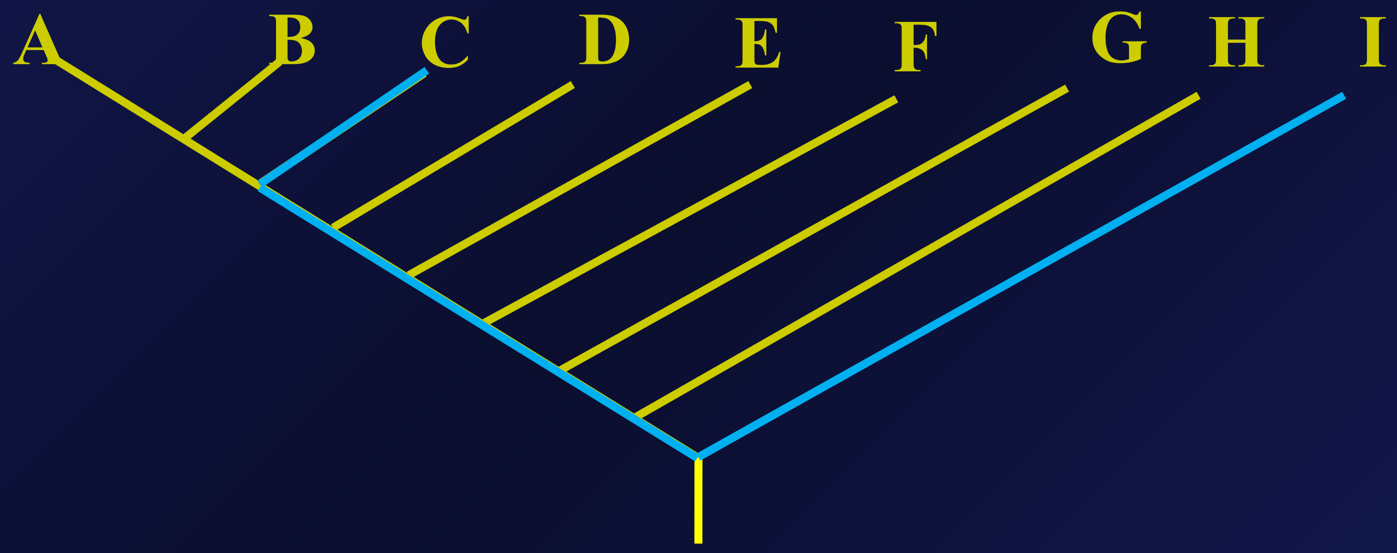


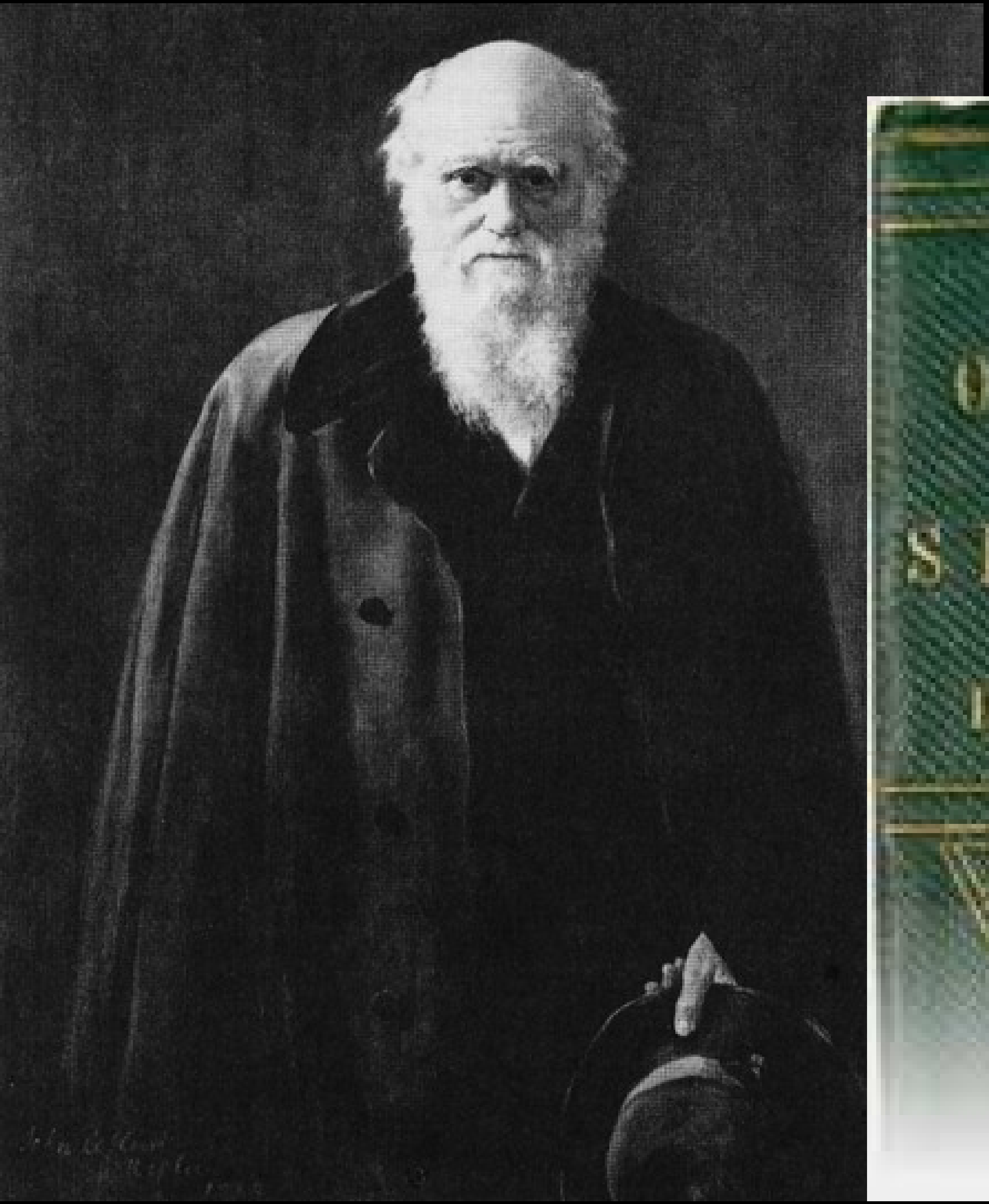
(https://www.digitalatlasofancientlife.org/learn/).

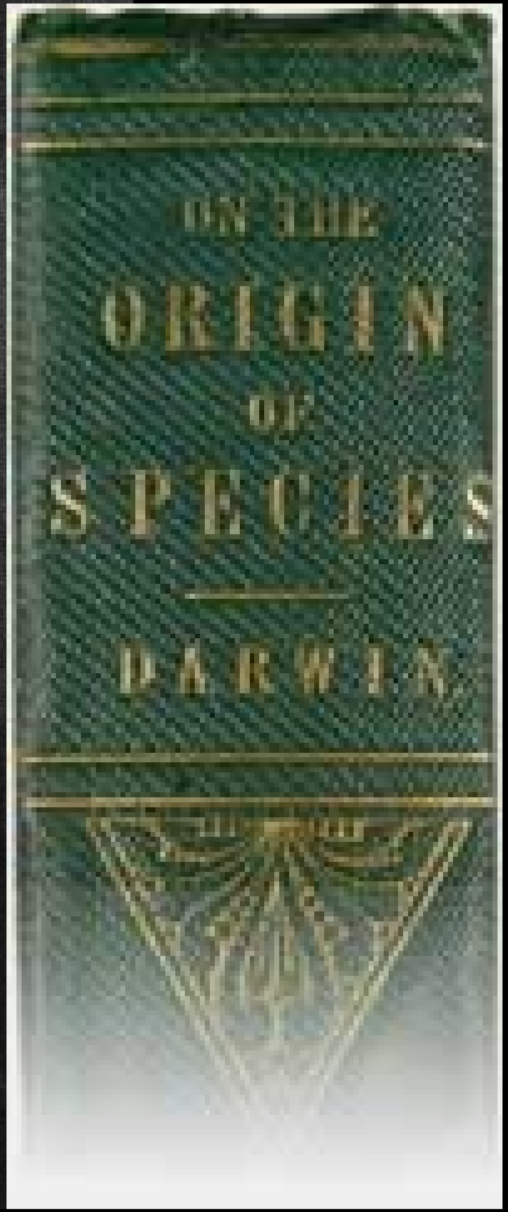

A
B
C
D
E
F
G
H
I

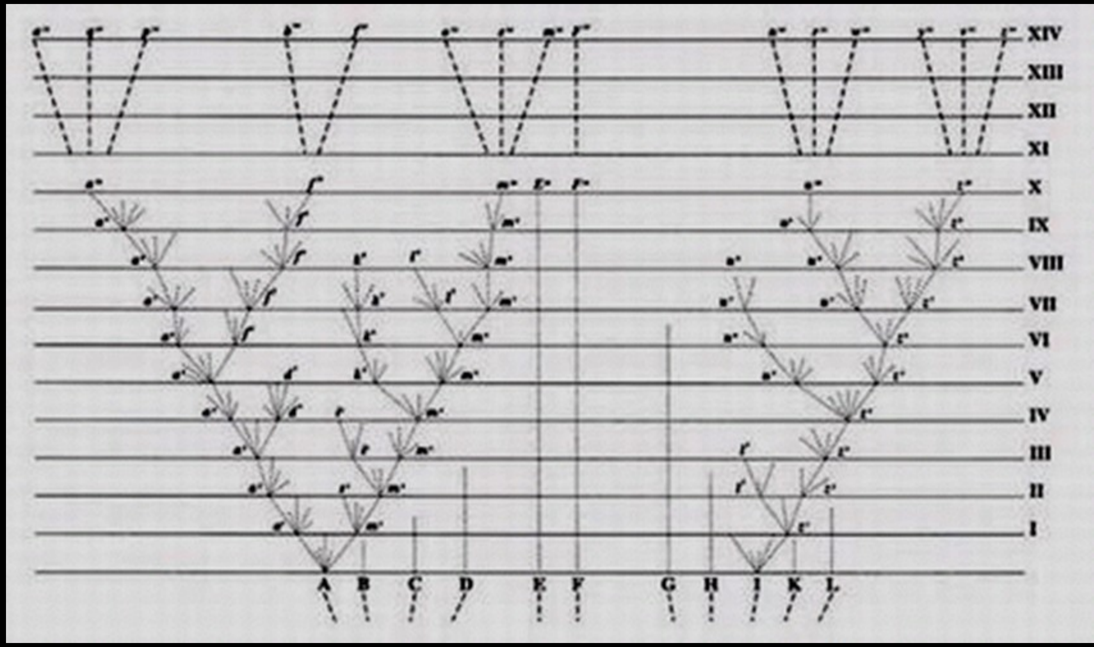

A
B
C
D
E
F
G
H
I

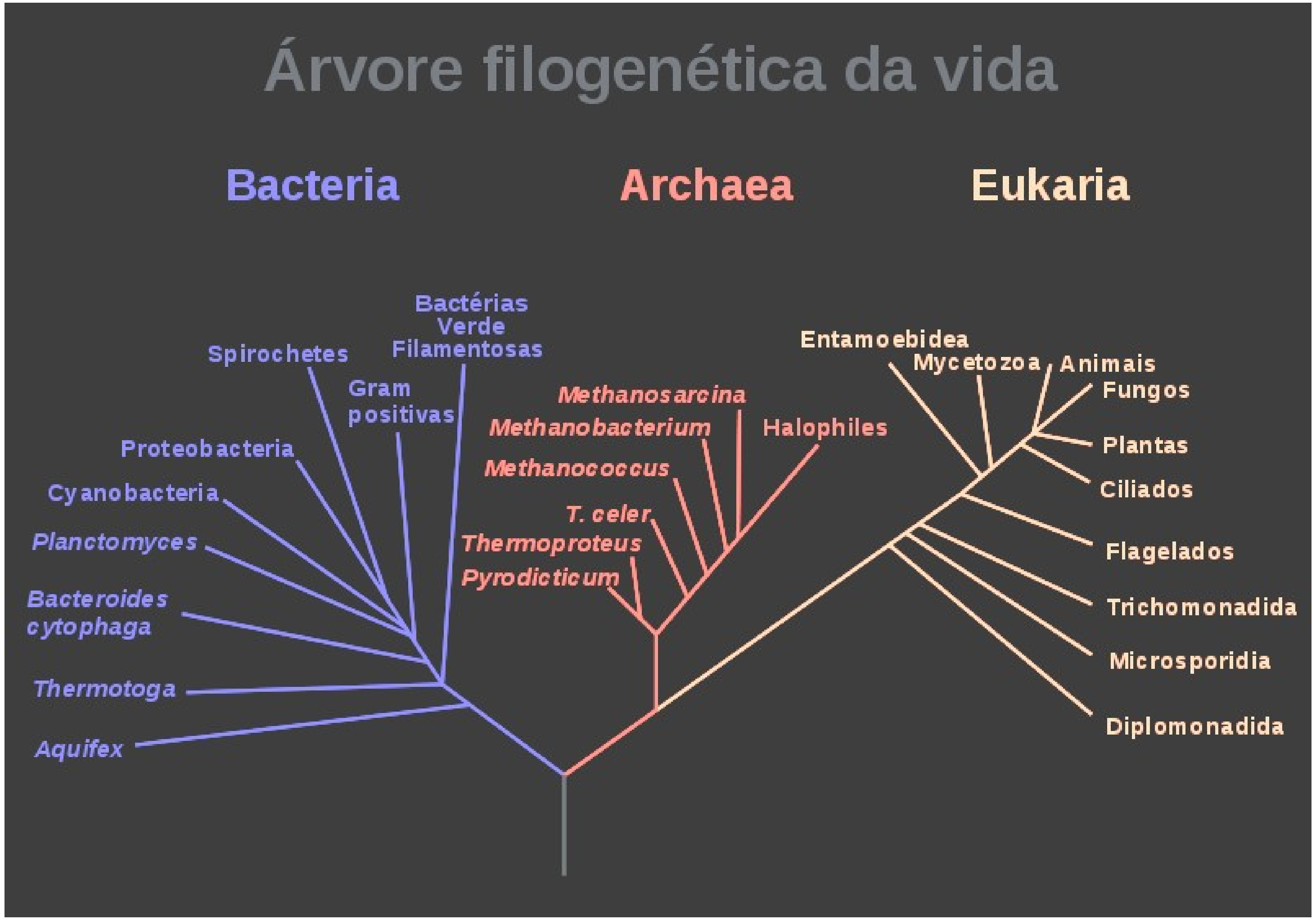

A
B
C
D
E
F
G
H
I


A
B
C
D
E
F
G
H
I

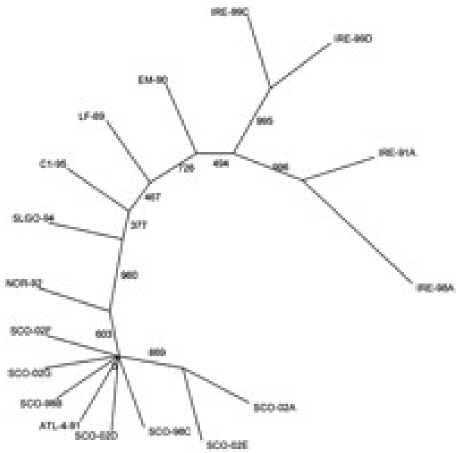


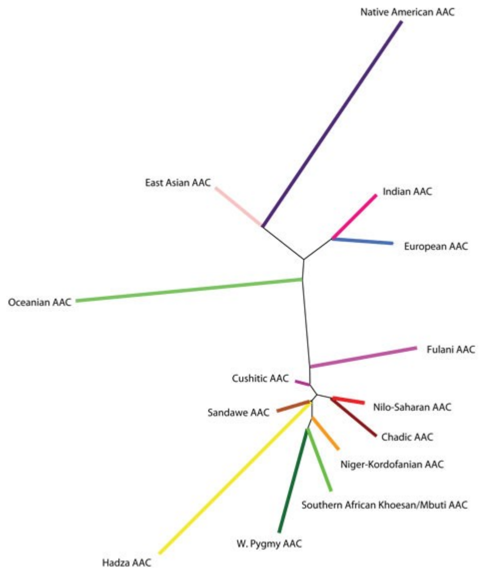

ON THE
ORIGIN
OF
SPECIES
DARWIN

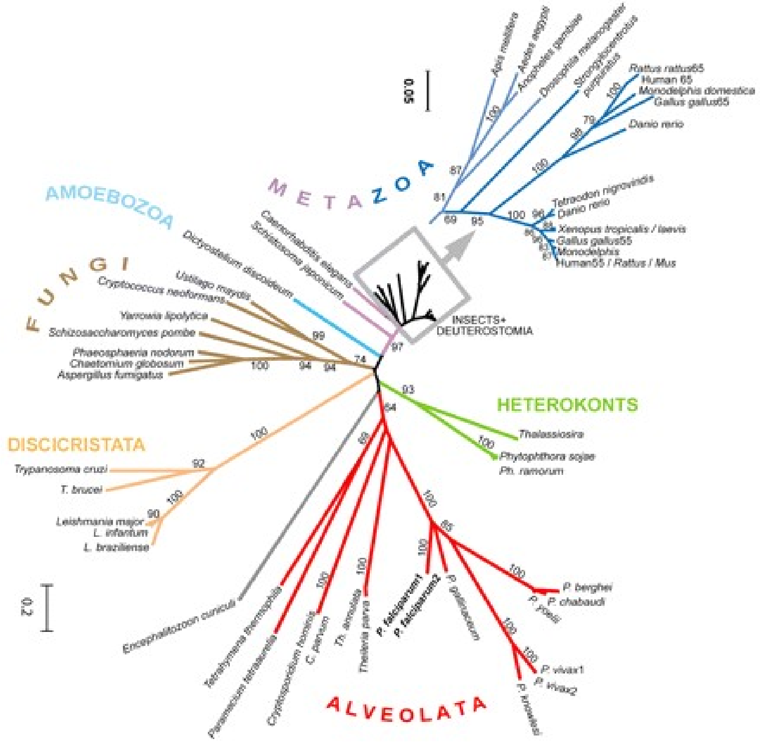

XIV
XIII
XII
XI
X
IX
VIII
VII
VI
V
IV
III
II
I
A
B
C
D
E
F
G
H
I
K
L

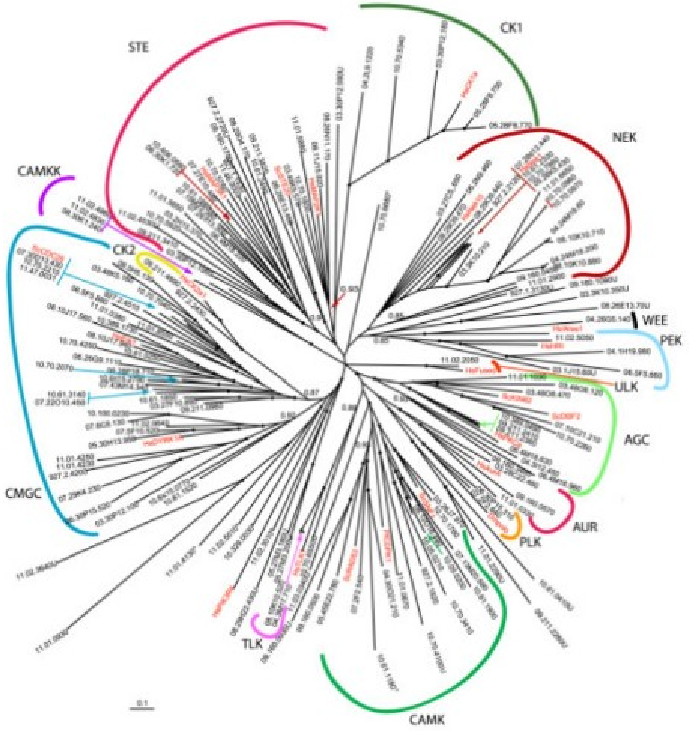


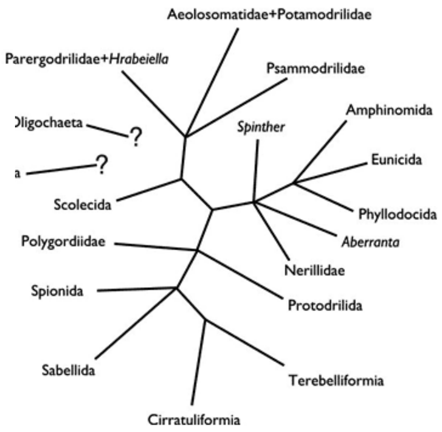
Árvore filogenética da vida
Bacteria
Archaea
Eukaria
Bactérias Verde Filamentosas
Spirochetes
Gram positivas
Proteobacteria
Cyanobacteria
Planctomyces
Bacteroides cytophaga
Thermotoga
Aquifex
Methanosarcina
Methanobacterium
Halophiles
Methanococcus
T. celer
Thermoproteus
Pyrodicticum
Entamoebidea
Mycetozoa
Animais
Fungos
Plantas
Ciliados
Flagelados
Trichomonadida
Microsporidia
Diplomonadida

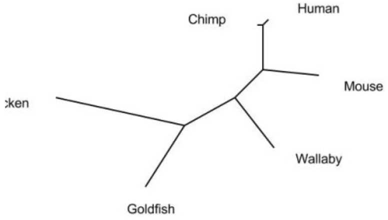


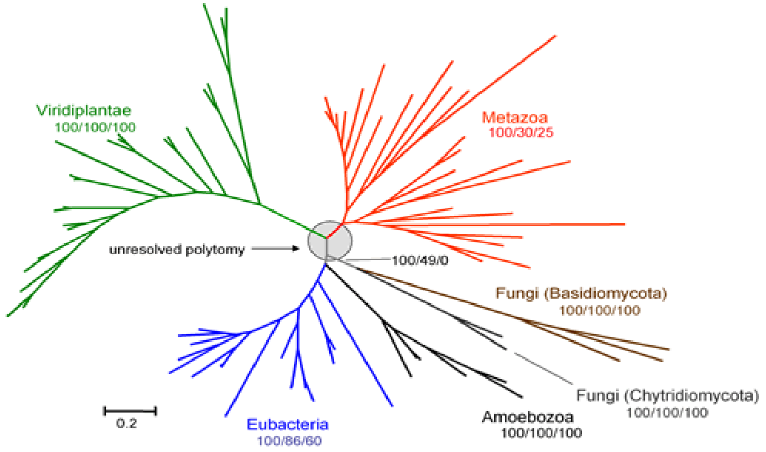

Native American AAC
East Asian AAC
Indian AAC
European AAC
Oceanian AAC
Fulani AAC
Cushitic AAC
Sandawe AAC
Nilo-Saharan AAC
Chadic AAC
Niger-Kordofanian AAC
Southern African Khoesan/Mbuti AAC
W. Pygmy AAC
Hadza AAC

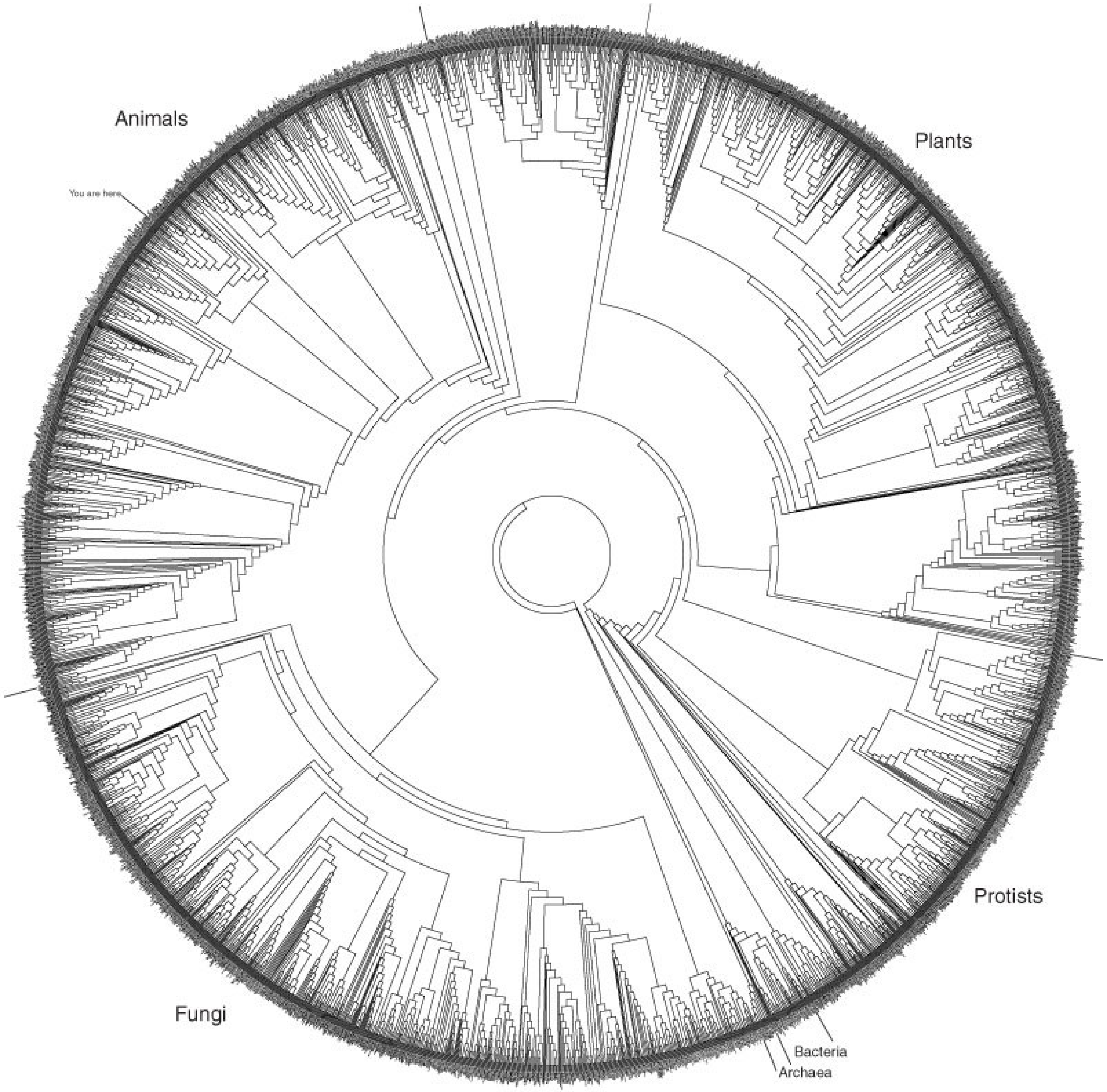

METAZOA
AMOEBOZOA
FUNGI
INSECTS+
DEUTEROSTOMIA
HETEROKONTS
DISCICRISTATA
ALVEOLATA
Rattus rattus65
Human 65
Monodelphis domestica
Gallus gallus65
Danio rerio
Tetraodon nigroviridis
Xenopus tropicalis / laevis
Human55 / Rattus / Mus
Dictyostelium discoideum
Caenorhabditis elegans
Schistosoma japonicum
Ustilago maydis
Cryptococcus neoformans
Yarrowia lipolytica
Schizosaccharomyces pombe
Phaeosphaeria nodorum
Chaetomium globosum
Aspergillus fumigatus
Thalassiosira
Phytophthora sojae
Ph. ramorum
Trypanosoma cruzi
T. brucei
Leishmania major
L. infantum
L. braziliense
Encephalitozoon cuniculi
Tetrahymena thermophila
Paramecium tetraurelia
Cryptosporidium hominis
C. parvum
Th. annulata
Theileria parva
P. falciparum1
P. falciparum2
P. gallinaceum
P. berghei
P. chabaudi
P. vivax1
P. vivax2
P. knowlesi


STE
CK1
NEK
CAMKK
CK2
WEE
PEK
ULK
AGC
CMGC
AUR
PLK
TLK
CAMK

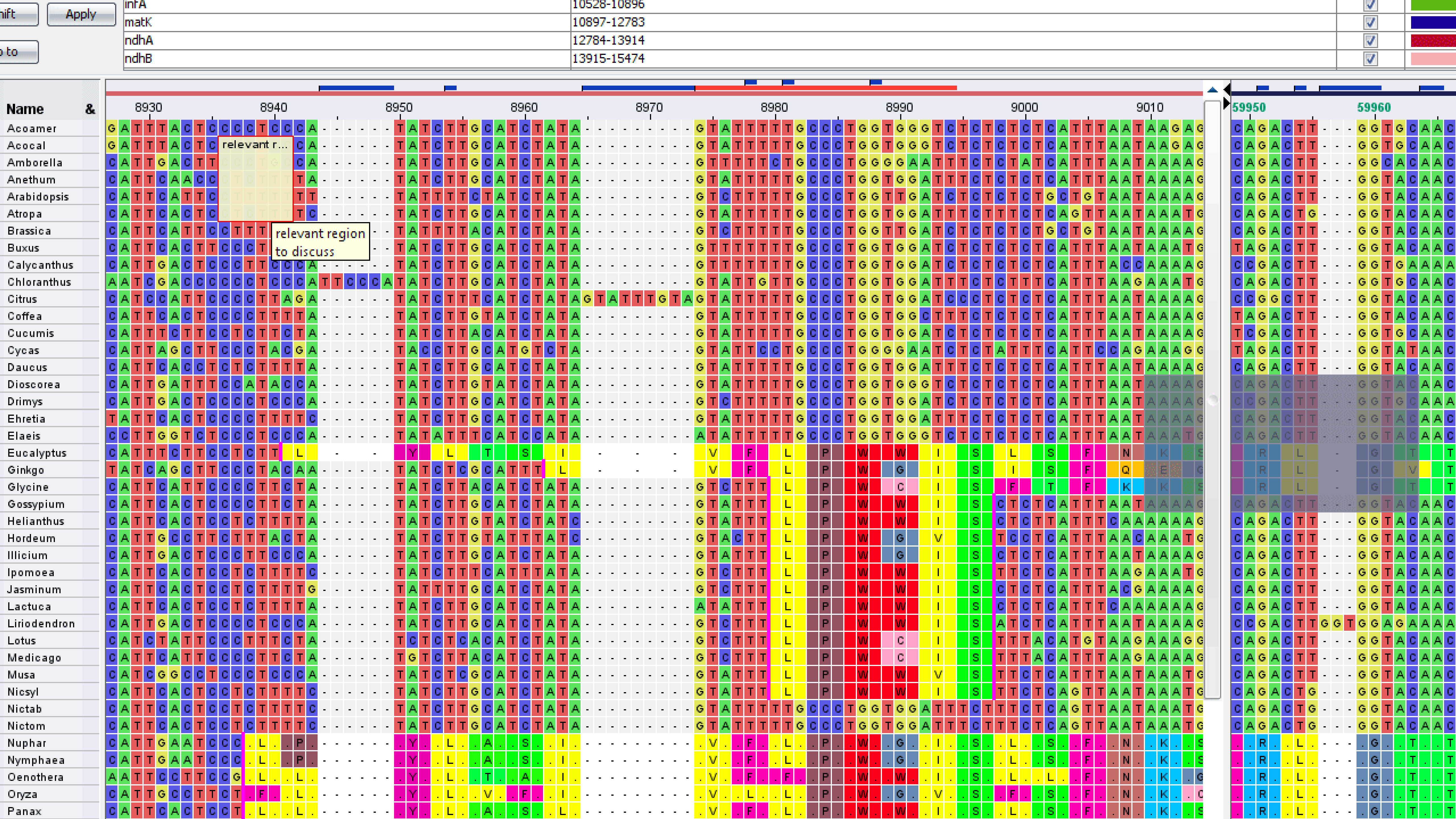

Aeolosomatidae+Potamodrilidae
Parergodrilidae+Hrabeiella
Psammodrilidae
Amphinomida
Spinther
Eunicida
Phyllodocida
Aberranta
Scolecida
Polygordiidae
Nerillidae
Spionida
Protodrilida
Sabellida
Terebelliformia
Cirratuliformia


Chimp
Human
Mouse
Wallaby
Goldfish

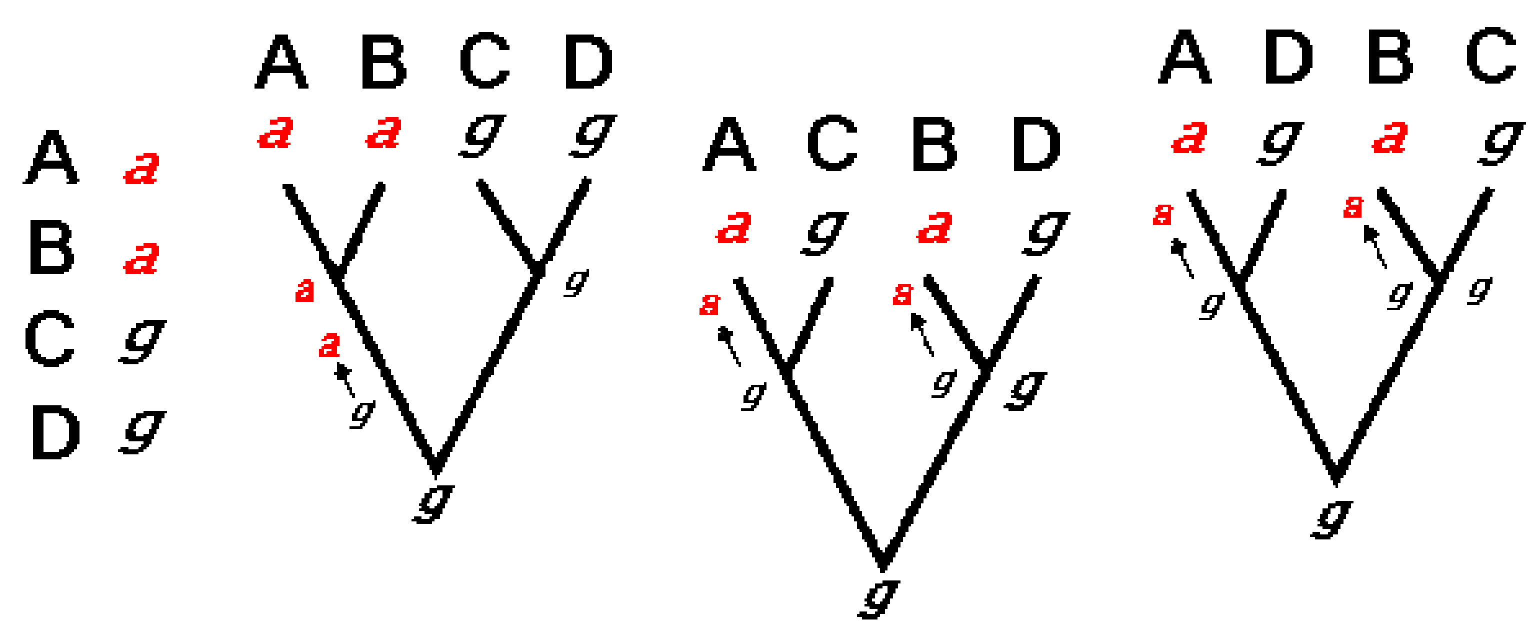

Viridiplantae
100/100/100
Metazoa
100/30/25
unresolved polytomy
100/49/0
Fungi (Basidiomycota)
100/100/100
Fungi (Chytridiomycota)
100/100/100
Amoebozoa
100/100/100
Eubacteria
100/86/60
0.2



Animals
You are here
Plants
Protists
Fungi
Bacteria
Archaea



Apply
infA 10528-10896
matK 10897-12783
ndhA 12784-13914
ndhB 13915-15474
Name
8930
8940
8950
8960
8970
8980
8990
9000
9010
59950
59960
relevant region to discuss
Acoamer
Acocal
Amborella
Anethum
Arabidopsis
Atropa
Brassica
Buxus
Calycanthus
Chloranthus
Citrus
Coffea
Cucumis
Cycas
Daucus
Dioscorea
Drimys
Ehretia
Elaeis
Eucalyptus
Ginkgo
Glycine
Gossypium
Helianthus
Hordeum
Illicium
Ipomoea
Jasminum
Lactuca
Liriodendron
Lotus
Medicago
Musa
Nicsyl
Nictab
Nictom
Nuphar
Nymphaea
Oenothera
Oryza
Panax



A a
B a
C g
D g
A B C D
a a g g
a
a
g
g
g
A C B D
a g a g
a
g
a
g
g
g
A D B C
a g a g
a
g
a
g
g
g

Jukes & Cantor 1969

	A	C	G	T
A	X	α	α	α
C	α	X	α	α
G	α	α	X	α
T	α	α	α	X

1 parameter
equiprobable changes

Kimura 1980

	A	C	G	T
A	X	α	$\kappa.\alpha$	α
C	α	X	α	$\kappa.\alpha$
G	$\kappa.\alpha$	α	X	α
T	α	$\kappa.\alpha$	α	X

2 parameters
transition rate ≠
transversion rate

Tamura 1992

	A	C	G	T
A	X	$\alpha\frac{1-\theta}{2}$	$\kappa\alpha\frac{1-\theta}{2}$	$\alpha\frac{1-\theta}{2}$
C	$\alpha\frac{\theta}{2}$	X	$\alpha\frac{\theta}{2}$	$\kappa\alpha\frac{\theta}{2}$
G	$\kappa\alpha\frac{\theta}{2}$	$\alpha\frac{\theta}{2}$	X	$\alpha\frac{\theta}{2}$
T	$\alpha\frac{1-\theta}{2}$	$\kappa\alpha\frac{1-\theta}{2}$	$\alpha\frac{1-\theta}{2}$	X

3 parameters
stationary GC% = $\theta \neq 50\%$

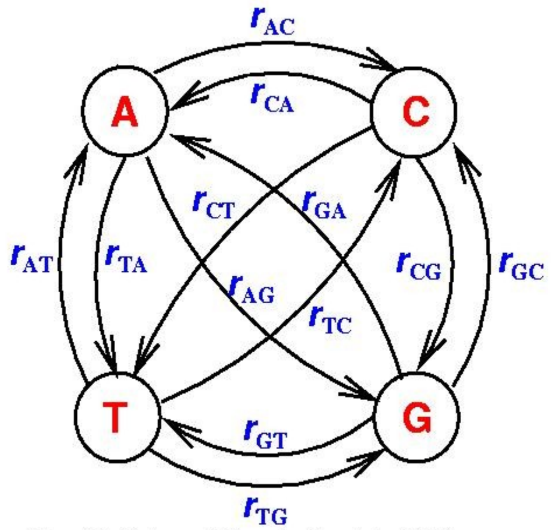
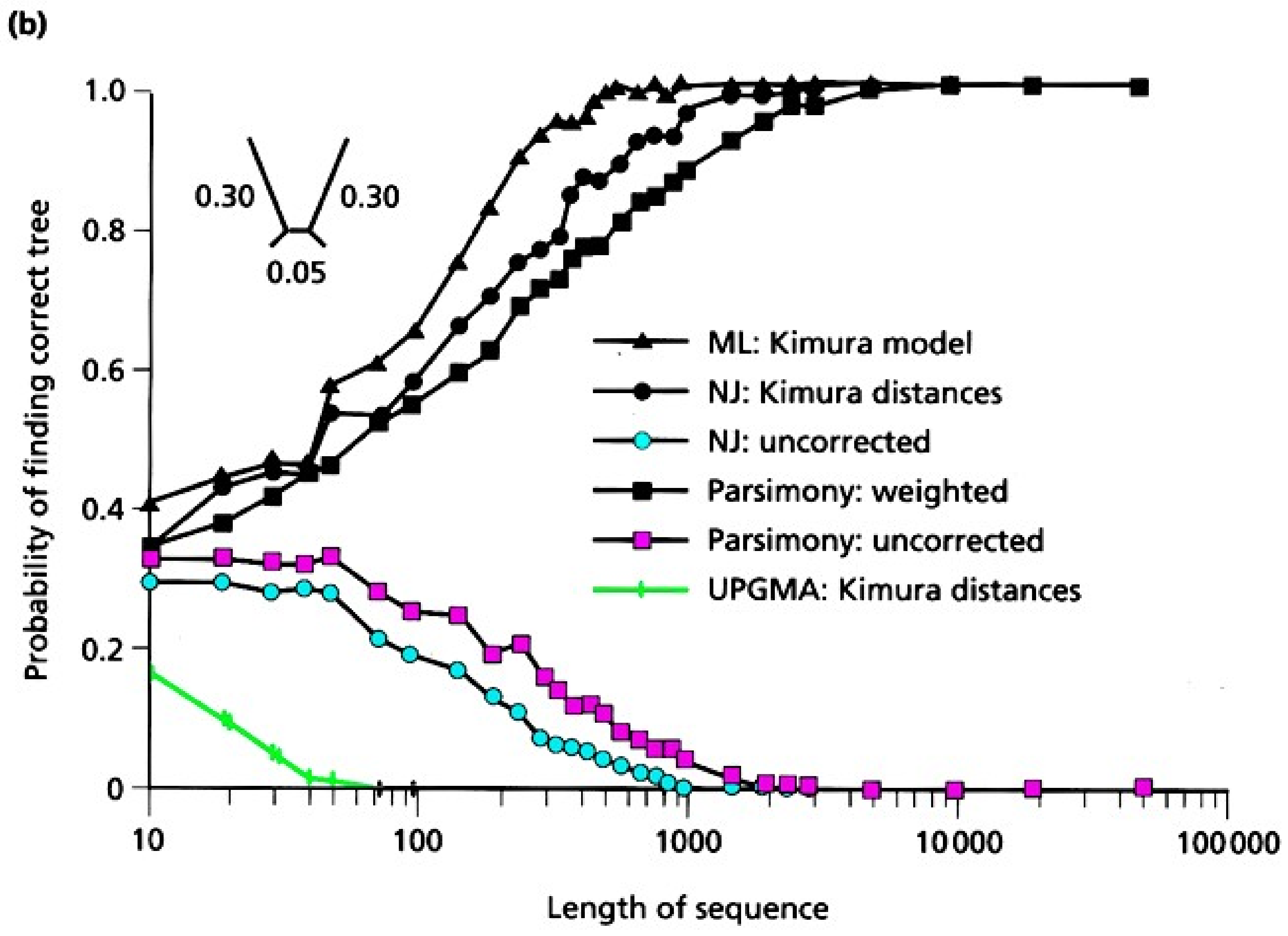


Figure 2.2: Markov model for nucleotide evolution in DNA sequences


(b)
0.30
0.30
0.05
ML: Kimura model
NJ: Kimura distances
NJ: uncorrected
Parsimony: weighted
Parsimony: uncorrected
UPGMA: Kimura distances
Probability of finding correct tree
1.0
0.8
0.6
0.4
0.2
0
10
100
1000
10000
100000
Length of sequence

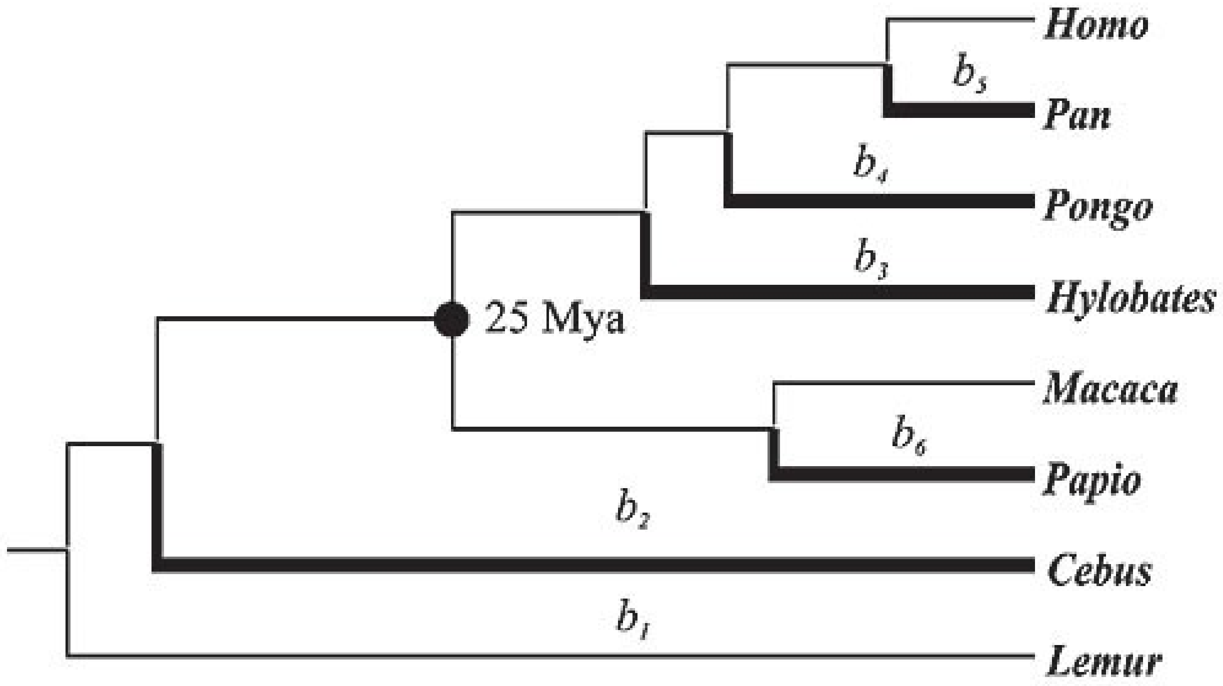
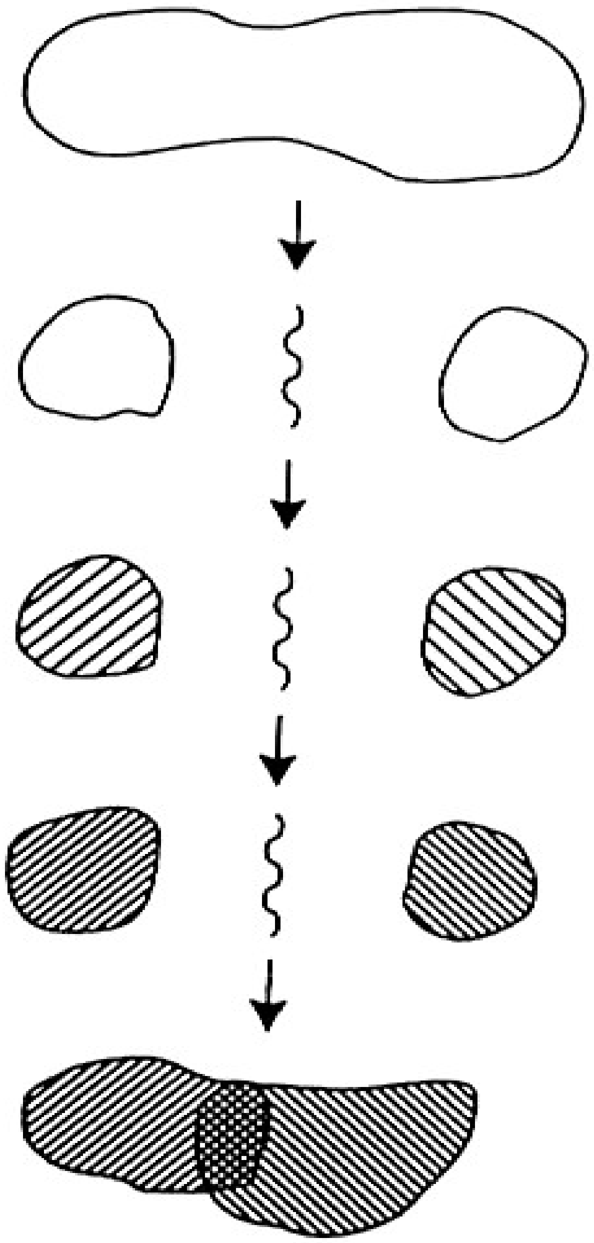
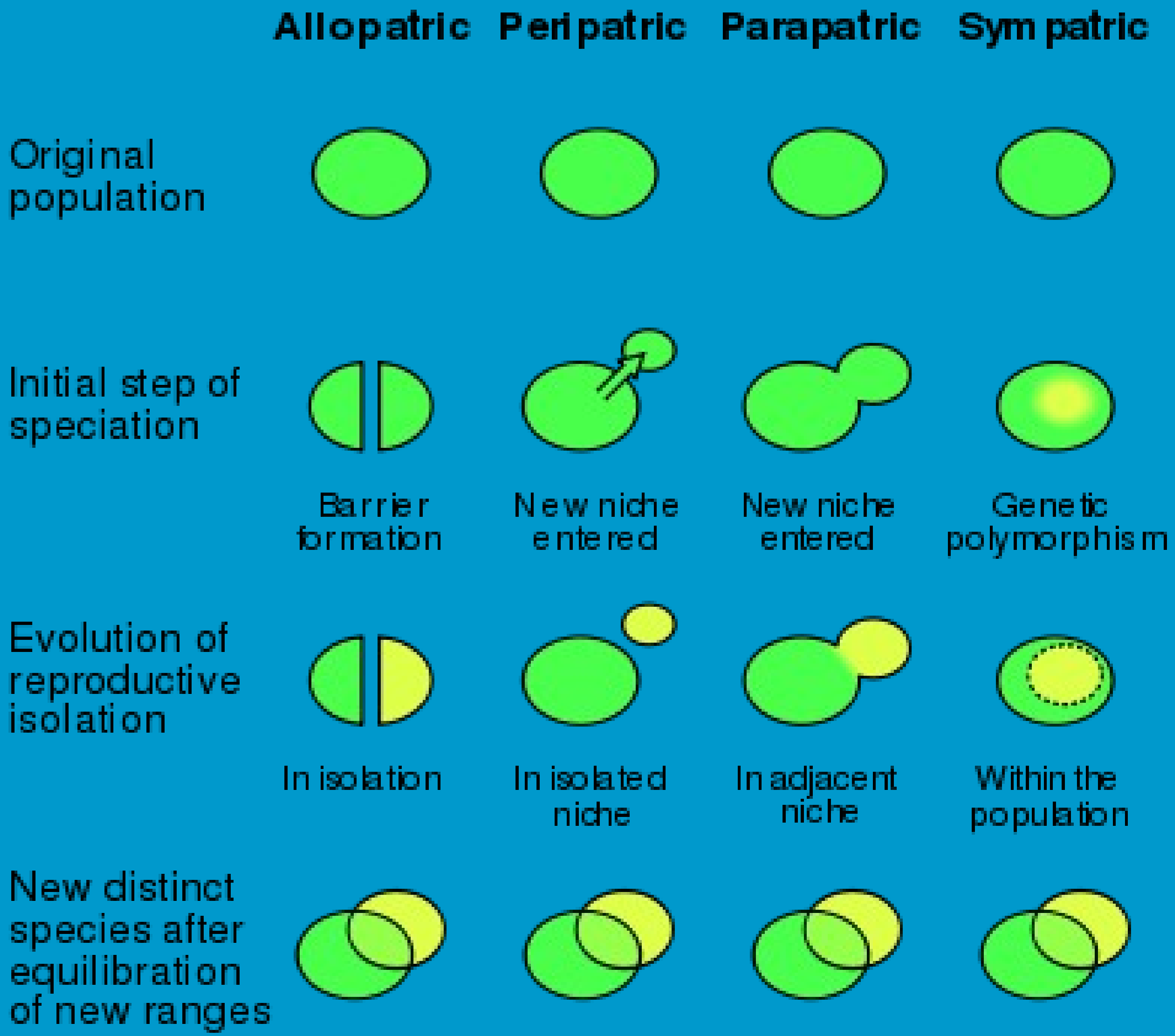
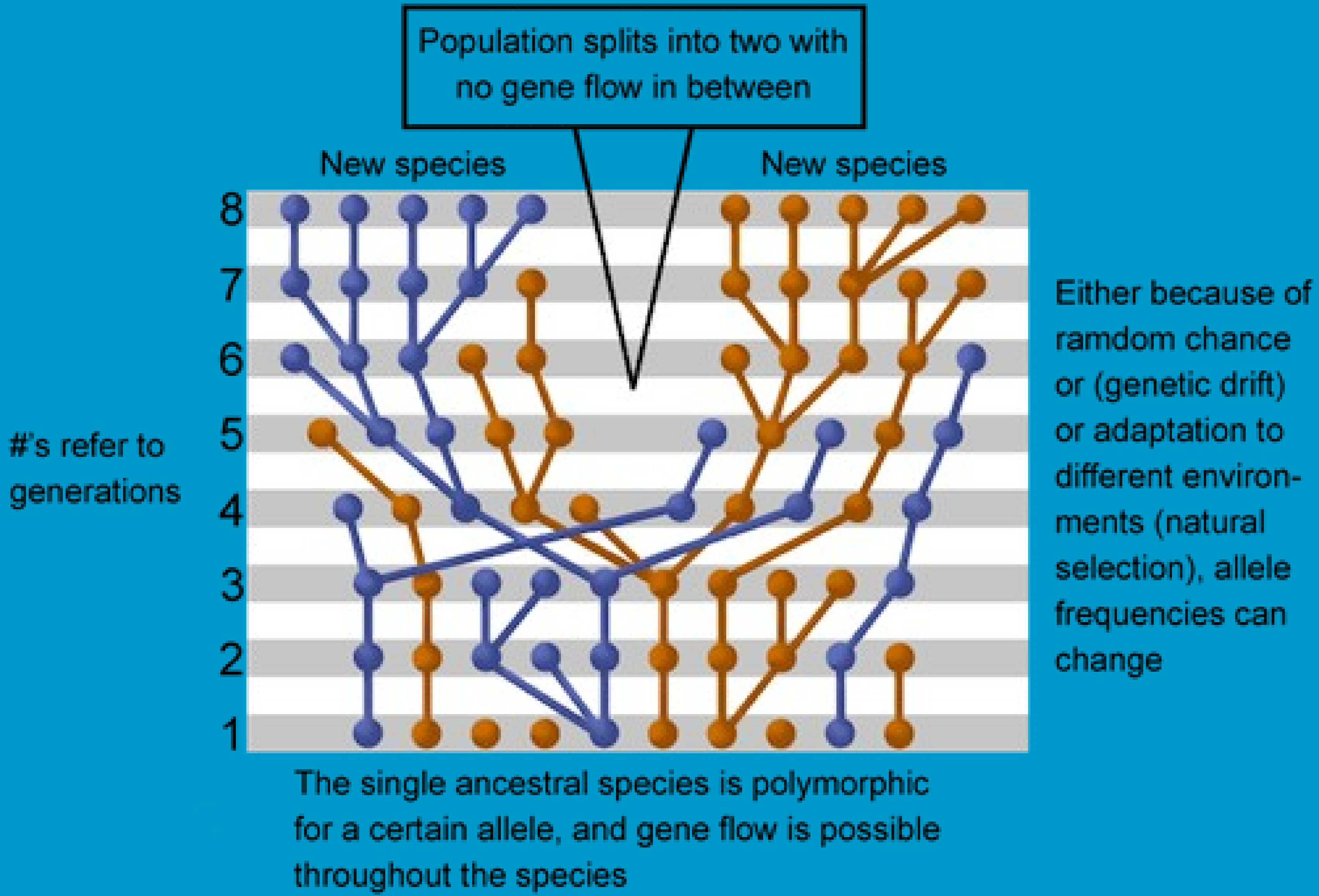


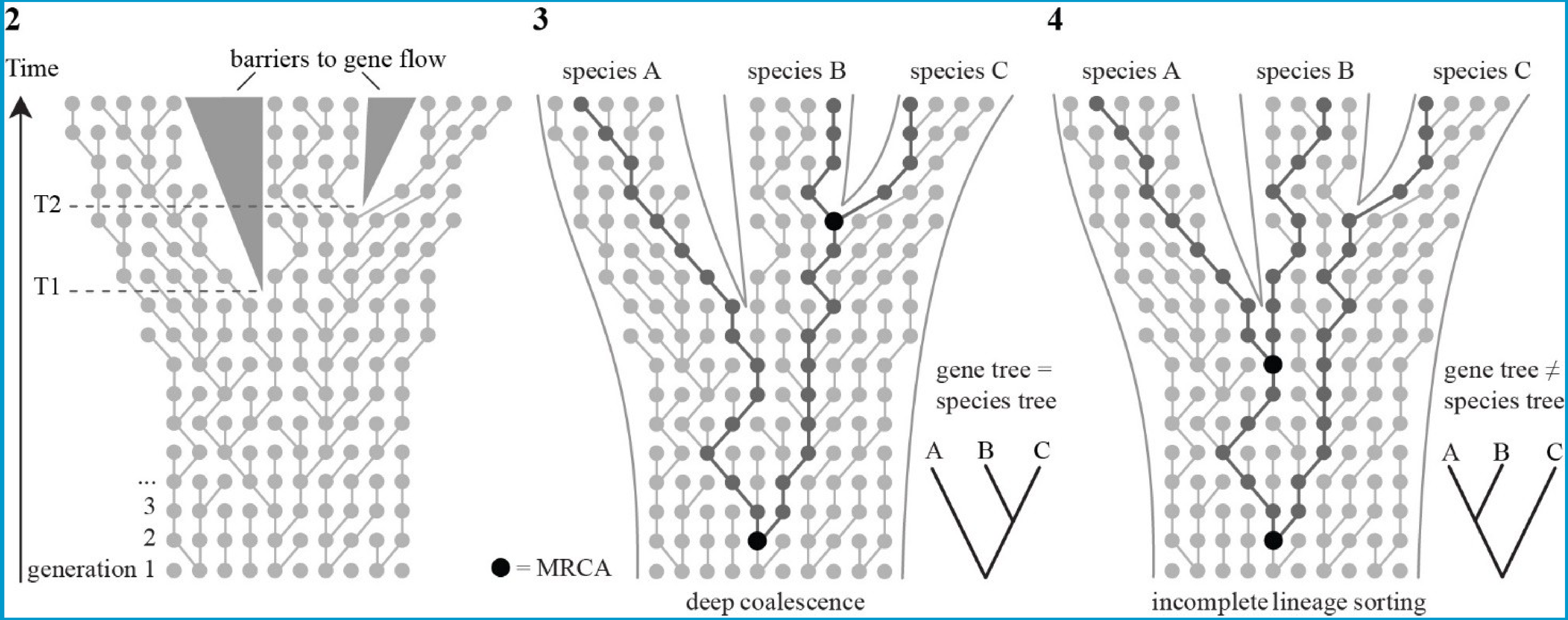
Figure 1. Standard primate phylogeny used in this study. The hominoid-cercopithecoid calibration point is depicted by the black circle. Branch lengths (times) are indicated following the classification used in the text. Mya = million years ago.

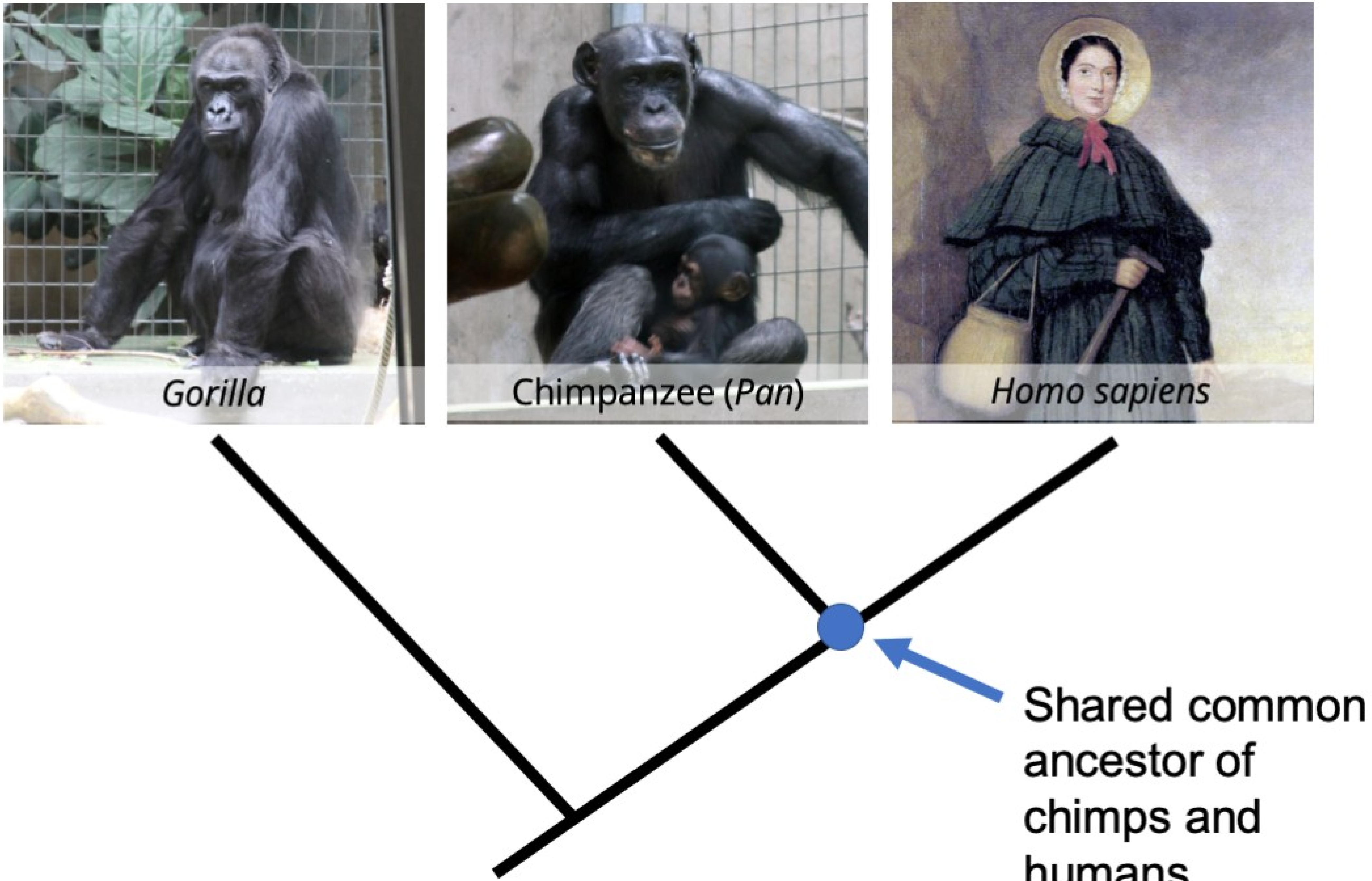


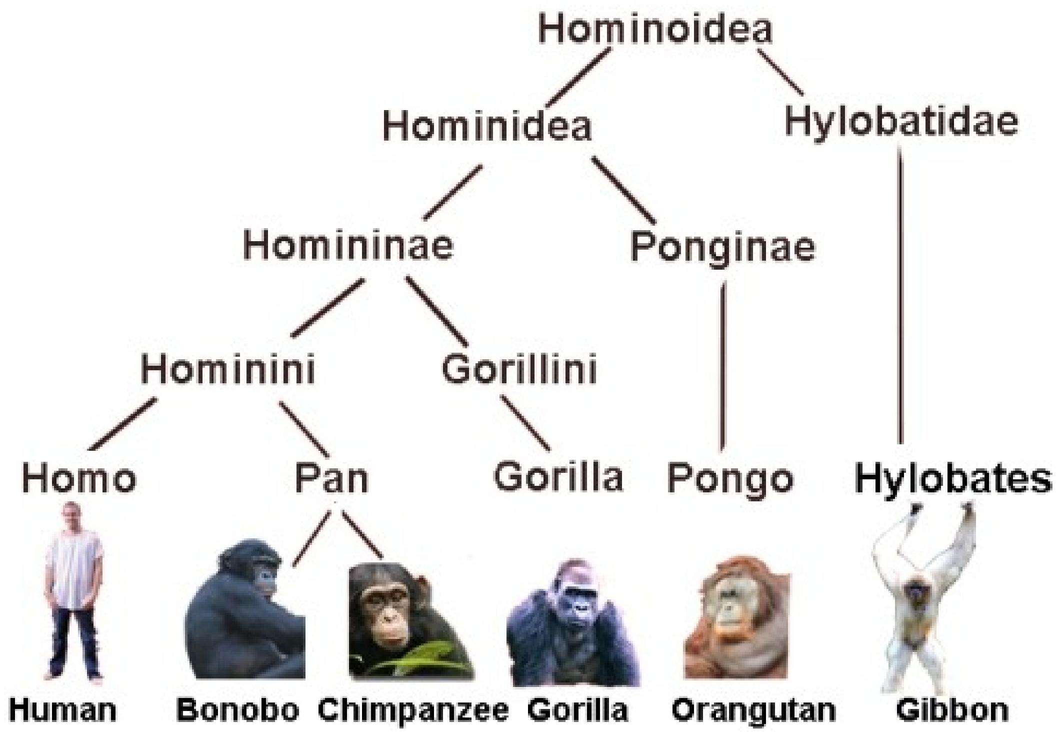


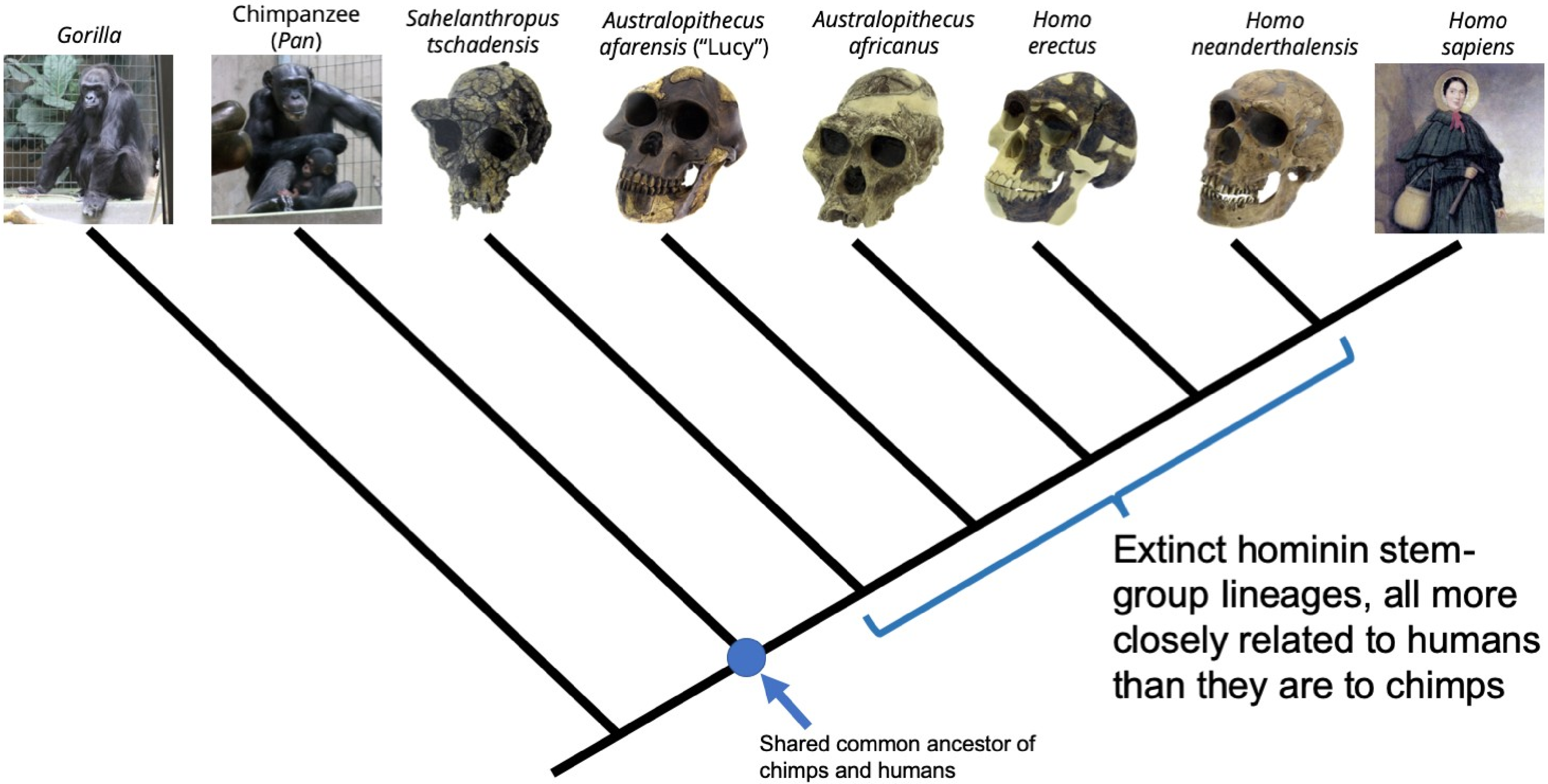
Allopatric
Peripatric
Parapatric
Sympatric
Original population
Initial step of speciation
Barrier formation
New niche entered
New niche entered
Genetic polymorphism
Evolution of reproductive isolation
In isolation
In isolated niche
In adjacent niche
Within the population
New distinct species after equilibration of new ranges


Population splits into two with no gene flow in between
New species
New species
8
7
6
5
4
3
2
1
#'s refer to generations
Either because of ramdom chance or (genetic drift) or adaptation to different environ-ments (natural selection), allele frequencies can change
The single ancestral species is polymorphic for a certain allele, and gene flow is possible throughout the species


2
Time
barriers to gene flow
T2
T1
...
3
2
generation 1
3
species A
species B
species C
= MRCA
gene tree =
species tree
A
B
C
deep coalescence
4
species A
species B
species C
gene tree ≠
species tree
A
B
C
incomplete lineage sorting

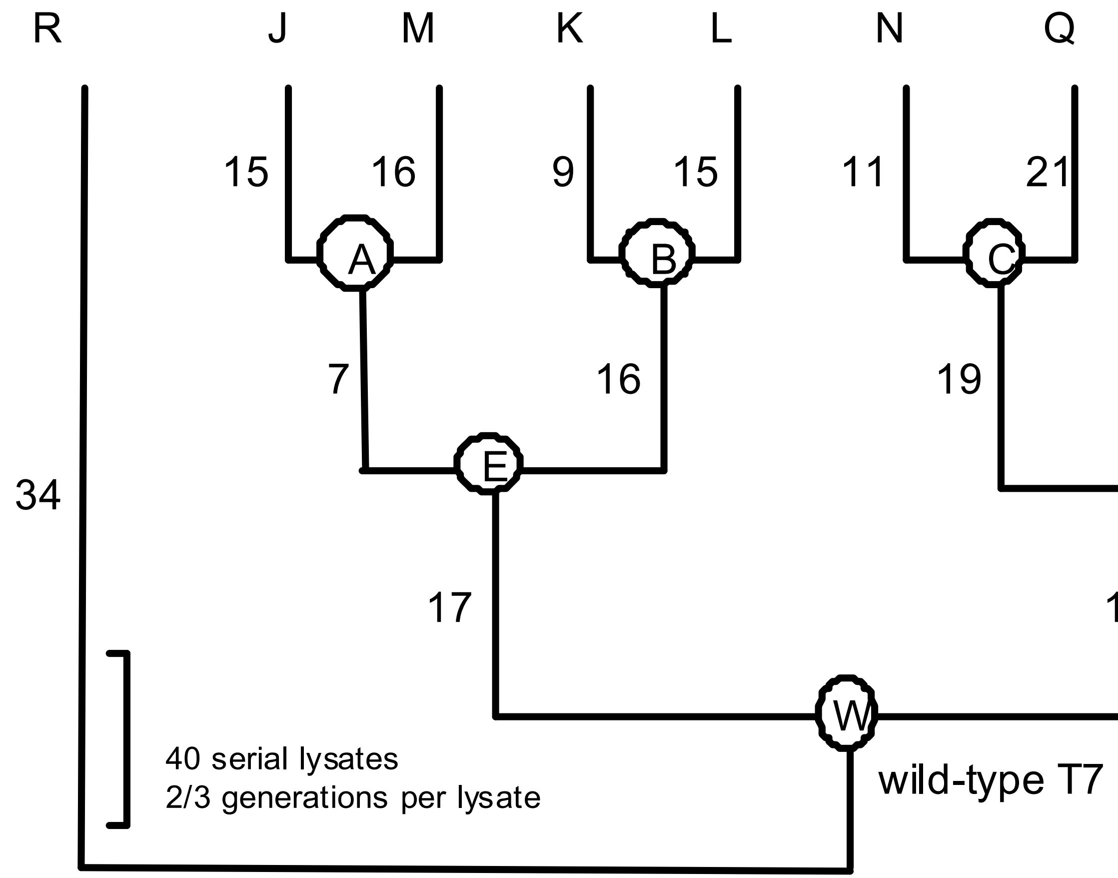

Gorilla
Chimpanzee (Pan)
Homo sapiens
Shared common ancestor of chimps and humans

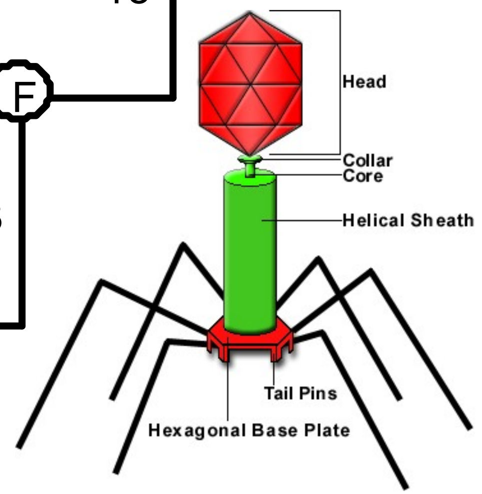

Hominoidea
Hominidea
Hylobatidae
Homininae
Ponginae
Hominini
Gorillini
Homo
Pan
Gorilla
Pongo
Hylobates
Human
Bonobo
Chimpanzee
Gorilla
Orangutan
Gibbon



(https://www.digitalatlasofancientlife.org/learn/).

Experimental phylogenetics





T7 bacteriophage in presence of *N*-methyl-*N'*-nitro-*N*-nitroguanidine

BMC Biology

BioMed Central

Research article

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Pair of lice lost or parasites regained: the evolutionary history of anthropoid primate lice

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Abstract

Background: The parasitic sucking lice of primates are known to have undergone at least 25 million years of coevolution with their hosts. For example, chimpanzee lice and human head/body lice last shared a common ancestor roughly six million years ago, a divergence that is contemporaneous with their hosts. In an assemblage where lice are often highly host specific, humans host two different genera of lice, one that is shared with chimpanzees and another that is

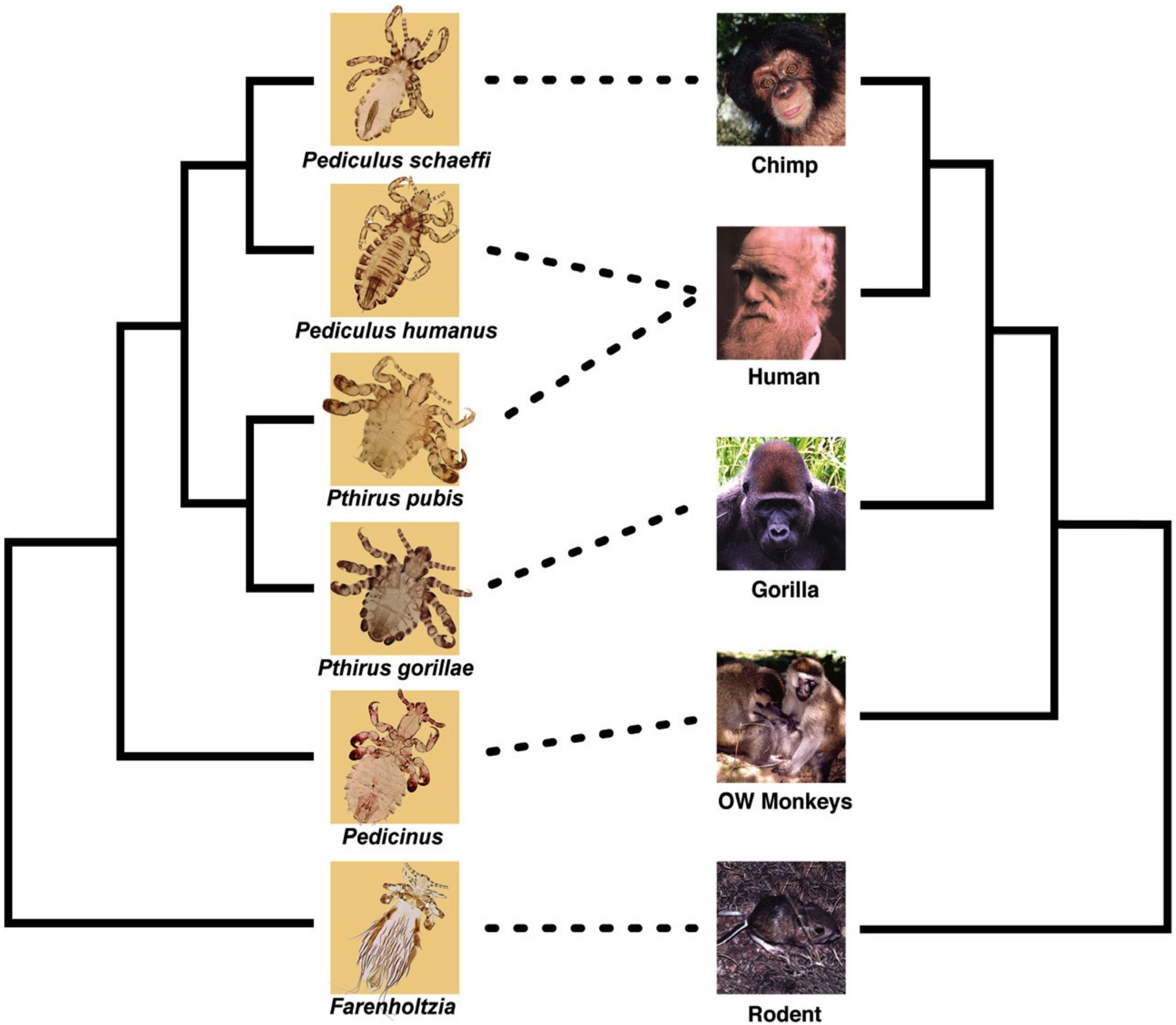
A tale of three lice

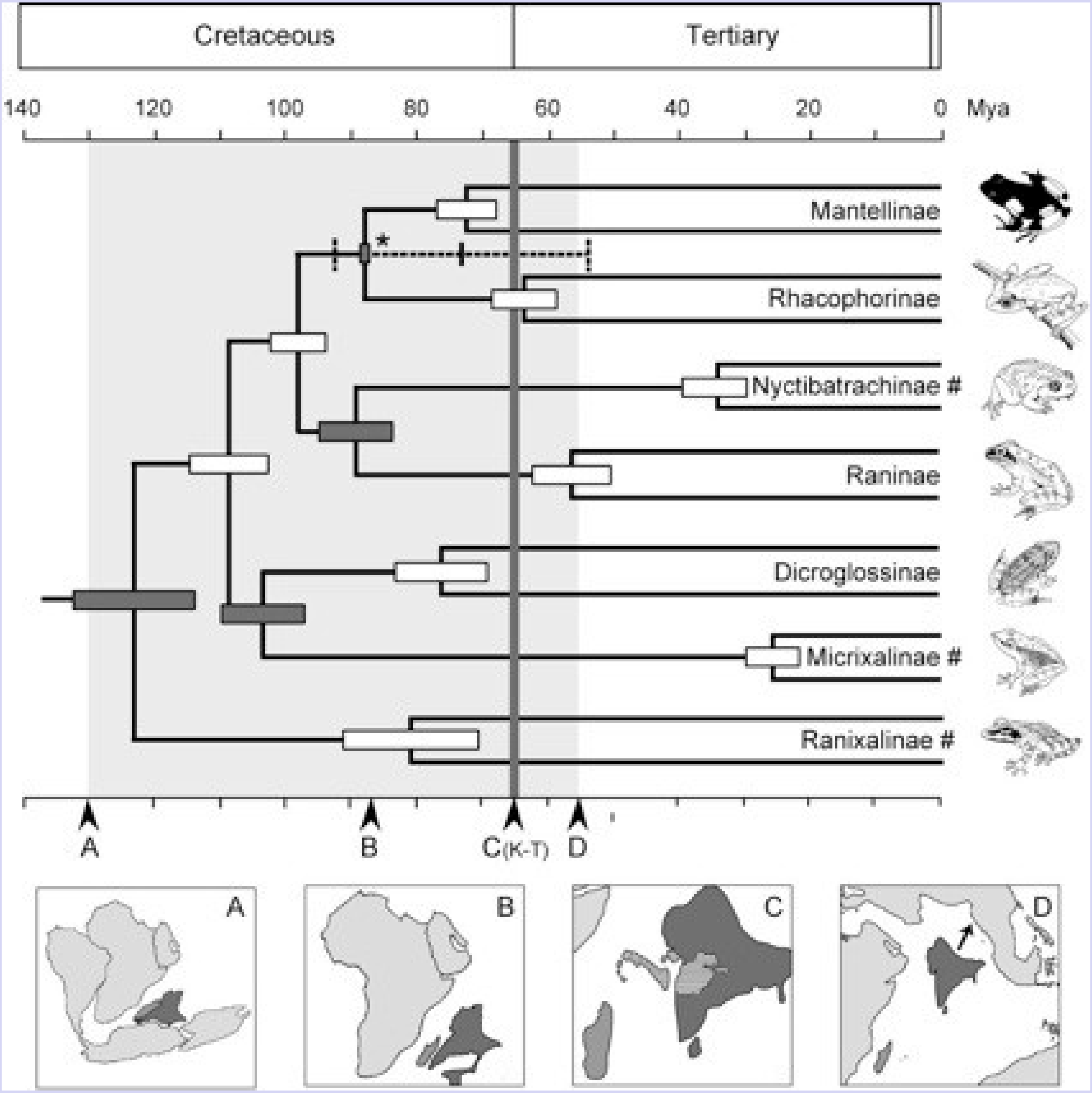
- Lice are highly specialized blood sucking parasites that live on a single host species.
- Each of our ape relatives hosts one louse species, but humans host three types of lice.

The head louse, *Pediculus humanus capitus*

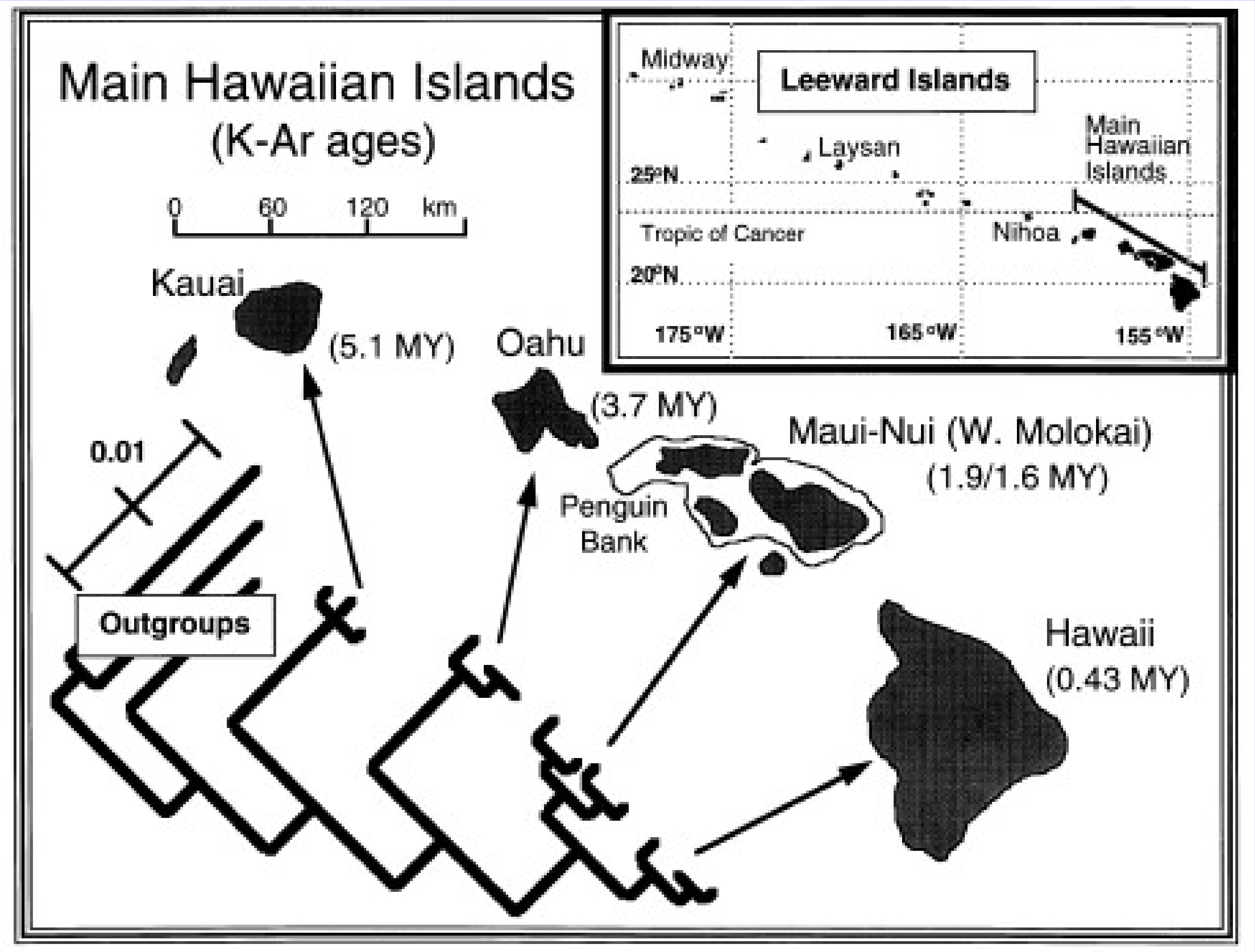
The pubic louse, *Phthirus pubis*

The body louse, *Pediculus humanus corporis*

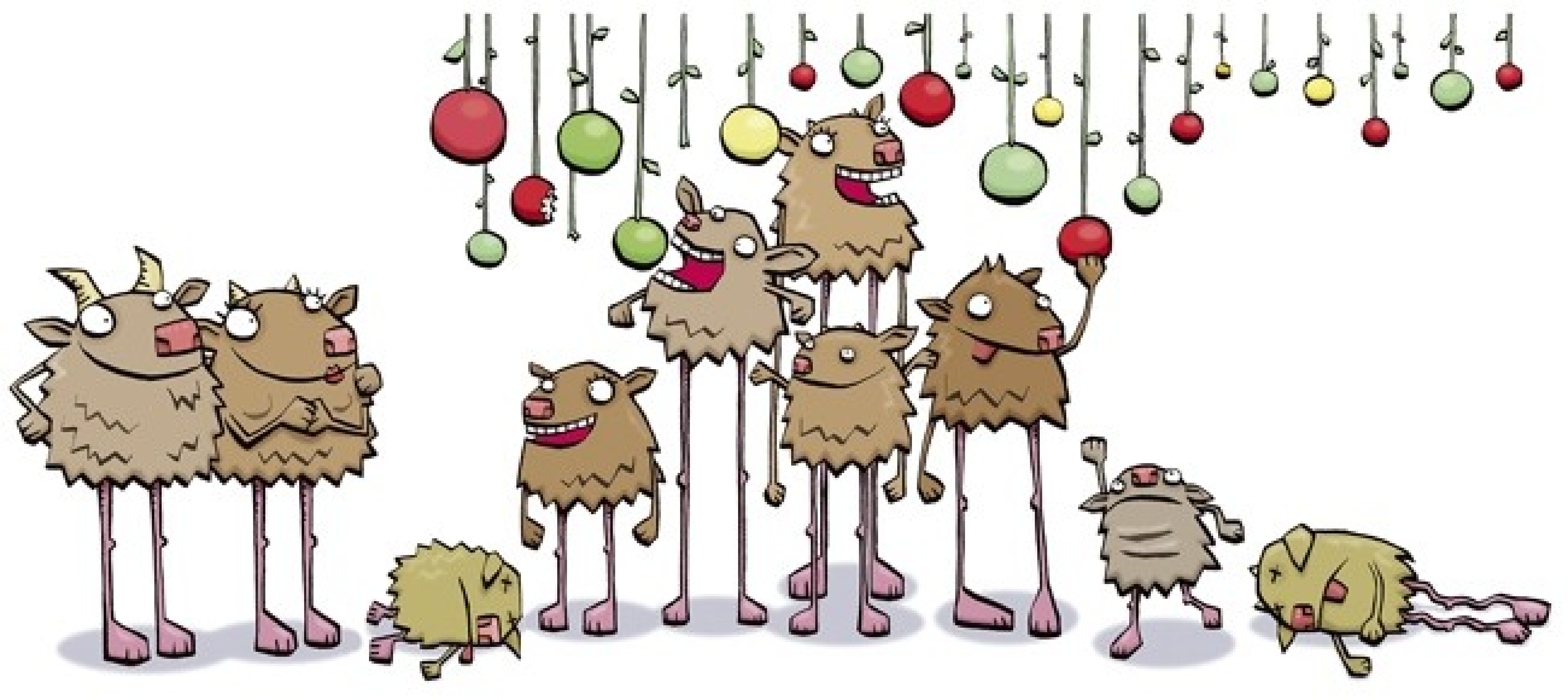

Pediculus schaeffi
Pediculus humanus
Pthirus pubis
Pthirus gorillae
Pedicinus
Farenholtzia
Chimp
Human
Gorilla
OW Monkeys
Rodent



Cretaceous
Tertiary
140
120
100
80
60
40
20
0
Mya
Mantellinae
Rhacophorinae
Nyctibatrachinae #
Raninae
Dicroglossinae
Micrixalinae #
Ranixalinae #
*
A
B
C(K-T)
D
A
B
C
D



Main Hawaiian Islands
(K-Ar ages)
0
60
120
km
Kauai
(5.1 MY)
Oahu
(3.7 MY)
Maui-Nui (W. Molokai)
(1.9/1.6 MY)
Penguin
Bank
Hawaii
(0.43 MY)
0.01
Outgroups
Midway
Leeward Islands
Laysan
Main
Hawaiian
Islands
25°N
Tropic of Cancer
Nihoa
20°N
175°W
165°W
155°W



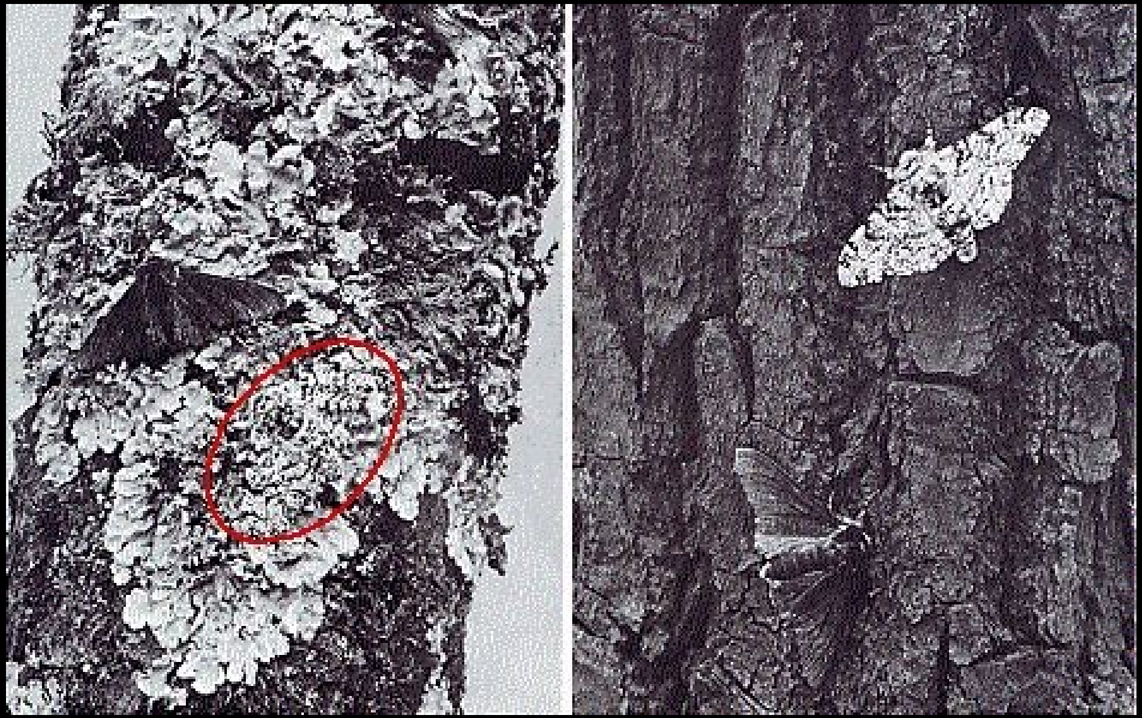
Natural Selection

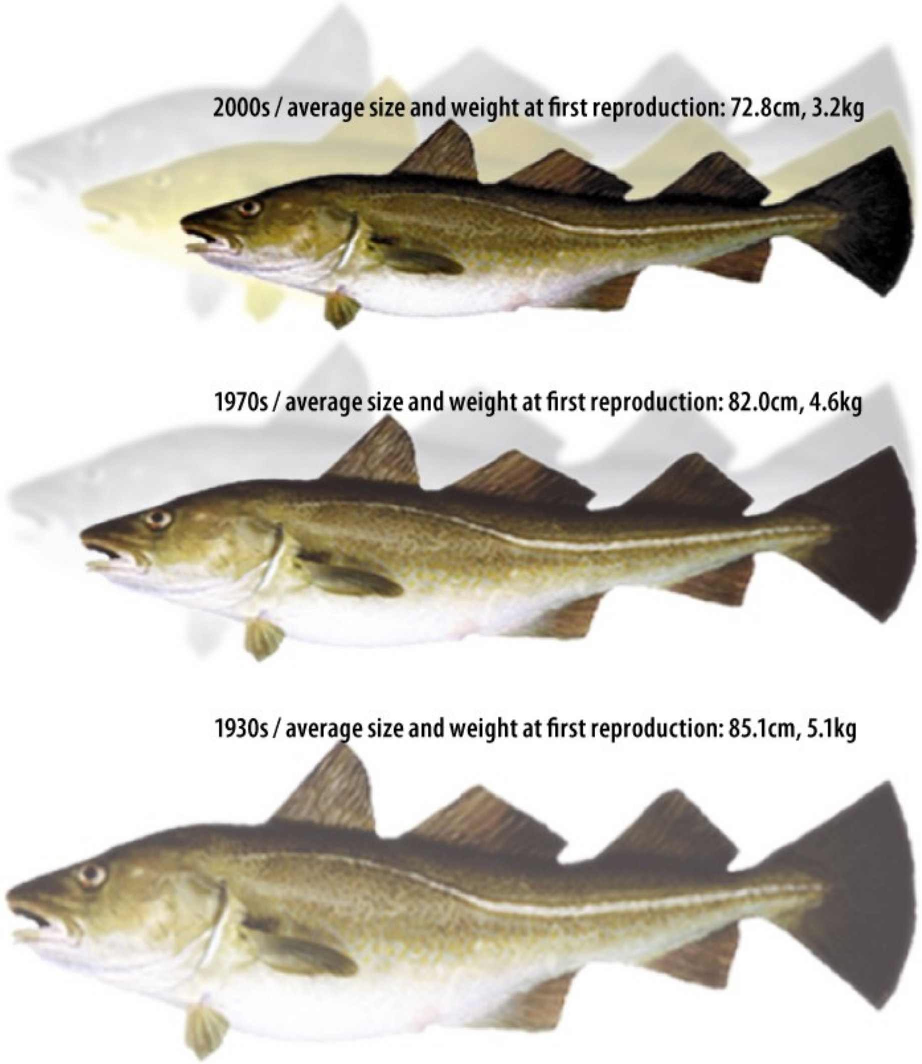
1. Individuals in natural populations display variation.

2. Certain individual variations are inheritable.

3. Certain heritable variations result in differential reproductive success.

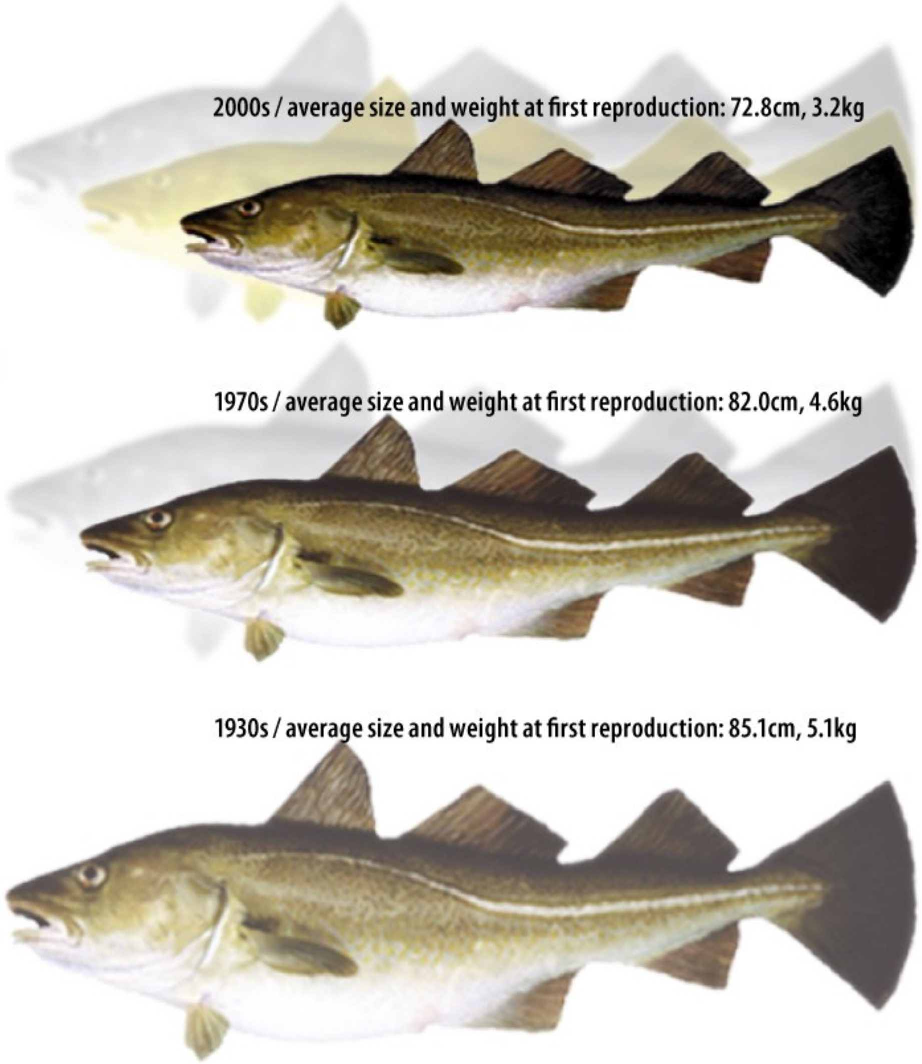
4. Differences in reproductive success due to heritable variation cause changes in the relative representation of such variations in the population.




2000s / average size and weight at first reproduction: 72.8cm, 3.2kg
1970s / average size and weight at first reproduction: 82.0cm, 4.6kg
1930s / average size and weight at first reproduction: 85.1cm, 5.1kg

EVOFISH

Evolutionary Fisheries Ecology



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SCIENTIFIC REPORTS

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De novo origins of multicellularity in response to predation

Matthew D. Herron[1,2], Joshua M. Borin[2,3], Jacob C. Boswell[1,2], Jillian Walker[2], I-Chen Kimberly Chen[2], Charles A. Knox[1], Margrethe Boyd[1,4], Frank Rosenzweig[1,2] & William C. Ratcliff[2]

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Accepted: 17 January 2019
Published online: 20 February 2019

The transition from unicellular to multicellular life was one of a few major events in the history of life that created new opportunities for more complex biological systems to evolve. Predation is hypothesized as one selective pressure that may have driven the evolution of multicellularity. Here we show that *de novo* origins of simple multicellularity can evolve in response to predation. We subjected outcrossed populations of the unicellular green alga *Chlamydomonas reinhardtii* to selection by the filter-feeding predator *Paramecium tetraurelia*. Two of five experimental populations evolved multicellular structures not observed in unselected control populations within ~750 asexual generations. Considerable variation exists in the evolved multicellular life cycles, with both cell number and propagule size varying among isolates. Survival assays show that evolved multicellular traits provide effective protection against predation. These results support the hypothesis that selection imposed by predators may have played a role in some origins of multicellularity.

Nearly all macroscopic life is multicellular. As Leo Buss emphasized in *The Evolution of Individuality*, the very existence of integrated multicellular organisms is an outcome of evolutionary processes, not a starting condition[1]. It seems, in fact, to be a common outcome: multicellular organisms have evolved from unicellular ancestors dozens of times[2–4]. Animals, land plants, fungi, red algae, brown algae, several groups of green algae, cellular and acrasid slime molds, and colonial ciliates, among others, each descend from a different unicellular ancestor[4,5].

Two retrospective approaches, comparative methods and the fossil record, have proven valuable in recon-

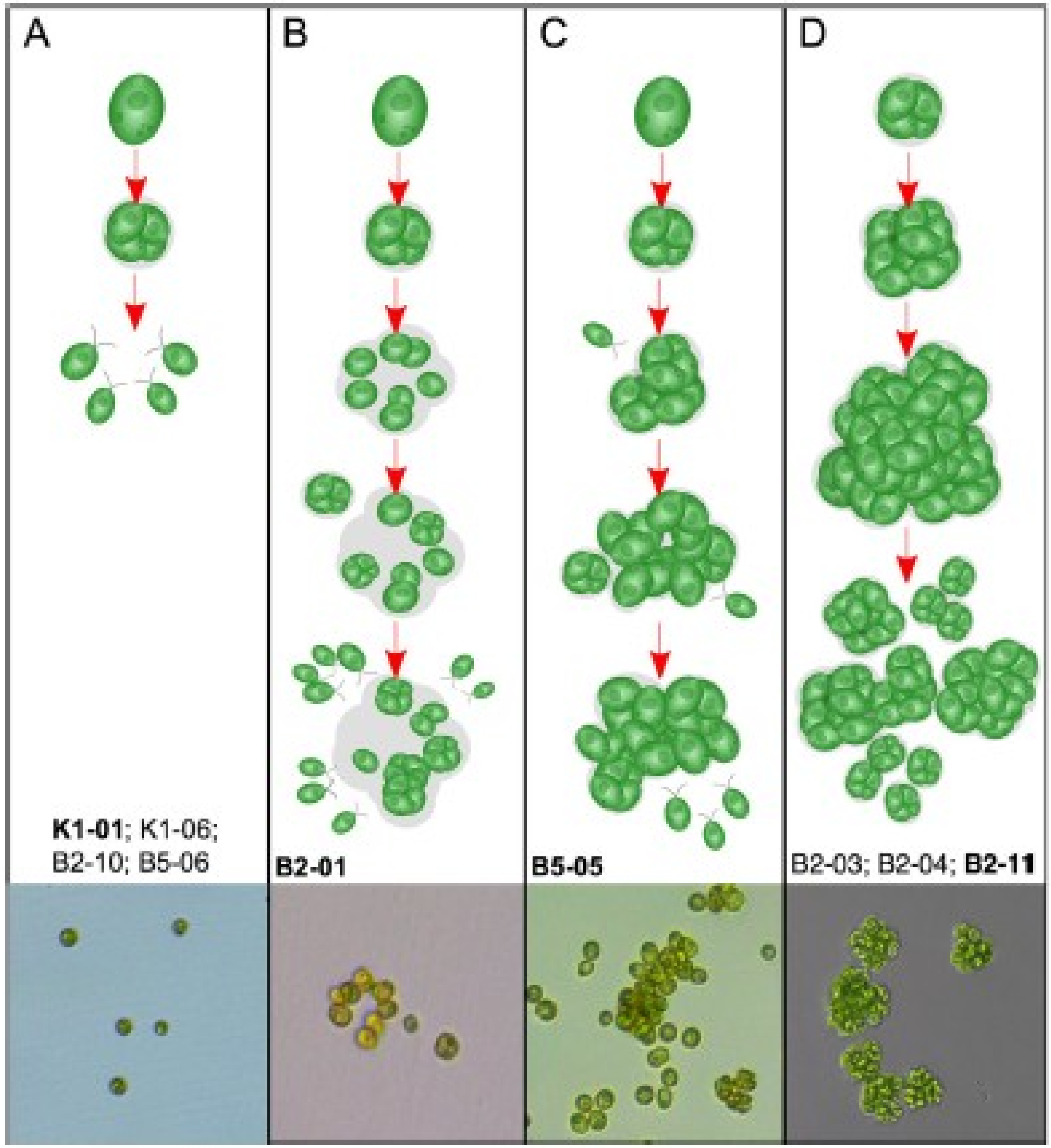
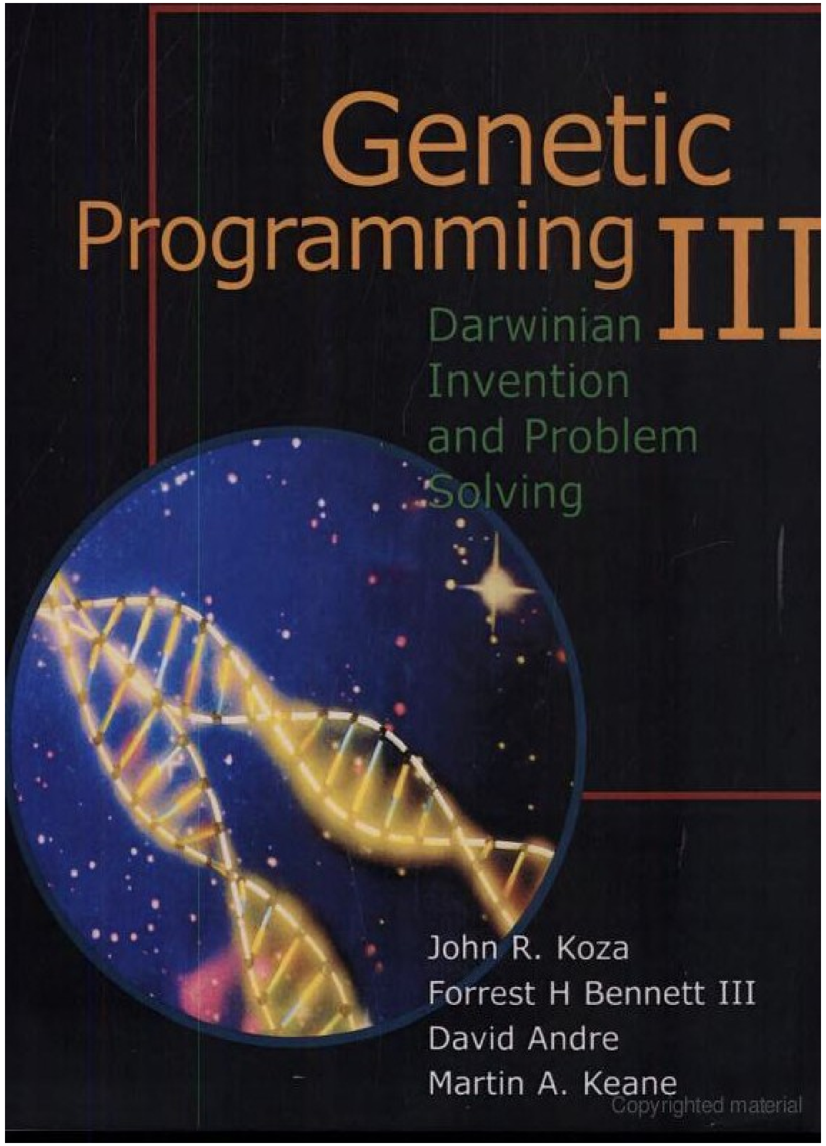


Figure 2. Depiction of *C. reinhardtii* life cycles following evolution with (B2, B5) or without (K1) predators for 50 weeks. Categories (A–D) show a variety of life cycle characteristics, from unicellular to various multicellular forms. Briefly, A shows the ancestral, wild-type life cycle; in B this is modified with cells embedded in an extracellular matrix; C is similar to B but forms much larger multicellular structures; while D shows a fully multicellular life cycle in which multicellular clusters release multicellular propagules. Evolved strains were qualitatively categorized based on growth during 72-hour time-lapse videos. Strains within each life cycle category are listed below illustrations. Representative microscopic images of each life cycle category are at the bottom (Depicted strain in boldface).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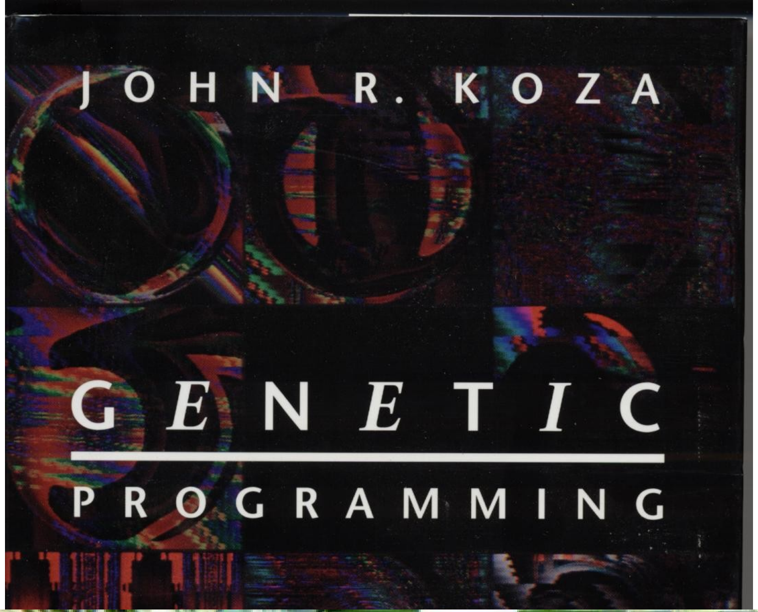
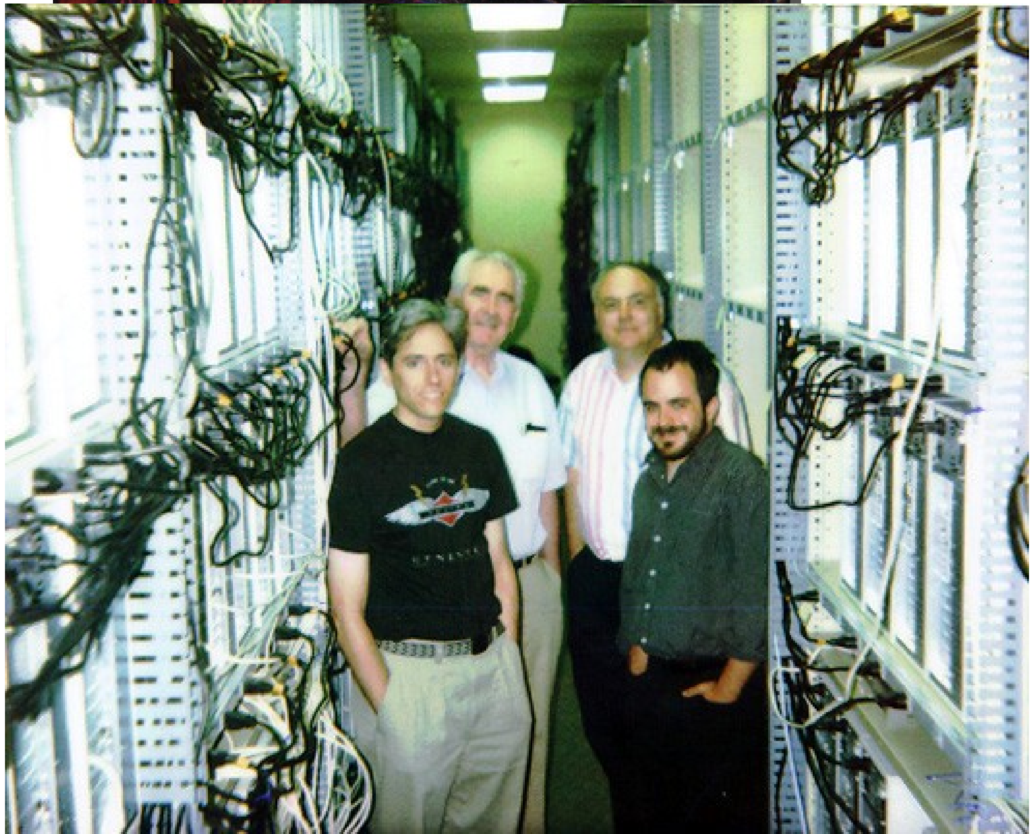
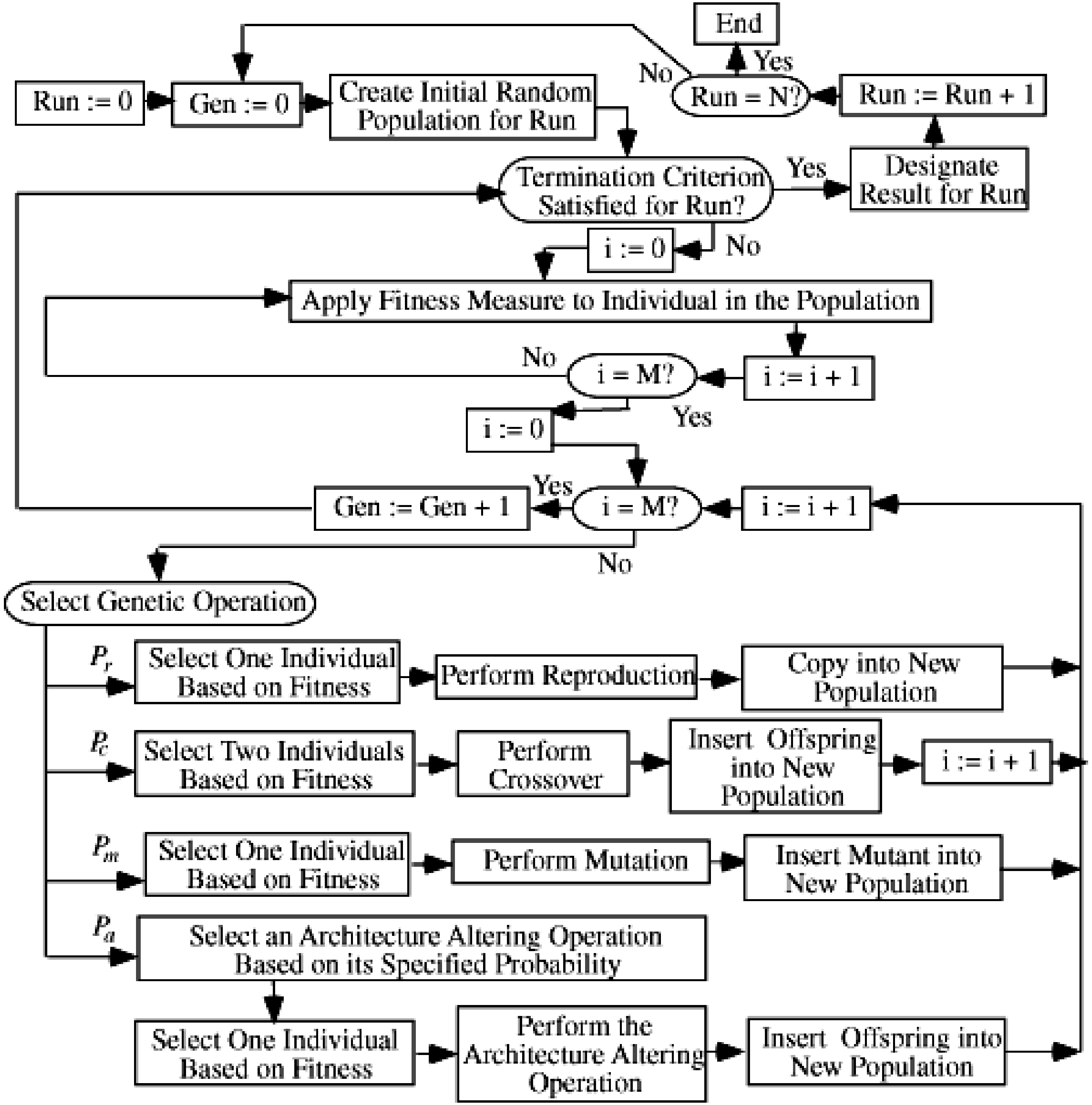
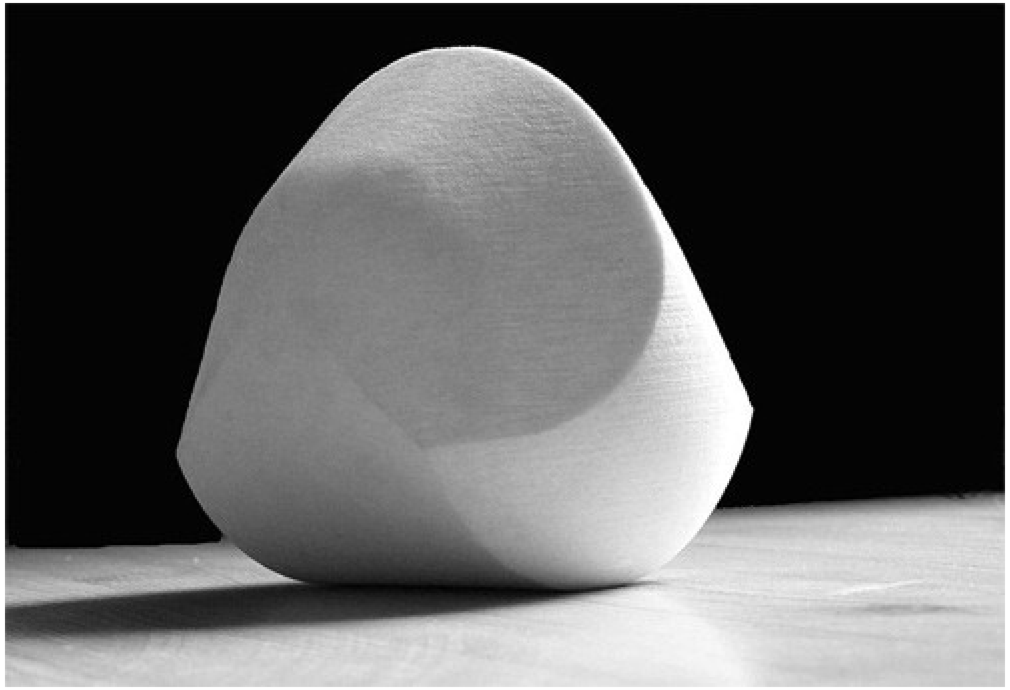

JOHN R. KOZA
GENETIC
PROGRAMMING



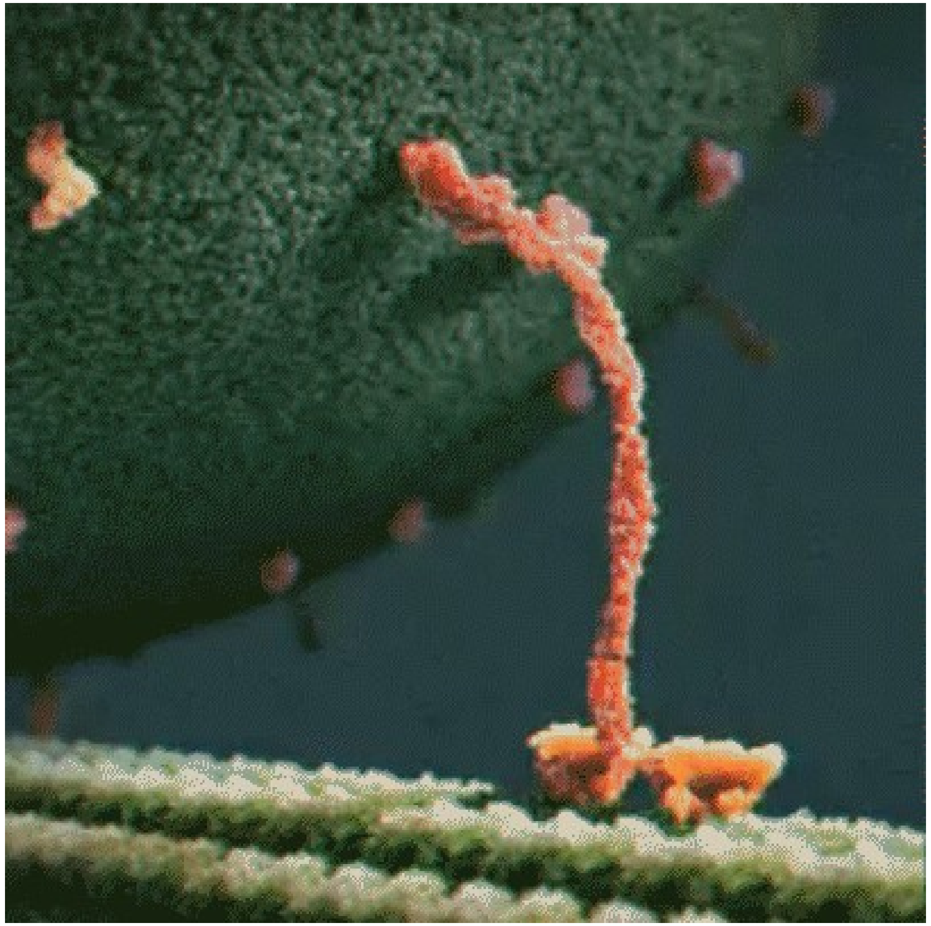


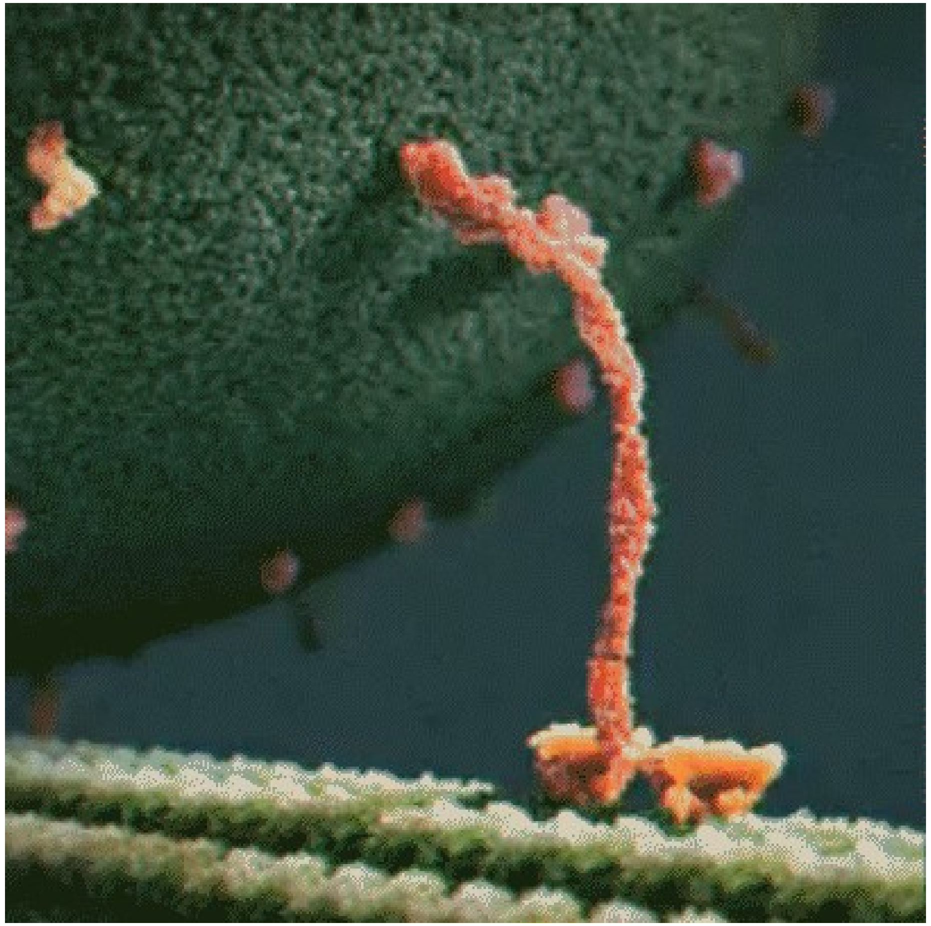
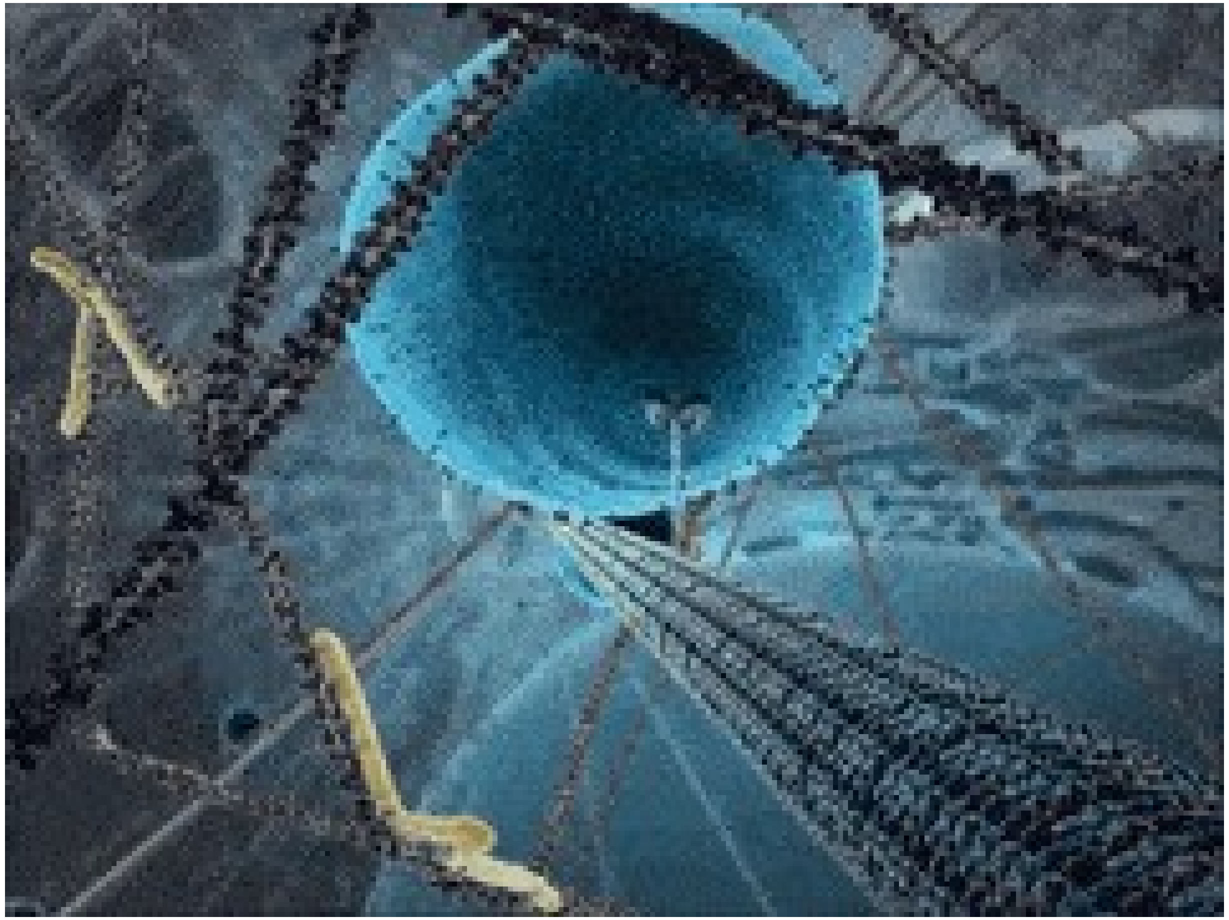
End
Yes
No
Run := 0
Gen := 0
Create Initial Random Population for Run
Run = N?
Run := Run + 1
Termination Criterion Satisfied for Run?
Yes
Designate Result for Run
i := 0
No
Apply Fitness Measure to Individual in the Population
No
i = M?
i := i + 1
Yes
i := 0
Yes
Gen := Gen + 1
i = M?
i := i + 1
No
Select Genetic Operation
P_r
Select One Individual Based on Fitness
Perform Reproduction
Copy into New Population
P_c
Select Two Individuals Based on Fitness
Perform Crossover
Insert Offspring into New Population
i := i + 1
P_m
Select One Individual Based on Fitness
Perform Mutation
Insert Mutant into New Population
P_a
Select an Architecture Altering Operation Based on its Specified Probability
Select One Individual Based on Fitness
Perform the Architecture Altering Operation
Insert Offspring into New Population



Gábor Domokos and Péter Várkonyi

“We discovered it with mathematics,
but evolution got there first.”



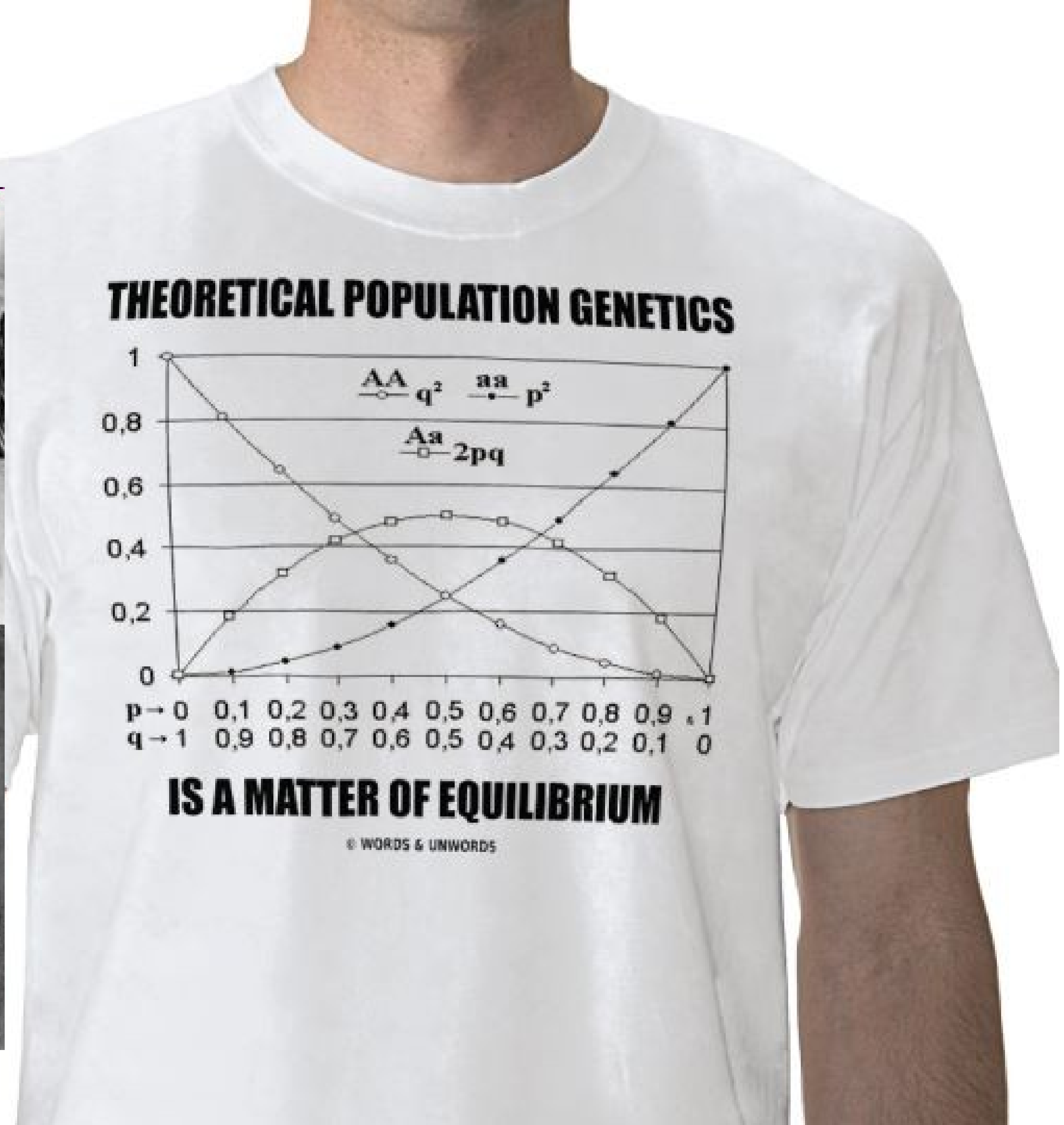
THE

GENETICAL THEORY OF NATURAL SELECTION

BY

R. A. FISHER, Sc.D., F.R.S.

OXFORD
AT THE CLARENDON PRESS
1930


THEORETICAL POPULATION GENETICS
1
0,8
0,6
0,4
0,2
0
AA q²
aa p²
Aa 2pq
p → 0 0,1 0,2 0,3 0,4 0,5 0,6 0,7 0,8 0,9 1
q → 1 0,9 0,8 0,7 0,6 0,5 0,4 0,3 0,2 0,1 0
IS A MATTER OF EQUILIBRIUM
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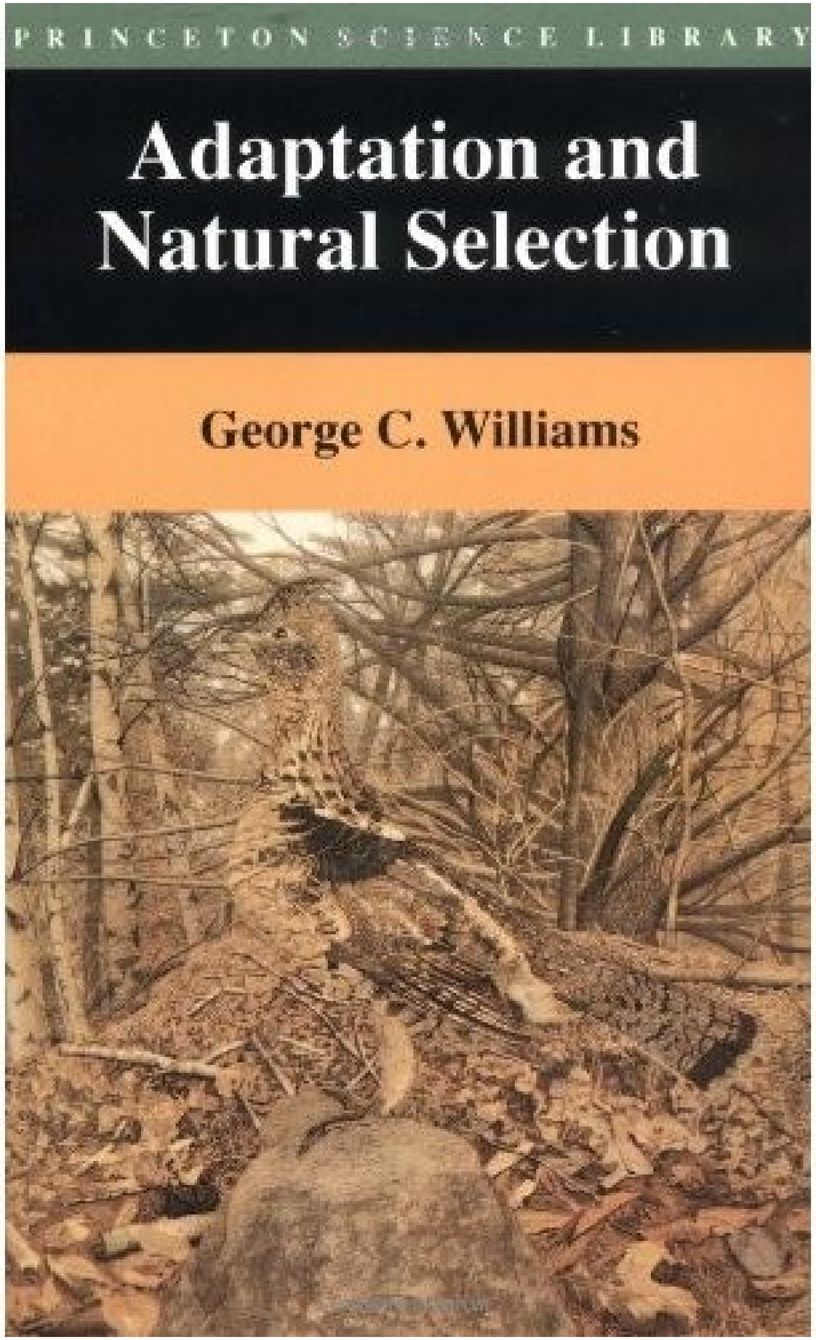
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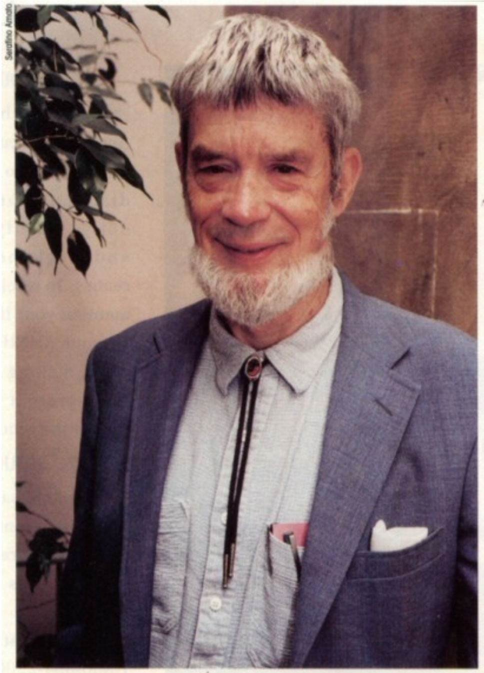
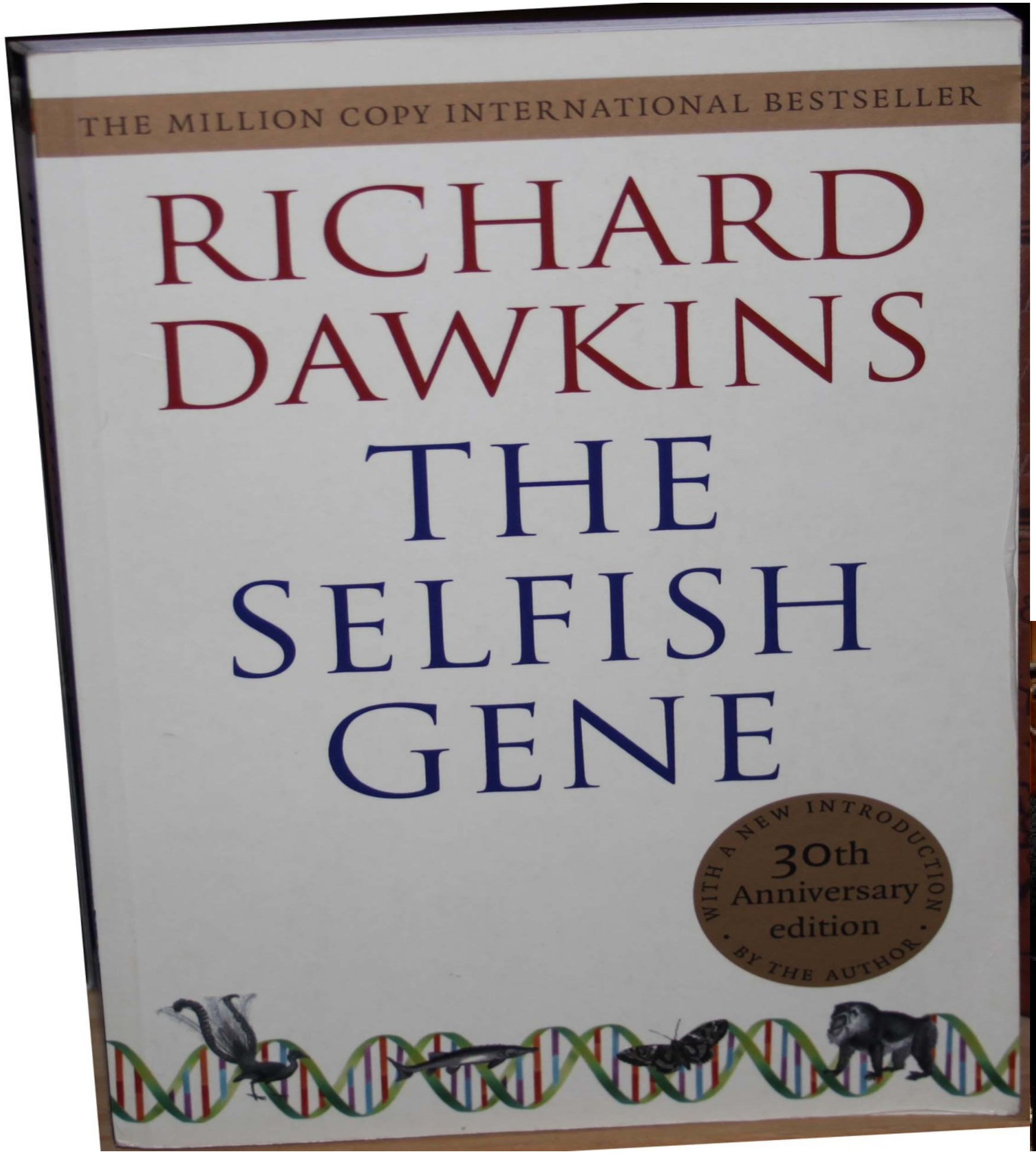
Adaptation and Natural Selection
George C. Williams

1966

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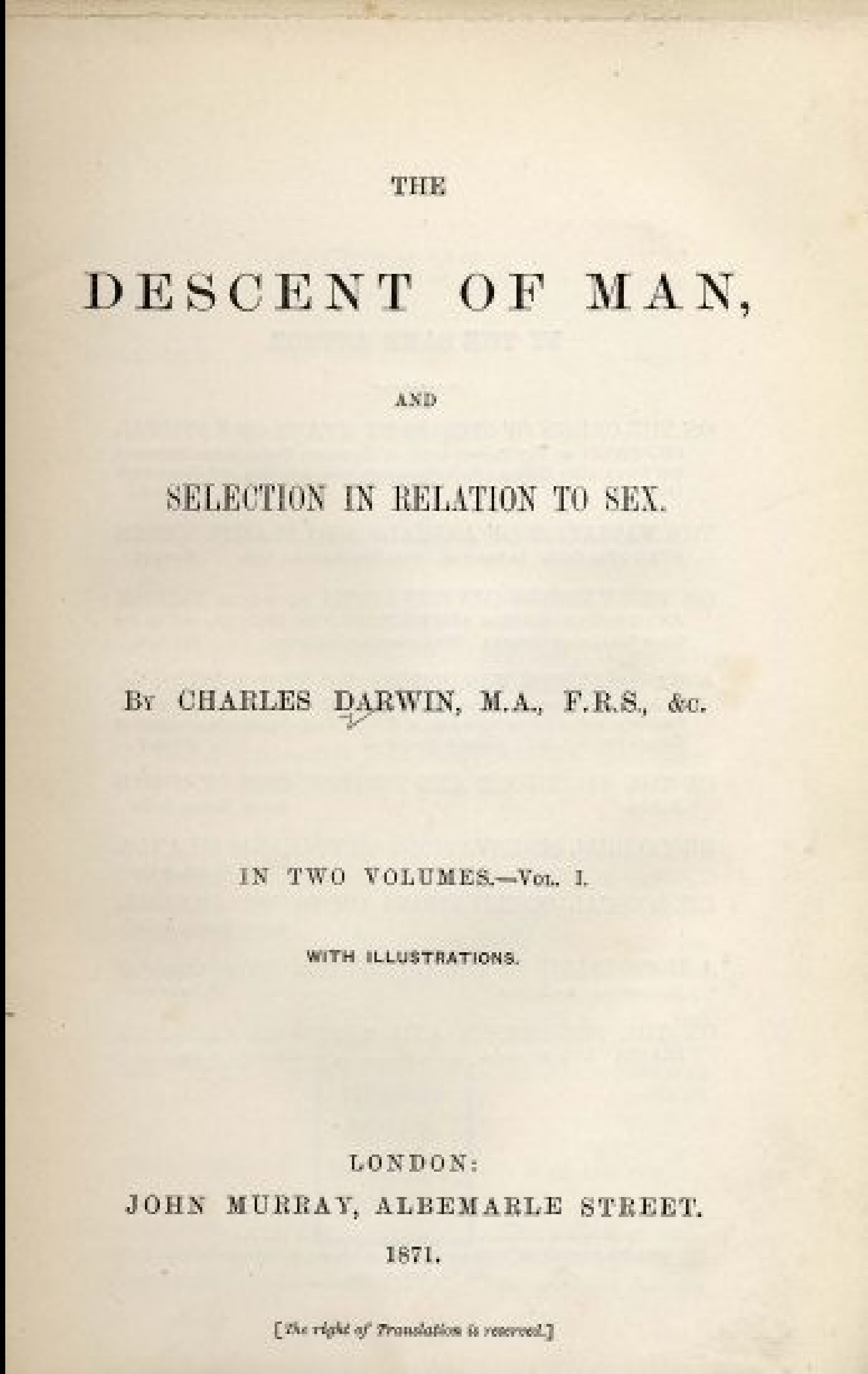


THE

DESCENT OF MAN,

AND

SELECTION IN RELATION TO SEX.

By CHARLES DARWIN, M.A., F.R.S., &c.

IN TWO VOLUMES.—Vol. I.

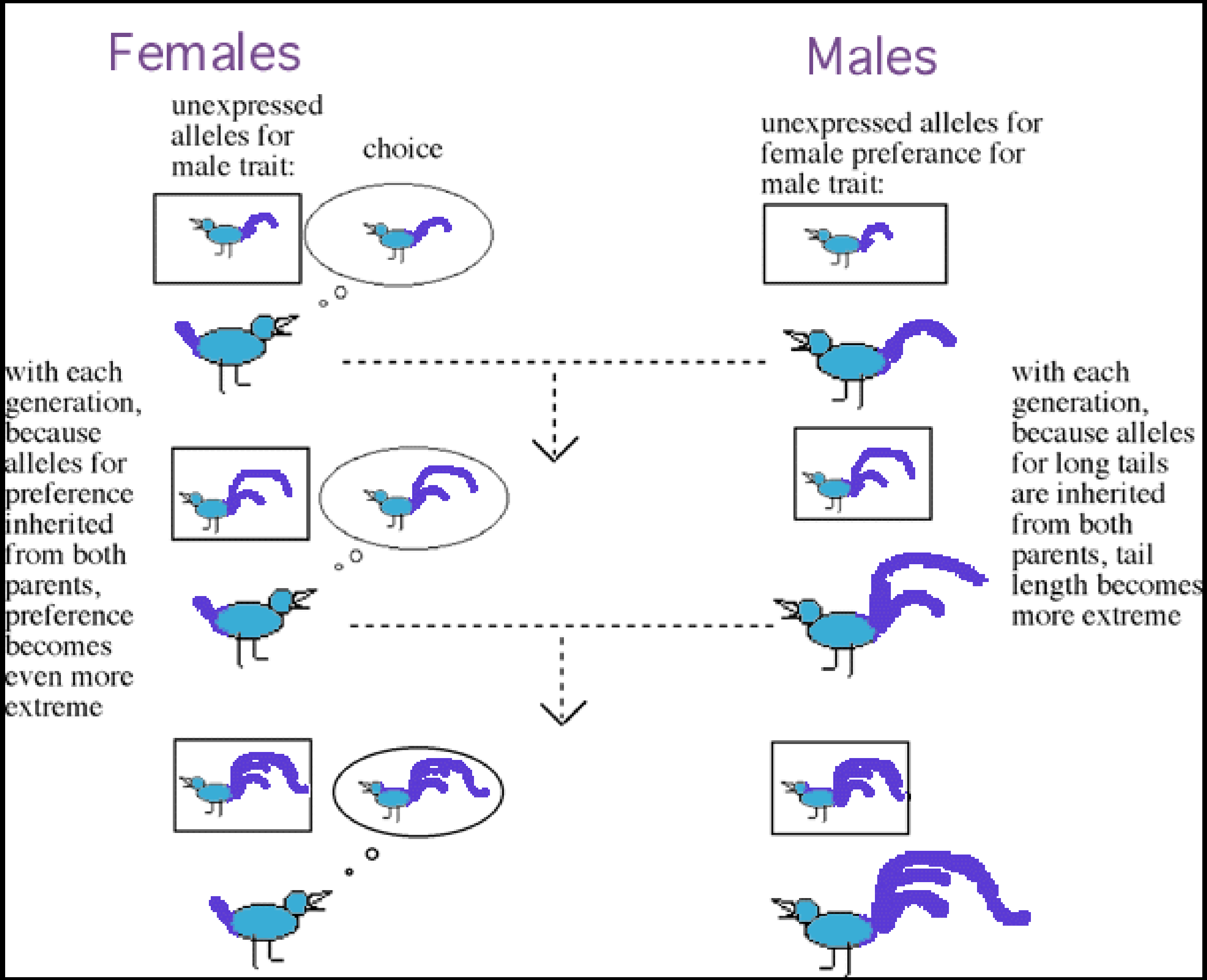
WITH ILLUSTRATIONS.

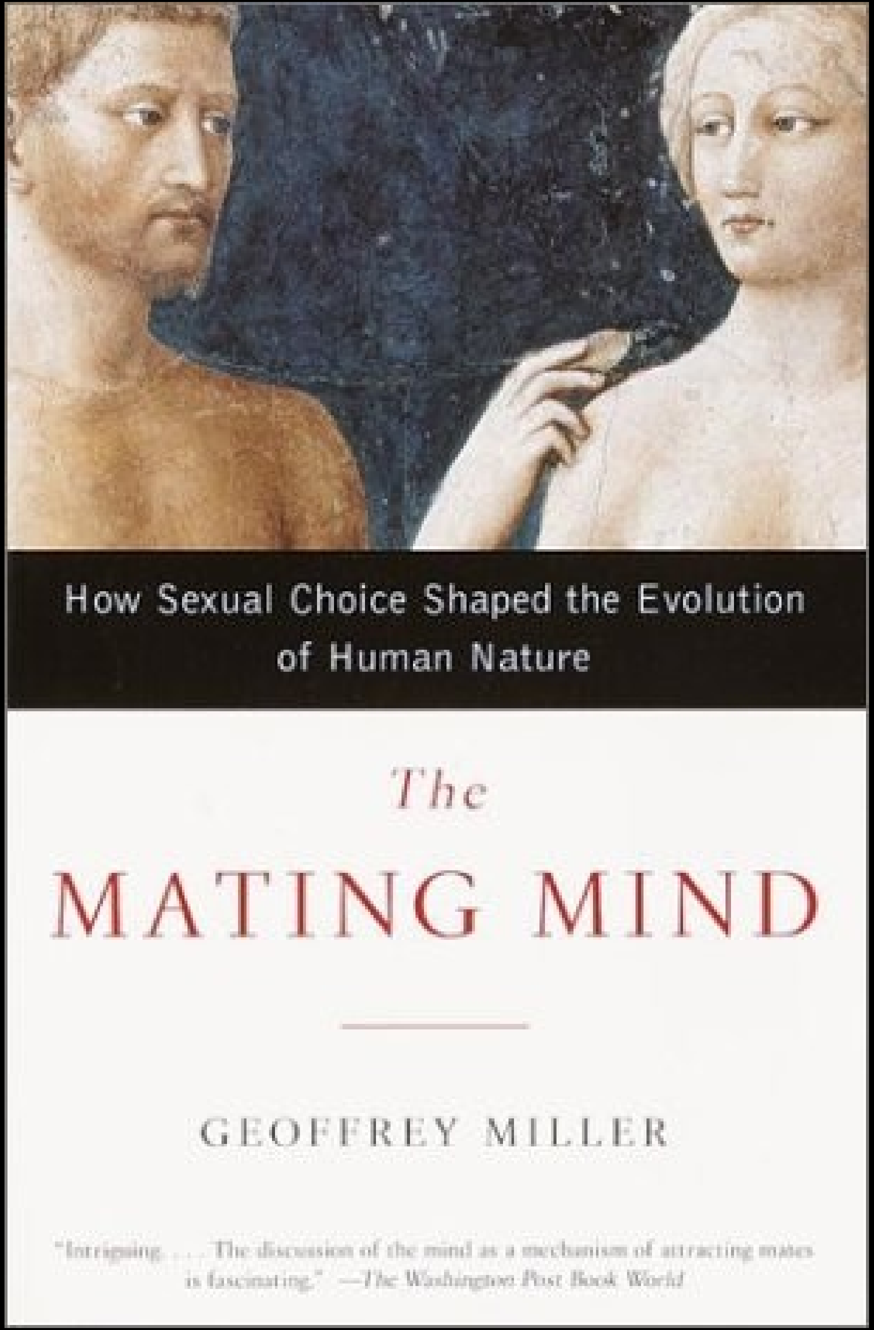
LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1871.

Ibis 1883 Pl. VIII

J. G. Keulemans lith. Hanhart imp.

PARADISEA DECORA


Females
Males
unexpressed alleles for male trait:
choice
unexpressed alleles for female preferance for male trait:
with each generation, because alleles for preference inherited from both parents, preference becomes even more extreme
with each generation, because alleles for long tails are inherited from both parents, tail length becomes more extreme


How Sexual Choice Shaped the Evolution of Human Nature
The MATING MIND
GEOFFREY MILLER
"Intriguing. . . . The discussion of the mind as a mechanism of attracting mates is fascinating." —The Washington Post Book World

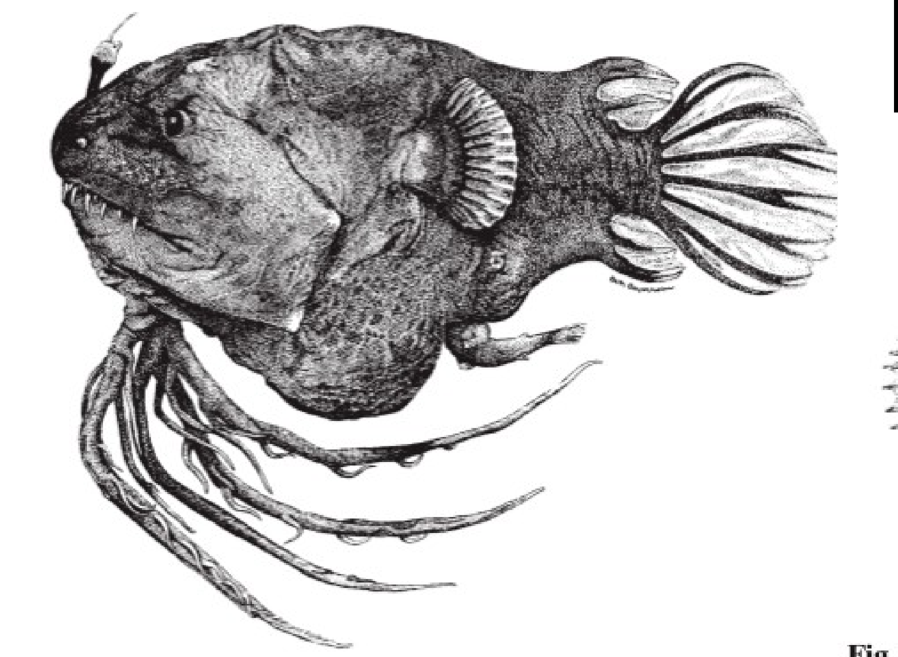


Fig. 22. *Linophryne brevibarbata*, 100-mm female, with an 18.5-
parasitic male, BMNH 1995.1.18.4. (Drawing by Elisabeth Beyerhc
after Bertelsen, 1980a)

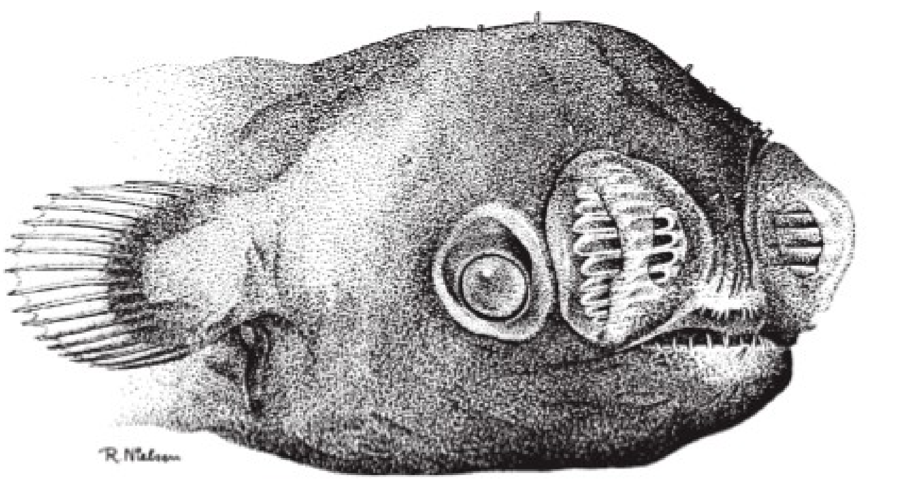
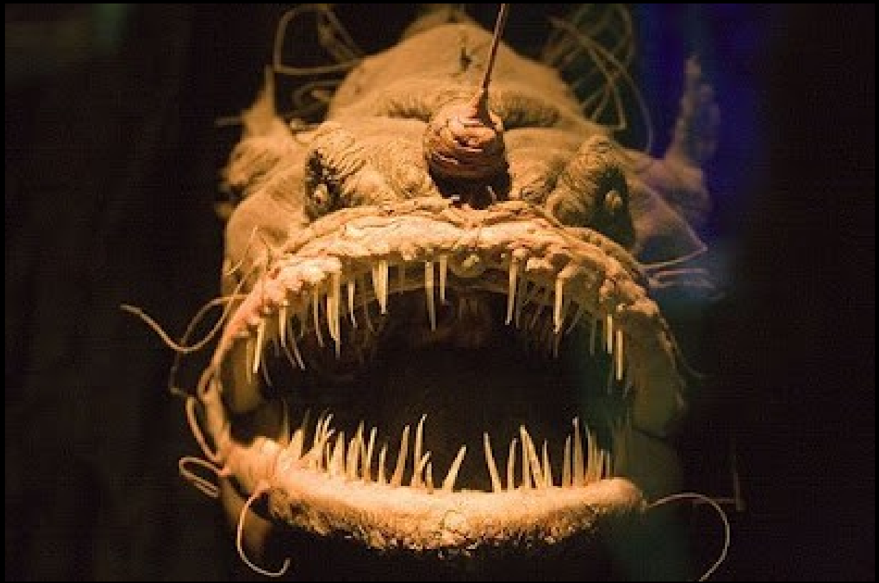


Fig. 18. Free-living male of *Linophryne arborifera*-group, 18.5 mm, BMNH 2004.7.5.1, showing extremely well-developed eyes and nostrils (Drawing by R. Nielsen; after Bertelsen, 1980a)



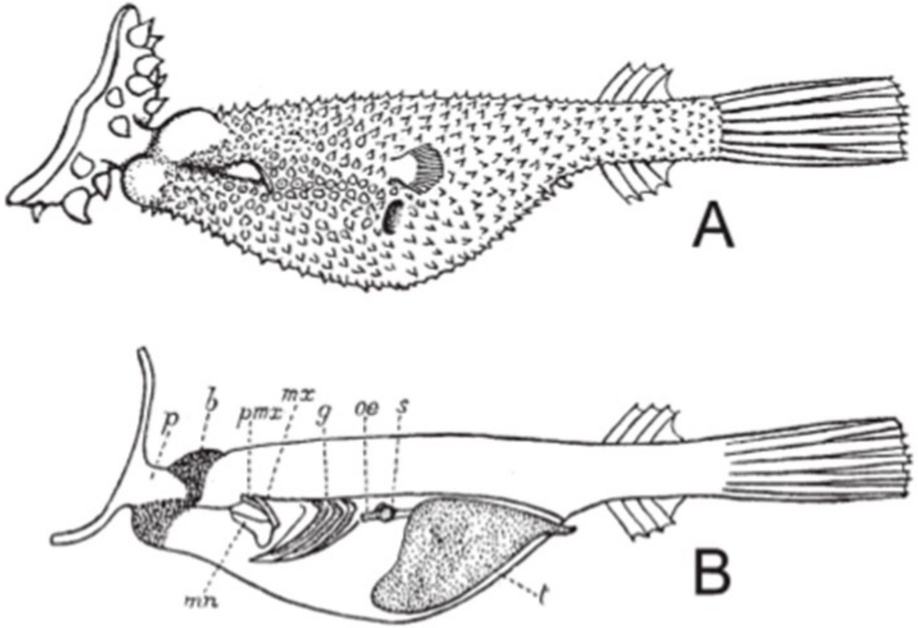


Fig. 4. Parasitic male of *Ceratias holboelli*, 75 mm, attached to a 670-mm female; BMNH 1924.12.29.2. **A** External view; **B** internal view: *b*, outgrowth of tissue at point of contact of male and female; *g*, gills; *mn*, mandible; *mx*, maxilla; *oe*, esophagus; *p*, papilla of female; *pmx*, premaxilla; *s*, stomach; *t*, testes. After Regan (1925b)


Lamprologus callipterus


04/20/2

REVUE SUISSE DE ZOOLOGIE 117 (4): 611-635; décembre 2010

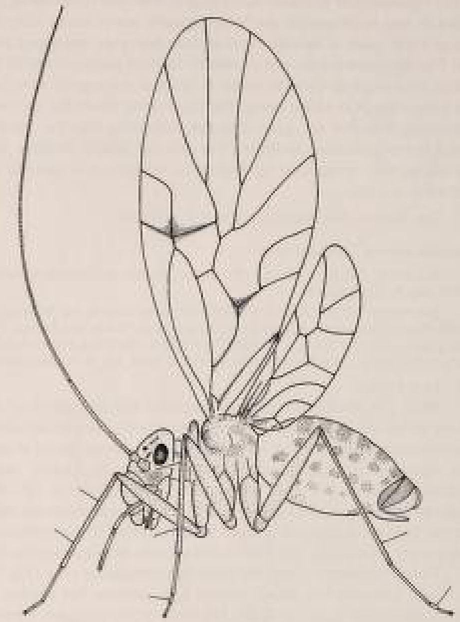
A new genus of Sensitibillini from Brazilian caves (Psocodea: 'Psocoptera': Prionoglarididae)

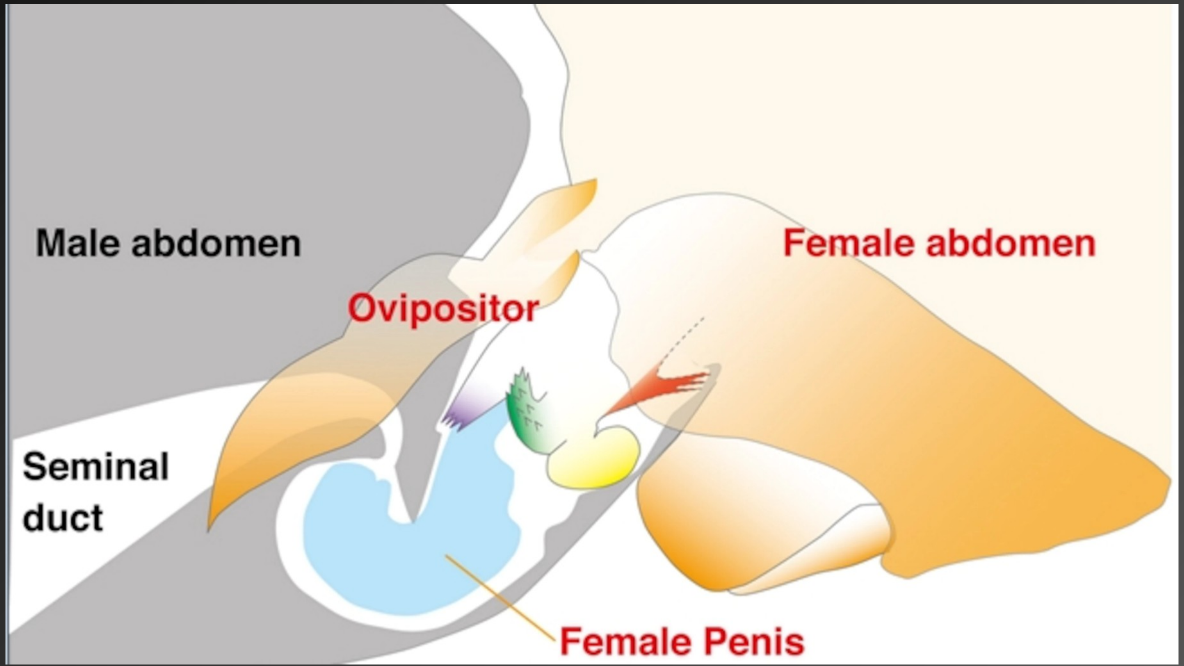
Charles LIENHARD[1], Thais OLIVEIRA DO CARMO[2] & Rodrigo LOPES FERREIRA[2]

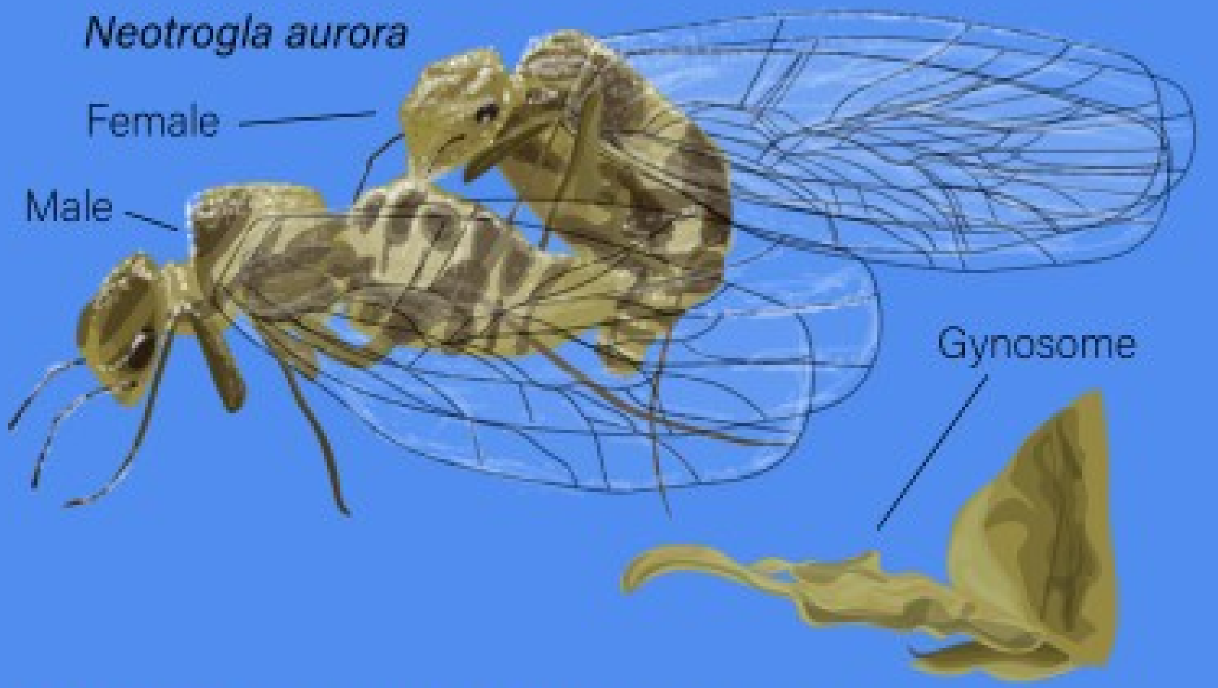
[1] Muséum d'histoire naturelle, c. p. 6434, CH-1211 Genève 6, Switzerland. Corresponding author. E-mail: charleslienhard@bluewin.ch

[2] Universidade Federal de Lavras, Departamento de Biologia (Zoologia), CP. 3037, CEP. 37200-000 Lavras (MG), Brazil.

A new genus of Sensitibillini from Brazilian caves (Psocodea: 'Psocoptera': Prionoglarididae). - The genus *Neotrogla* Lienhard gen. n. is described for three new cave-dwelling species from Brazil: *Neotrogla brasiliensis* Lienhard sp. n. (from Minas Gerais State), *N. curupira* Lienhard







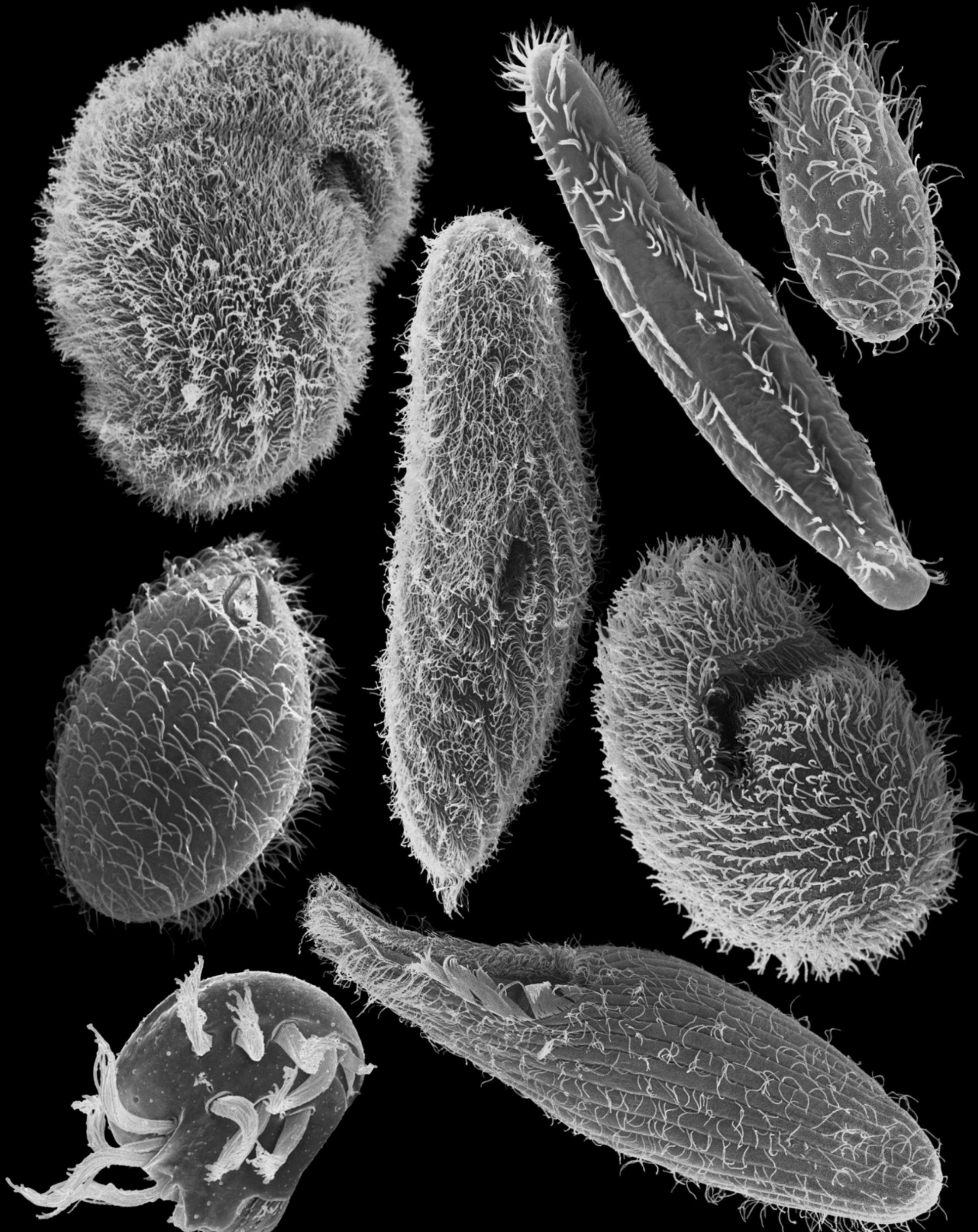
Neotrogla is a genus of Psocoptera, very small insects, that dwell in very dry caves. The females have structures, ***gymnosomes***, that enter the males during mating, to retrieve a ***spermatophore***, a packet of sperm and nutrients. Researchers hypothesize that females developed these structures because the spermatophores are so valuable.

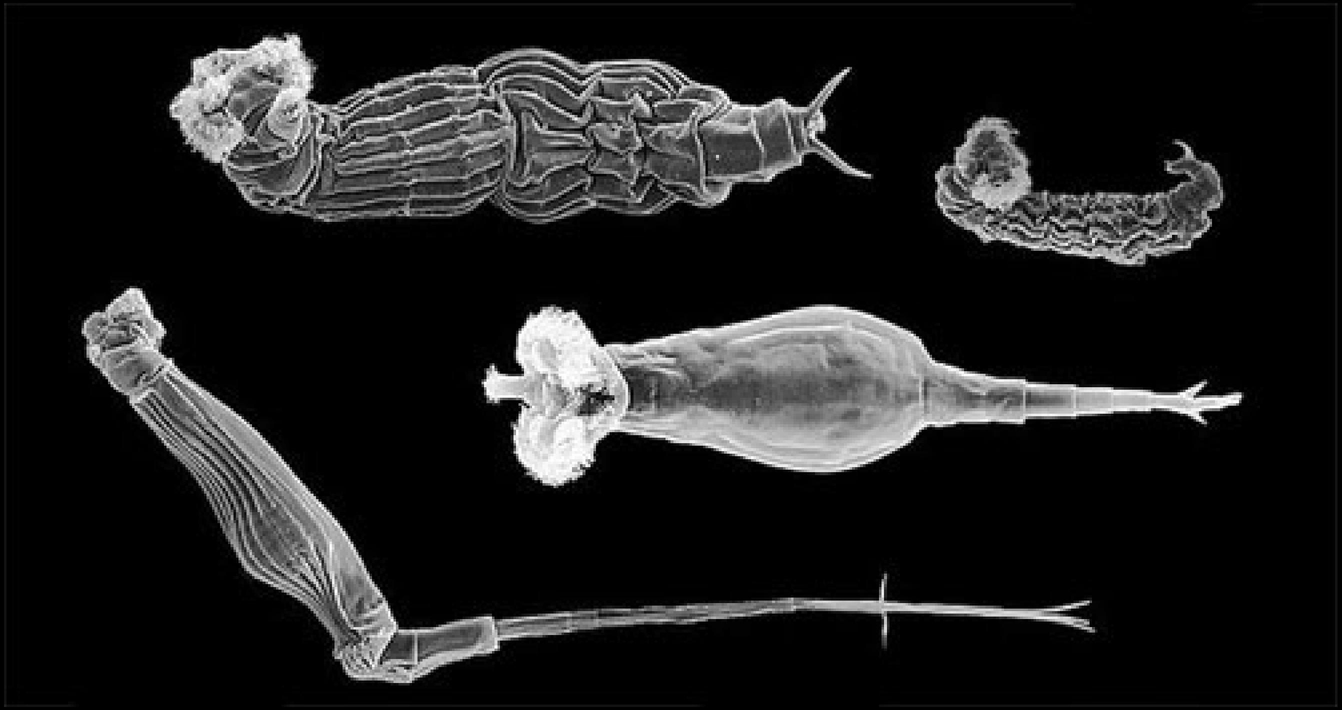
#dailypeen birdoptera.net

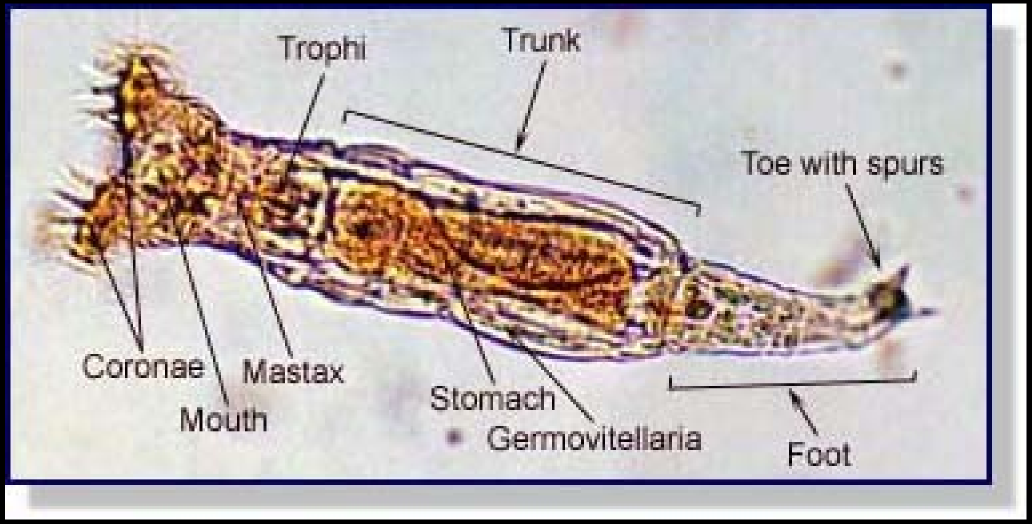
Cnemidophorus neomexicanus

Poecilia formosa

Cupressus dupreziana




Trophi
Trunk
Toe with spurs
Coronae
Mouth
Mastax
Stomach
Germovitellaria
Foot

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Independently Evolving Species in Asexual Bdelloid Rotifers

Diego Fontaneto[1©], Elisabeth A. Herniou[2,3©], Chiara Boschetti[4], Manuela Caprioli[1], Giulio Melone[1], Claudia Ricci[1], Timothy G. Barraclough[2,3,5*]

1 Dipartimento di Biologia, Università di Milano, Milan, Italy, **2** Division of Biology, Imperial College London, Ascot, United Kingdom, **3** Natural Environment Research Council Centre for Population Biology, Imperial College London, Ascot, United Kingdom, **4** Institute of Biotechnology, University of Cambridge, Cambridge, United Kingdom, **5** Jodrell Laboratory, Royal Botanic Gardens, Kew, United Kingdom

Asexuals are an important test case for theories of why species exist. If asexual clades displayed the same pattern of discrete variation as sexual clades, this would challenge the traditional view that sex is necessary for diversification into species. However, critical evidence has been lacking: all putative examples have involved organisms with recent or ongoing histories of recombination and have relied on visual interpretation of patterns of genetic and phenotypic variation rather than on formal tests of alternative evolutionary scenarios. Here we show that a classic asexual clade, the bdelloid rotifers, has diversified into distinct evolutionary species. Intensive sampling of the genus *Rotaria* reveals the presence of well-separated genetic clusters indicative of independent evolution. Moreover, combined genetic and morphological analyses reveal divergent selection in feeding morphology, indicative of niche divergence. Some of the morphologically coherent groups experiencing divergent selection contain several genetic clusters, in common with findings of cryptic species in sexual organisms. Our results show that the main causes of speciation in sexual organisms, population isolation and divergent selection, have the same qualitative effects in an asexual clade. The study also demonstrates how combined molecular and morphological analyses can shed new light on the evolutionary nature of species.

Citation: Fontaneto D, Herniou EA, Boschetti C, Caprioli M, Melone G, et al. (2007) Independently evolving species in asexual bdelloid rotifers. PLoS Biol 5(4): e87. doi:10.1371/journal.pbio.0050087

Introduction

Species are fundamental units of biology, but there remains uncertainty on both the pattern and processes of species existence. Are species real evolutionary entities or convenient figments of taxonomists' imagination [1–3]? If they exist, what are the main processes causing organisms to diversify [1,4]? Despite considerable debate, surprisingly few studies have formally tested the evolutionary status of species [1,5,6].

One central question concerning the nature of species has been whether asexual organisms diversify into species [1]. The traditional view is that species in sexual clades arise mainly because interbreeding maintains cohesion within species, whereas reproductive isolation causes divergence between species [7]. If so, asexuals might not diversify into distinct species, because there is no interbreeding to maintain cohesive units above the level of the individual. However, if other processes were more important for maintaining cohesion and causing divergence, for example, specialization into distinct niches, then asexuals should diversify in a

Although horizontal gene transfer can occur between distantly related bacteria, homologous recombination occurs only at appreciable frequency between closely related strains [20,21]. Therefore, clusters in these bacteria could arise from similar processes to interbreeding and reproductive isolation in sexual eukaryotes [20]. Aside from issues of sexuality, previous studies looking for distinct clusters have been descriptive, relying on visual interpretation of plots of genetic or phenotypic variation rather than on formal tests of predictions under null and alternative evolutionary scenarios [1].

Here, we demonstrate that a classic asexual clade, the bdelloid rotifers, has diversified into independently evolving and distinct entities arguably equivalent to species. Bdelloids are abundant animals in aquatic or occasionally wet terrestrial habitats and represent one of the best-supported clades of ancient asexuals [22–24]. They reproduce solely via parthenogenetic eggs, and no males or traces of meiosis have ever been observed. Molecular evidence that bdelloid

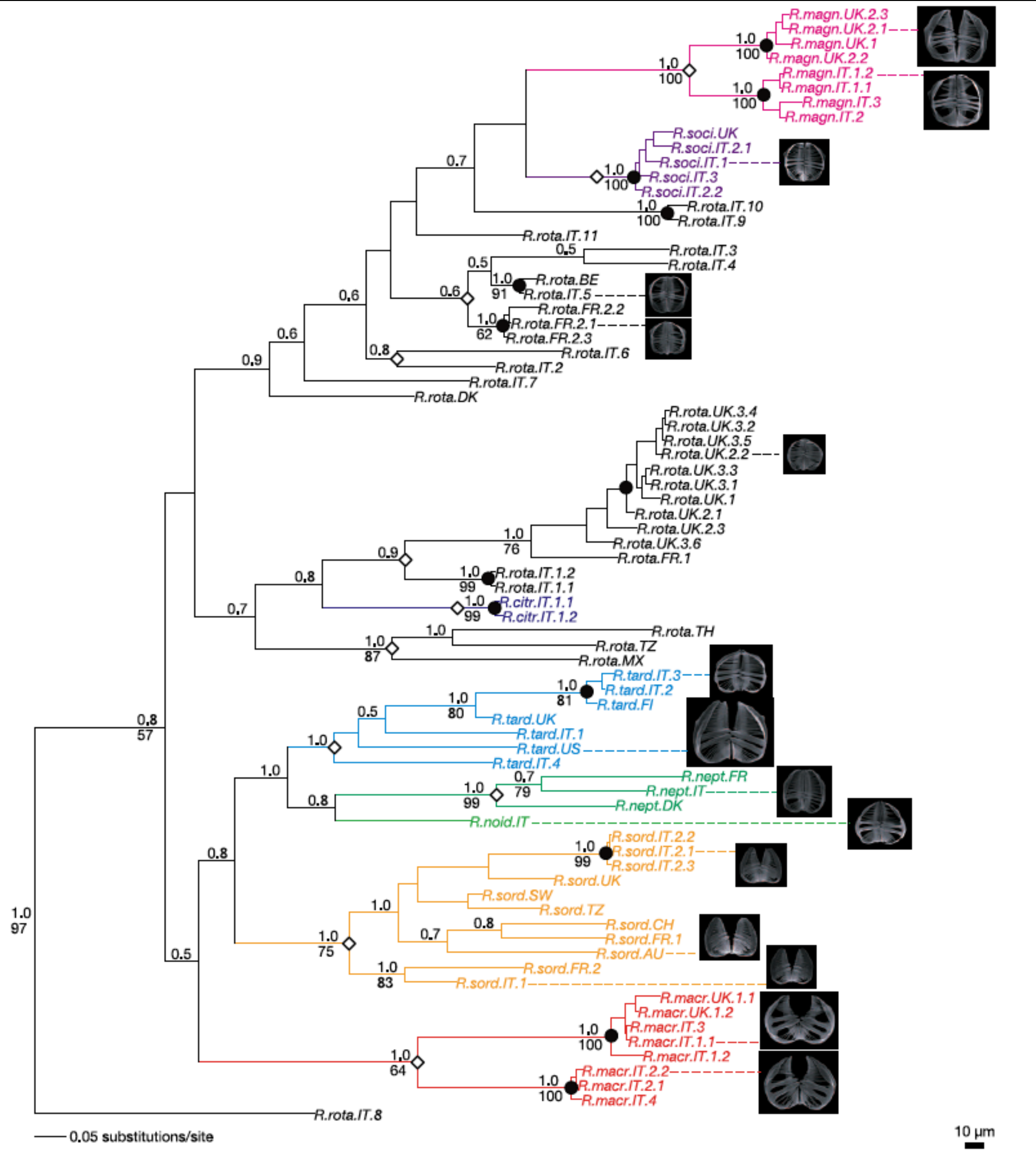


Figure 3. Phylogenetic Relationships in the Genus *Rotaria*

The consensus of 80,000 sampled trees from Bayesian analysis of the combined *cox1* and *28S* rDNA data sets is shown, displaying all compatible groupings and with average branch lengths proportional to numbers of substitutions per site under a separate GTR + invgamma substitution model for the *cox1* and *28S* partitions. Posterior probabilities above 0.5 and bootstrap support above 50% from a maximum parsimony bootstrap analysis are shown above and below each branch, respectively. Support values for within-species relationships are not shown for very short branches but are shown in Figures S1 through S3. Closed circles indicate clusters identified by the clustering analysis. Colors represent traditional species memberships. Diamonds indicate taxonomic species and monophyletic groups of *Rotaria*. Names refer to the species, the country, the number of site within that country for that species, and the number of individual from that site if several were isolated; for example, R.macr.IT.1.1 refers to the first individual from site 1 in Italy for *R. macrura*. Pictures of trophi from one individual from each cluster are shown to scale: Representatives of all sampled populations are shown in Figure S4. A full list of names and localities of samples is available in Table S1.
doi:10.1371/journal.pbio.0050087.g003

These studies were supported by the Intramural Research www.sciencemag.org/cgi/content/full/320/5880/1207/DC1 10.1126/science.1157643

Massive Horizontal Gene Transfer in Bdelloid Rotifers

Eugene A. Gladyshev,[1] Matthew Meselson,[1,2]* Irina R. Arkhipova[1,2]*

Horizontal gene transfer in metazoans has been documented in only a few species and is usually associated with endosymbiosis or parasitism. By contrast, in bdelloid rotifers we found many genes that appear to have originated in bacteria, fungi, and plants, concentrated in telomeric regions along with diverse mobile genetic elements. Bdelloid proximal gene-rich regions, however, appeared to lack foreign genes, thereby resembling those of model metazoan organisms. Some of the foreign genes were defective, whereas others were intact and transcribed; some of the latter contained functional spliceosomal introns. One such gene, apparently of bacterial origin, was overexpressed in *Escherichia coli* and yielded an active enzyme. The capture and functional assimilation of exogenous genes may represent an important force in bdelloid evolution.

Horizontal gene transfer (HGT), the movement of genes from one organism to another by means other than direct descent (vertical inheritance), has been documented in prokaryotes (*1*) and in phagocytic and parasitic unicellular eukaryotes (*2*–*4*). Despite the large number of sequenced genomes, documented HGT is rare in metazoans, at least in part because of the sequestration of the germ line (*5*, *6*). HGT may be facilitated by long-term association with organelles or with intracellular endosymbionts and parasites (*7*, *8*), or it may involve transposable elements (TEs) (*9*, *10*).

Bdelloid rotifers are small freshwater invertebrates that apparently lack sexual reproduction and can withstand desiccation at any life stage (*11*, *12*). Their genomes contain diverse TEs, including DNA transposons and retrovirus-like *env*-containing retrotransposons, such as *Juno* and *Vesta*, possibly acquired from exogenous sources and concentrated near telomeres (*13*, *14*). We investigated TE distribution in bdelloids by sequencing clones from an *Adineta vaga* fosmid library hybridizing to *Juno1* probes. Unexpectedly, in two *Juno1* long terminal repeat (LTR)–containing clones (contigs Av240A and Av212A), we found 10 protein-coding sequences (CDS) yielding strong database hits (BLAST E-values of $8E^{-102}$ to 0.0) to bacterial and fungal genes (Fig. 1A, Table 1, fig. S1A, and table S1). Half of these CDS have no metazoan orthologs, and three apparently bacterial CDS are interrupted by canonical spliceosomal introns, which are nonexistent in bacteria.

J. Theoret. Biol. (1964) **7**, 1–16

The Genetical Evolution of Social Behaviour. I

W. D. Hamilton

The Galton Laboratory, University College, London, W.C.2

(*Received* 13 *May* 1963, *and in revised form* 24 *February* 1964)

A genetical mathematical model is described which allows for interactions between relatives on one another's fitness. Making use of Wright's Coefficient of Relationship as the measure of the proportion of replica genes in a relative, a quantity is found which incorporates the maximizing property of Darwinian fitness. This quantity is named "inclusive fitness". Species following the model should tend to evolve behaviour such that each organism appears to be attempting to maximize its inclusive fitness. This implies a limited restraint on selfish competitive behaviour and possibility of limited self-sacrifices.

Special cases of the model are used to show (a) that selection in the social situations newly covered tends to be slower than classical selection, (b) how in populations of rather non-dispersive organisms the model may apply to genes affecting dispersion, and (c) how it may apply approximately to competition between relatives, for example, within sibships. Some artificialities of the model are discussed.

1. Introduction

With very few exceptions, the only parts of the theory of natural selection which have been supported by mathematical models admit no possibility of the evolution of any characters which are on average to the disadvantage of the individuals possessing them. If natural selection followed the classical models exclusively, species would not show any behaviour more positively social than the coming together of the sexes and parental care.

Sacrifices involved in parental care are a possibility implicit in any model in which the definition of fitness is based, as it should be, on the number of adult offspring. In certain circumstances an individual may leave more adult offspring by expending care and materials on its offspring already born than by reserving them for its own survival and further fecundity. A gene causing its possessor to give parental care will then leave more replica genes in the next generation than an allele having the opposite tendency. The selective advantage may be seen to lie through benefits conferred indifferently on a set of relatives each of which has a half chance of carrying the gene in question.

J. Theoret. Biol. (1964) **7**, 17–52

The Genetical Evolution of Social Behaviour. II

W. D. Hamilton

The Galton Laboratory, University College, London, W.C.2

(*Received* 13 *May* 1963, *and in revised form* 20 *March* 1964)

Grounds for thinking that the model described in the previous paper can be used to support general biological principles of social evolution are briefly discussed.

Two principles are presented, the first concerning the evolution of social behaviour in general and the second the evolution of social discrimination. Some tentative evidence is given.

More general application of the theory in biology is then discussed, particular attention being given to cases where the indicated interpretation differs from previous views and to cases which appear anomalous. A hypothesis is outlined concerning social evolution in the Hymenoptera; but the evidence that at present exists is found somewhat contrary on certain points. Other subjects considered include warning behaviour, the evolution of distasteful properties in insects, clones of cells and clones of zooids as contrasted with other types of colonies, the confinement of parental care to true offspring in birds and insects, fights, the behaviour of parasitoid insect larvae within a host, parental care in connection with monogyny and monandry and multi-ovulate ovaries in plants in connection with wind and insect pollination.

1. Introduction

In the previous paper (Hamilton, 1964) a genetical mathematical model was used to deduce a principle concerning the evolution of social behaviour which, if true generally, may be of considerable importance in biology. It has now to be considered whether there is any logical justification for the extension of this principle beyond the model case of non-overlapping generations, and, if so, whether there is evidence that it does work effectively in nature.

In brief outline, the theory points out that for a gene to receive positive selection it is not necessarily enough that it should increase the fitness of its bearer above the average if this tends to be done at the heavy expense of related individuals, because relatives, on account of their common ancestry, tend to carry replicas of the same gene; and conversely that a gene may receive positive selection even though disadvantageous to its bearers if it causes them to confer sufficiently large advantages on relatives. Relationship alone

J. Theoret. Biol. (1966) **12**, 12–45

The Moulding of Senescence by Natural Selection

W. D. HAMILTON

Imperial College Field Station, Silwood Park, Sunninghill, Berks., England

(*Received* 16 *October* 1965)

The consequences to fitness of several types of small age-specific effects on mortality are formulated mathematically. An effect of given form always has a larger consequence, or at least one as large, when it occurs earlier. By reference to a model in which mortality is constant it is shown that this implication cannot be avoided by any conceivable organism. A basis for the theory that senescence is an inevitable outcome of evolution is thus established.

The simple theory cannot explain specially high infant mortalities. Fisher's "reproductive value", the form of which gave rise to an erroneous opinion on this point, is shown to be not directly relevant to the situation. Infant mortality may evolve when the early death of one infant makes more likely the creation or survival of a close relative. Similarly, post-reproductive life-spans may evolve when the old animal still benefits its younger relatives.

The model shows that higher fertility will be a primary factor leading to the evolution of higher rates of senescence unless the resulting extra mortality is confined to the immature period. Some more general analytical notes on the consequences of modifications to the reproductive schedule are given.

Applications to species with populations in continual fluctuation are briefly discussed. Such species apart, it is argued that general stationarity of population can be assumed, in which case the measurement of consequences to fitness in terms of consequences to numerical expectation of offspring is justified.

All the age-functions discussed are illustrated by graphs derived from the life-table of the Taiwanese about 1906, and the method of computation is shown.

1. Introduction

Consider four hypothetical genes in man. Suppose all are limited in their expression to the female sex and also age-limited in the following way: each

would confer a selective advantage of about 0
novelty: it emerges equally well in the treatm
in which the rate of increase or Malthusian p
of the imbalance of births and deaths. If b is
the death rate per head, for a population in
rate of natural increase is given by

$$r = b - d$$

whence the stated result. Of course, it must be
mortality by affecting the rate of increase alters
consequent effects on b and d: hence such sta

If the mortality effect terminates at age b w

$$\frac{dm}{d\mu_{(a\ldots b)}} = \frac{\int_a^\infty (x-a)\lambda^{-x} l_x f_x \,dx + (\ldots}{W}. \quad (12)$$

This gives equation (9) as $b \to \infty$ and tends to zero as $b \to a$. By defining $\Delta_{(a\ldots b)}$ analogous to Δ_a, we can find the substitution

$$d\mu_{(a\ldots b)} = \frac{1}{b-a}\, d\Delta_{(a\ldots b)}.$$

Hence, if equation (12) is correct, we have

$$\frac{dm}{d\Delta_{(a\ldots b)}} = \frac{\int_a^b (x-a)\lambda^{-x} l_x f_x \,dx}{(b-a)W} + \frac{\int_b^\infty \lambda^{-x} l_x f_x \,dx}{W} \quad (13)$$

in which the left-hand term vanishes as $b \to a$, leaving equation (11).

5. The Effects of Age-of-Onset Modifiers

By integrating by parts we find that

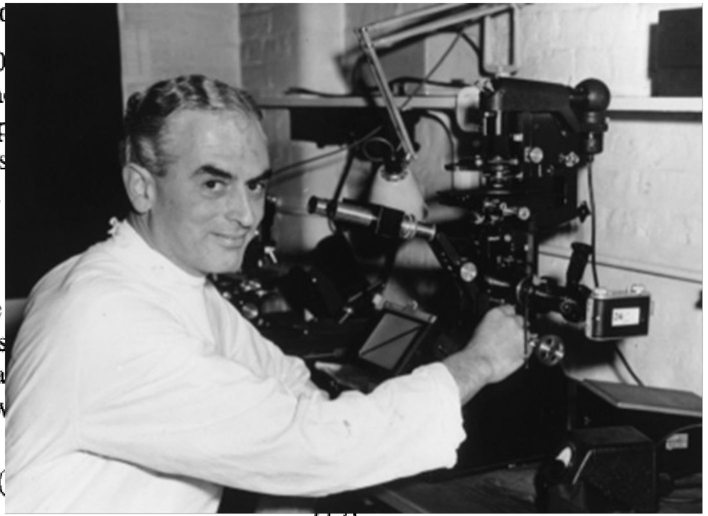
$$\int_a^\infty \left(\int_x^\infty \lambda^{-t} l_t f_t \,dt \right) dx = \int_a^\infty (x-a)\lambda^{-x} l_x f_x \,dx. \quad (14)$$

Thus adopting the notation

$$g_0(a) = \lambda^{-a} l_a f_a, \quad (15)$$

$$g_1(a) = \int_a^\infty \lambda^{-x} l_x f_x \,dx, \quad (16)$$

$$g_2(a) = \int_a^\infty (x-a)\lambda^{-x} l_x f_x \,dx, \quad (17)$$



Peter Medawar

Kin selection

Hamilton's rule

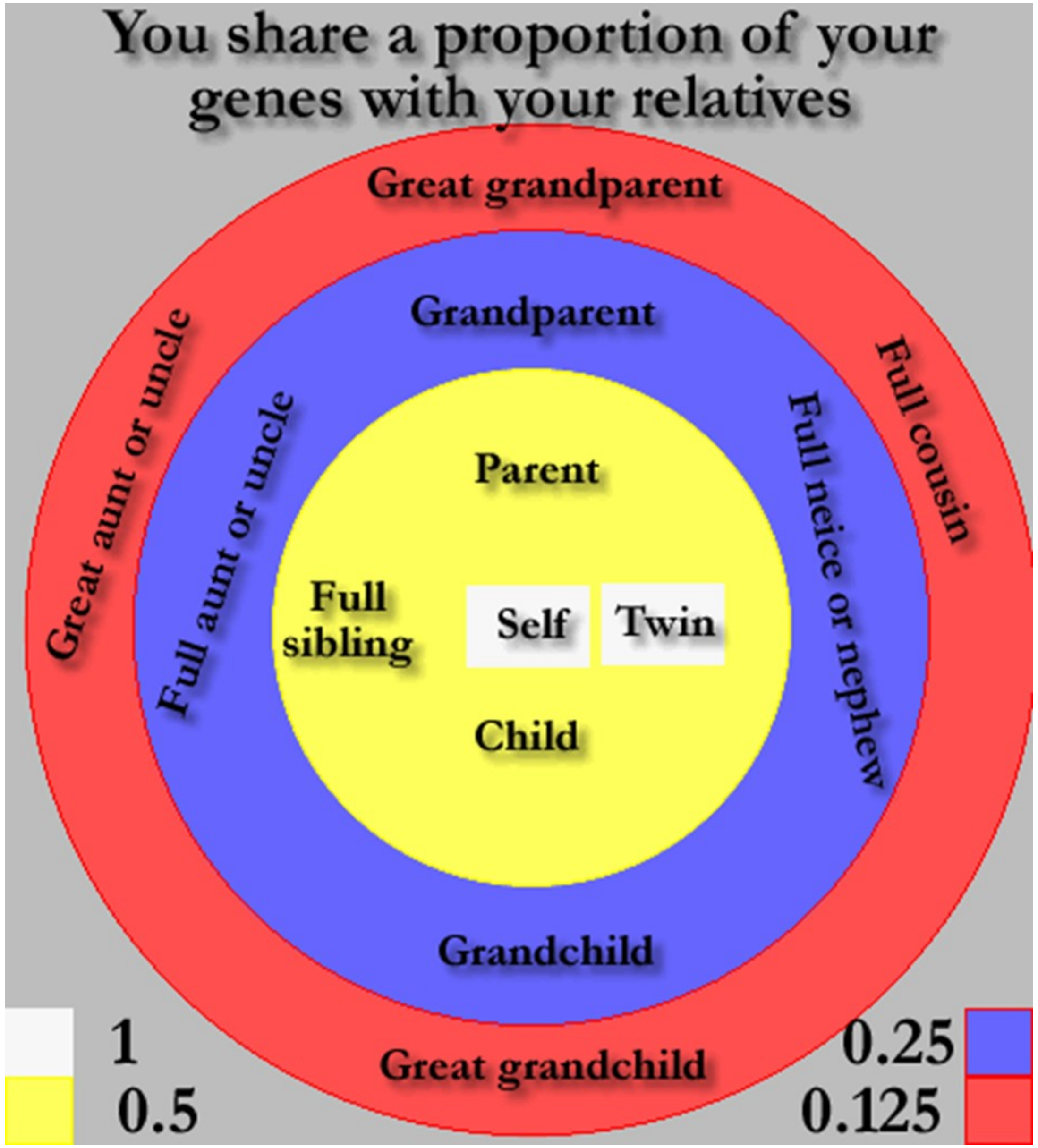
$$r > c / b$$

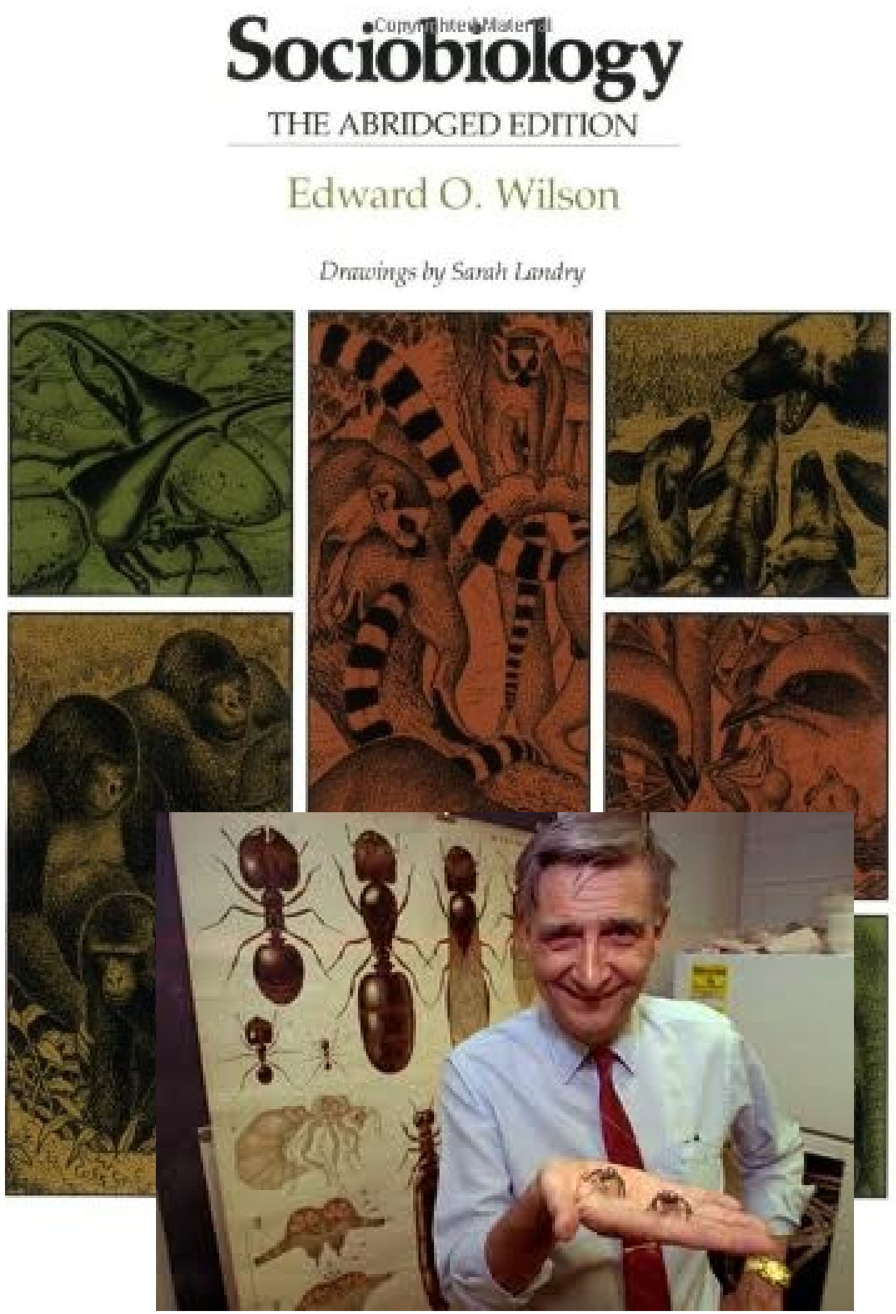
William Hamilton

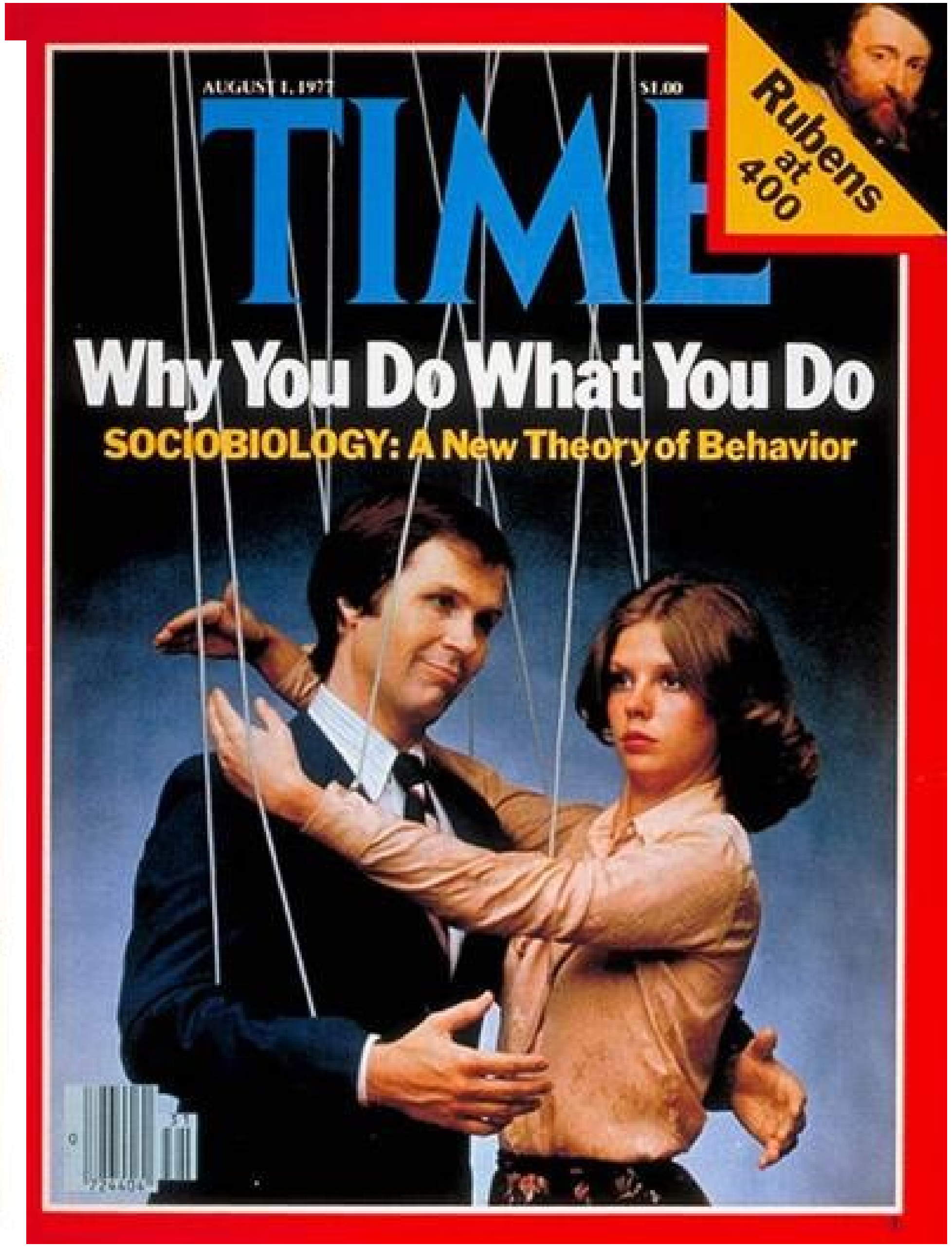
r … coefficient of relatedness

c … cost of cooperation

b … benefit of cooperation


You share a proportion of your genes with your relatives
Great grandparent
Grandparent
Great aunt or uncle
Full aunt or uncle
Full cousin
Full neice or nephew
Parent
Full sibling
Self
Twin
Child
Grandchild
Great grandchild
1
0.5
0.25
0.125


Sociobiology
THE ABRIDGED EDITION
Edward O. Wilson
Drawings by Sarah Landry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$1.00
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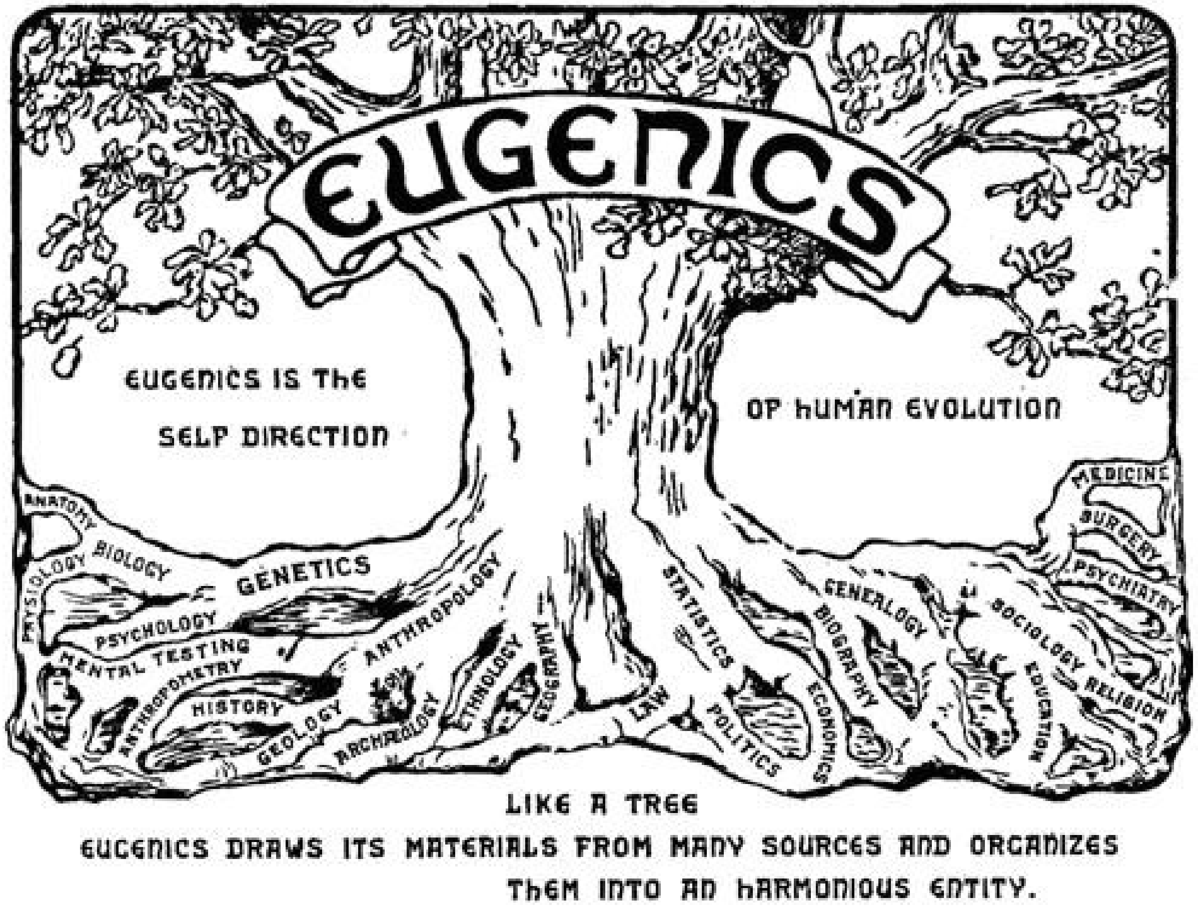
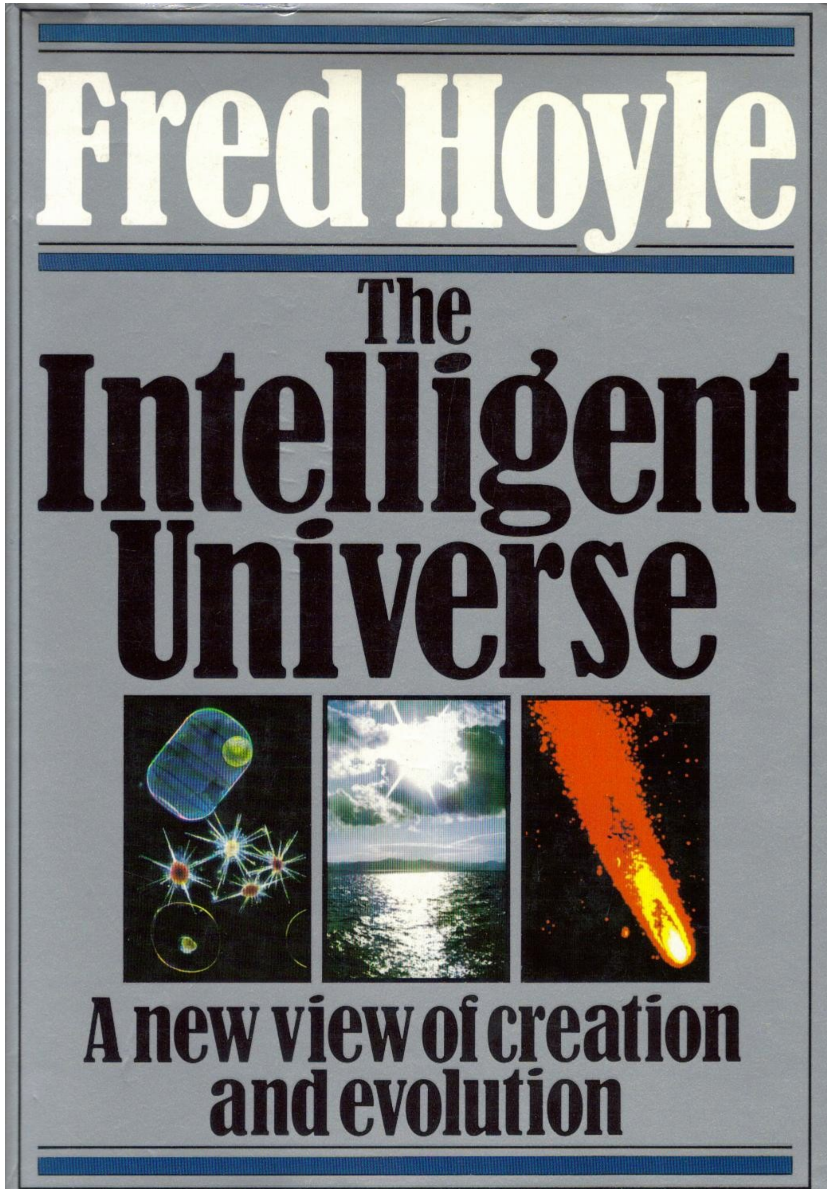
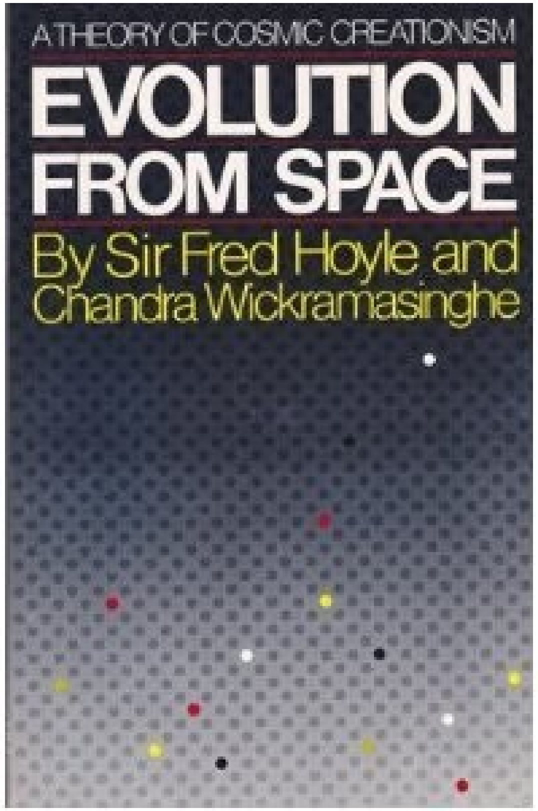
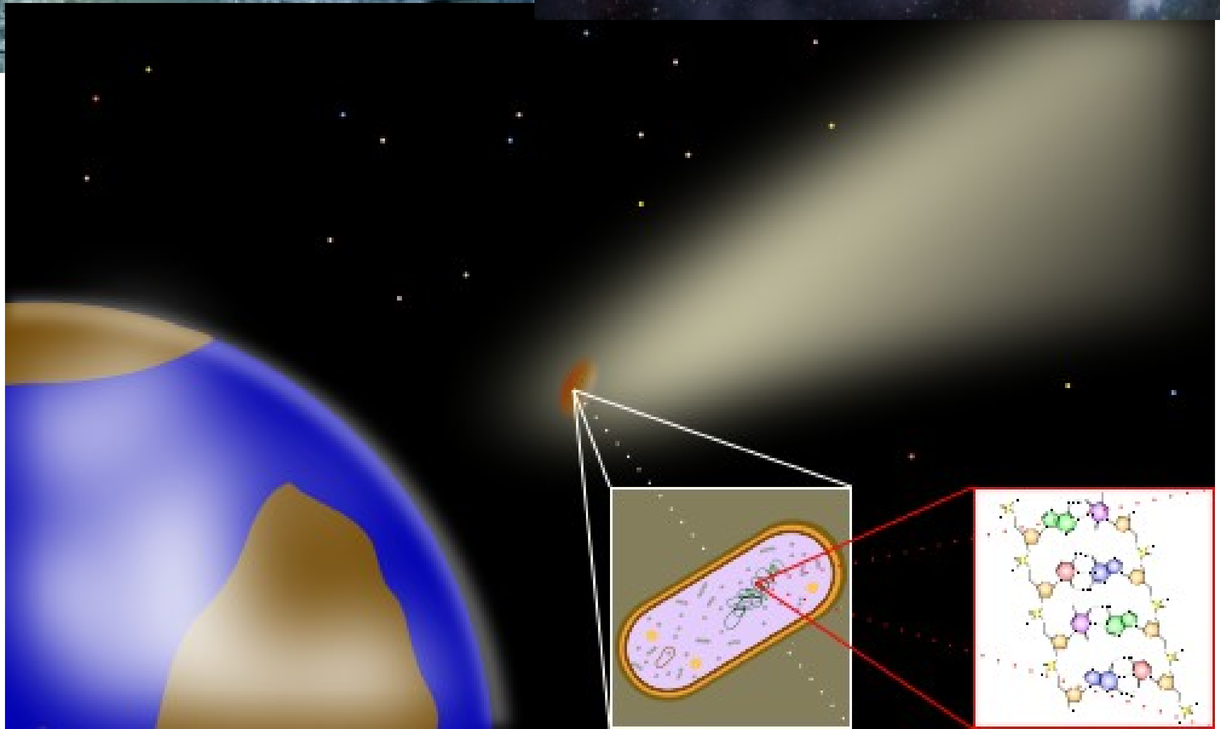
Rubens at 400
Why You Do What You Do
SOCIOBIOLOGY: A New Theory of Behavior

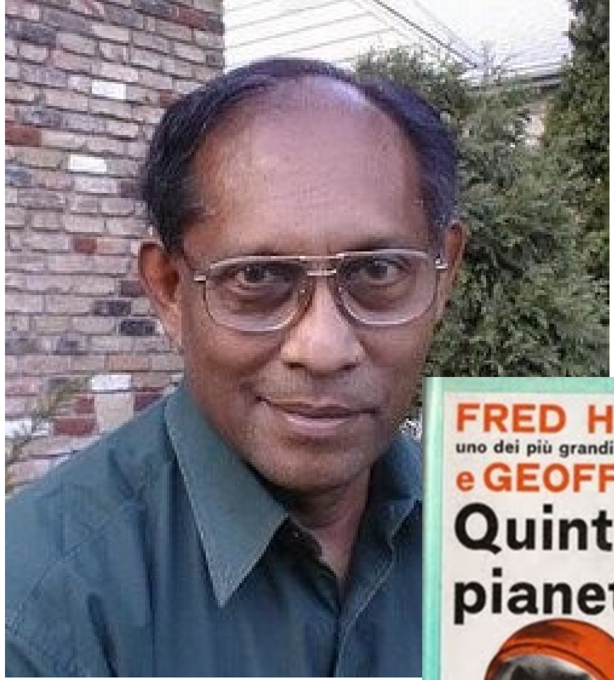

EUGENICS
EUGENICS IS THE SELF DIRECTION OF HUMAN EVOLUTION
MEDICINE
SURGERY
PSYCHIATRY
ANATOMY
PHYSIOLOGY
BIOLOGY
GENETICS
PSYCHOLOGY
MENTAL TESTING
ANTHROPOMETRY
HISTORY
GEOLOGY
ARCHAEOLOGY
ANTHROPOLOGY
ETHNOLOGY
GEOGRAPHY
LAW
STATISTICS
POLITICS
ECONOMICS
BIOGRAPHY
GENEALOGY
SOCIOLOGY
EDUCATION
RELIGION
LIKE A TREE
EUGENICS DRAWS ITS MATERIALS FROM MANY SOURCES AND ORGANIZES
THEM INTO AN HARMONIOUS ENTITY.

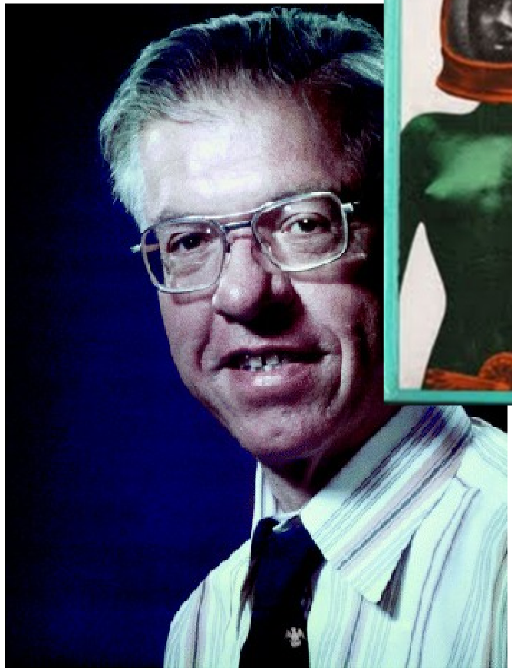

Fred Hoyle
The Intelligent Universe
A new view of creation and evolution


A THEORY OF COSMIC CREATIONISM
EVOLUTION FROM SPACE
By Sir Fred Hoyle and Chandra Wickramasinghe

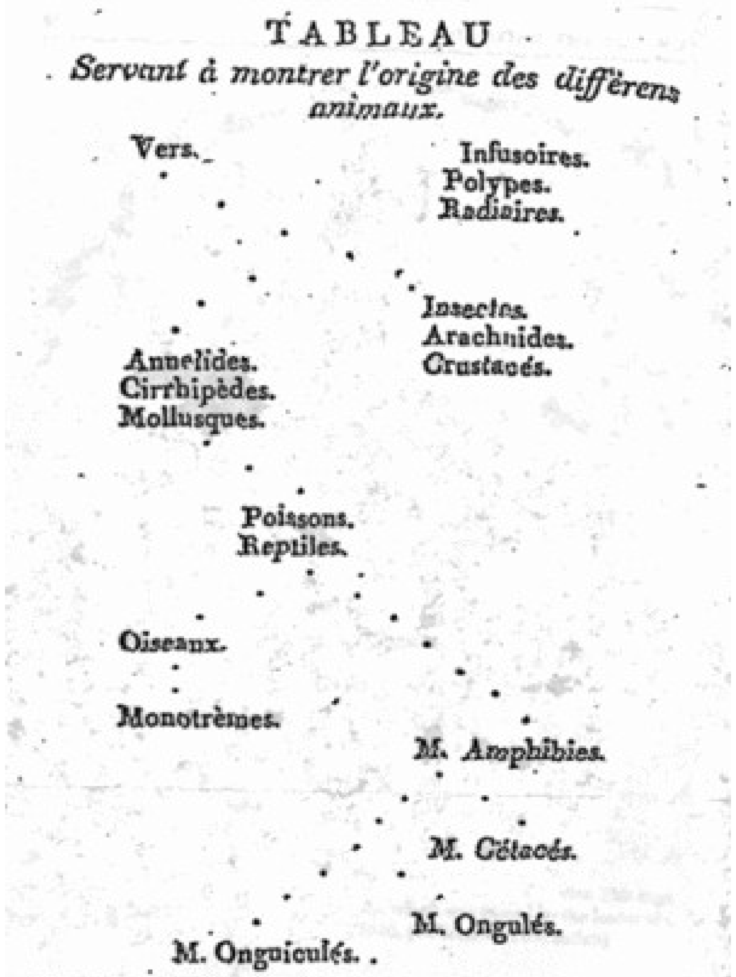




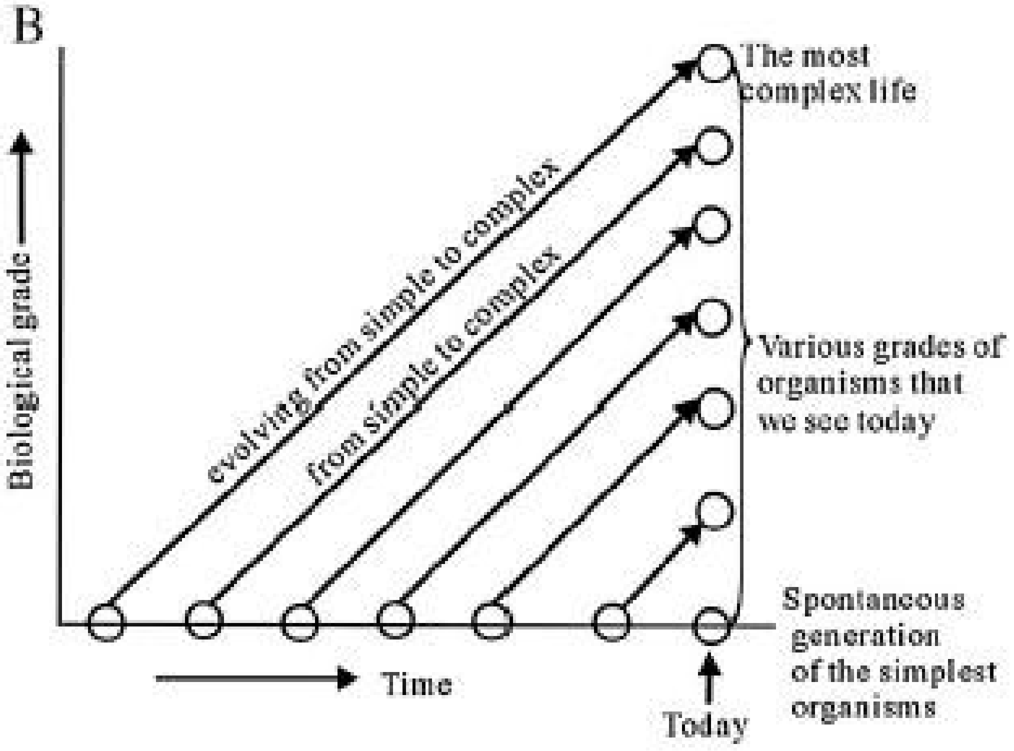


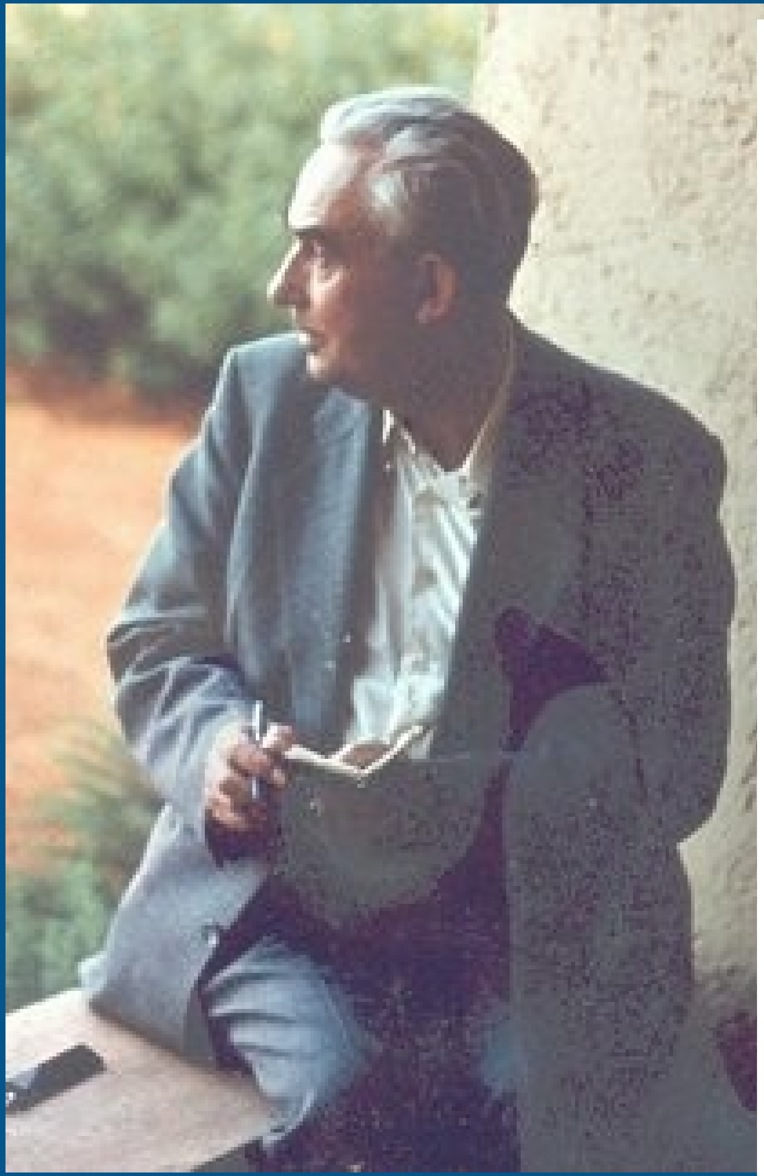


"esta contribuição é um dos mais hediondos escritos que já tive o infortúnio de ler. Mostra completo desprezo pelos padrões mínimos de profissionalismo [...] permancerá por um longo tempo como uma mancha na reputação de ambos autores" (Halstead, 1987).



The first evolutionary tree, upside down from the modern point of view, published in Lamarck's *Philosophie zoologique* in 1809. Note the difference from the old notion of the continuous scale of nature, or chain of being. Lamarck's is a truly branching evolution. "I do not wish to say . . . that existing animals form a very simple and evenly nuanced series," *he wrote,* "but *I say that they form a branching series irregularly graduated which has no discontinuity in its parts, or which, at least, if it is true that there are some [discontinuities] because of some lost species, has not always had such. It follows that the species which terminate each branch of the general series are related, at least on one side, to the other neighboring species which shade into them."





WILLI HENNIG

Phylogenetic Systematics

TRANSLATED BY D. DWIGHT DAVIS AND RAINER ZANGERL

Foreword by Donn E. Rosen, Gareth Nelson, and Colin Patterson

UNIVERSITY OF ILLINOIS PRESS Urbana Chicago London

EUGENICS

"IS THE STUDY OF THE AGENCIES UNDER SOCIAL CONTROL, THAT IMPROVE OR IMPAIR THE RACIAL QUALITIES OF FUTURE GENERATIONS EITHER PHYSICALLY OR MENTALLY."

SIR FRANCIS GALTON.

Vol. I. No. IV. JANUARY, 1910.

The Eugenics Review

"EUGENICS IS THE STUDY OF AGENCIES UNDER SOCIAL CONTROL THAT MAY IMPROVE OR IMPAIR THE RACIAL QUALITIES OF FUTURE GENERATIONS, EITHER PHYSICALLY OR MENTALLY."

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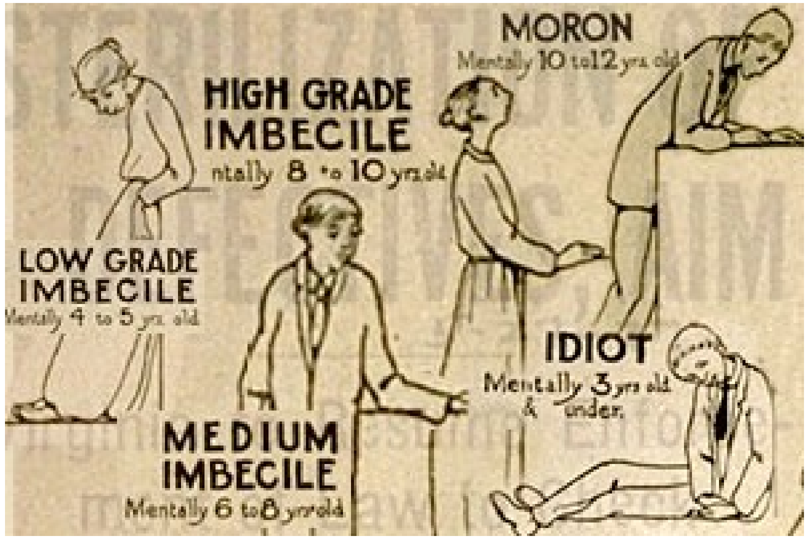
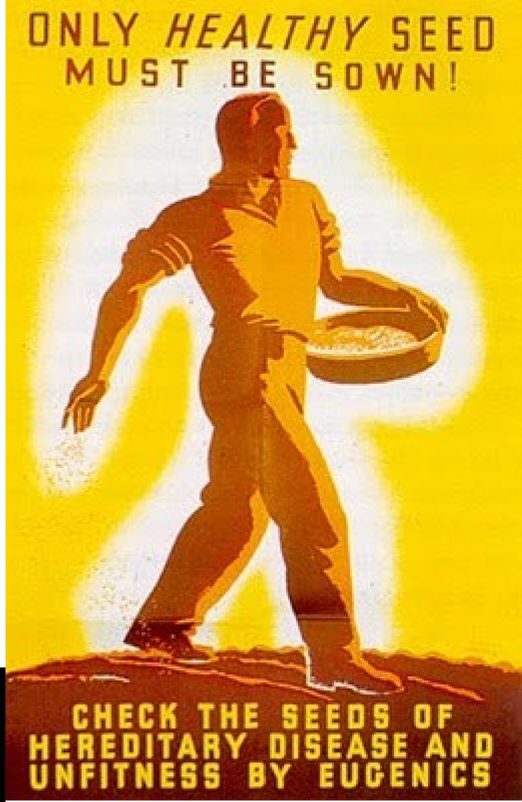

MORON
Mentally 10 to 12 yrs old
HIGH GRADE
IMBECILE
ntally 8 to 10 yrs old
LOW GRADE
IMBECILE
Mentally 4 to 5 yrs old
IDIOT
Mentally 3 yrs old
& under.
MEDIUM
IMBECILE
Mentally 6 to 8 yrs old


ONLY HEALTHY SEED
MUST BE SOWN!
CHECK THE SEEDS OF
HEREDITARY DISEASE AND
UNFITNESS BY EUGENICS


£3,000,000
is the life-time cost
to our community of
this disabled person
British People!
That is your
Money!
support
the work of
Atos
Healthcare
Atos Macht Frei - the executive arm of the DWP


"The most merciful
thing that a
large family
does to one of its
infant members
is to kill it."
–Margaret Sanger
Founder of Planned Parenthood
From her book, Women and the New Race,
Chapter 5: The Wickedness of Creating Large Families

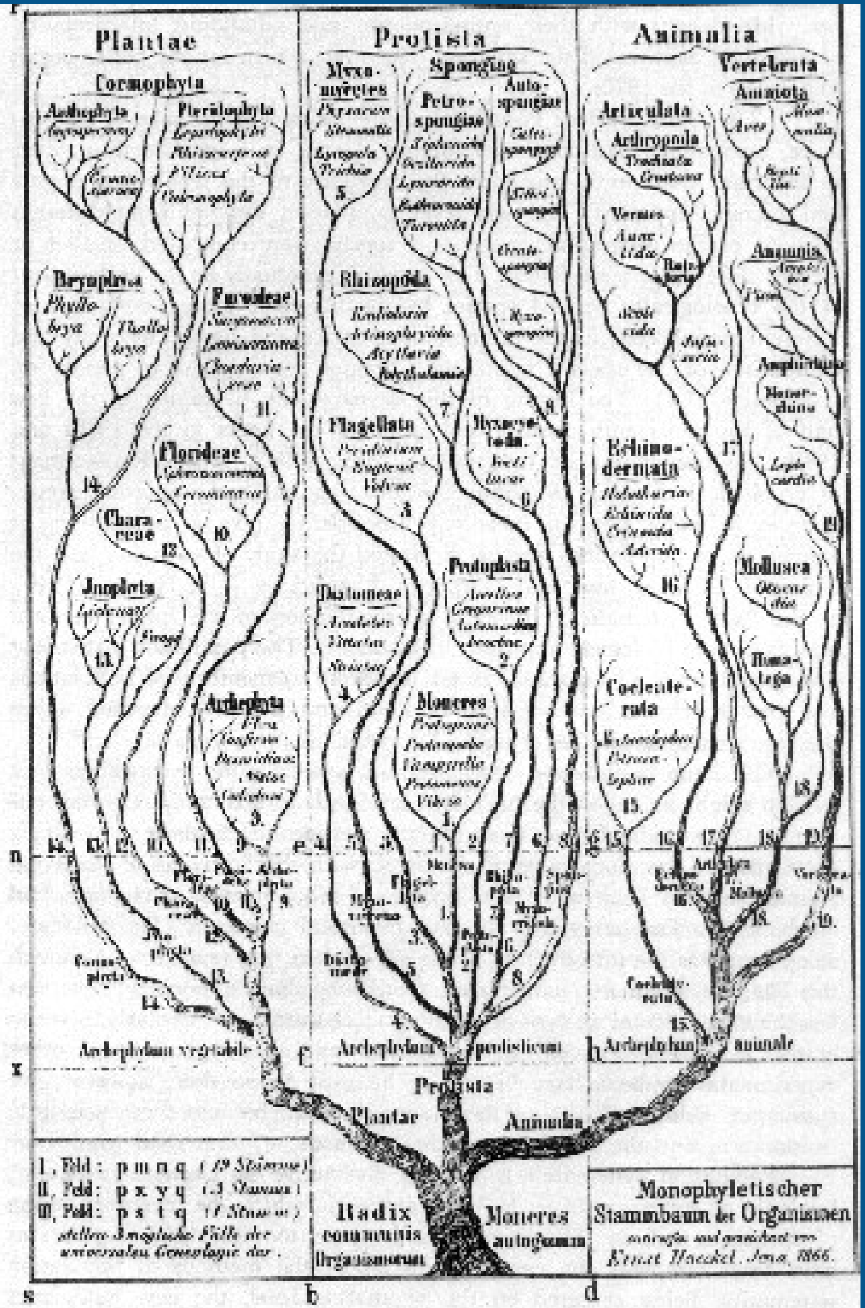


Fig. 4-3. The phylogeny of living beings as conceived by Haeckel (1866) and expressed in a formal treelike diagram.

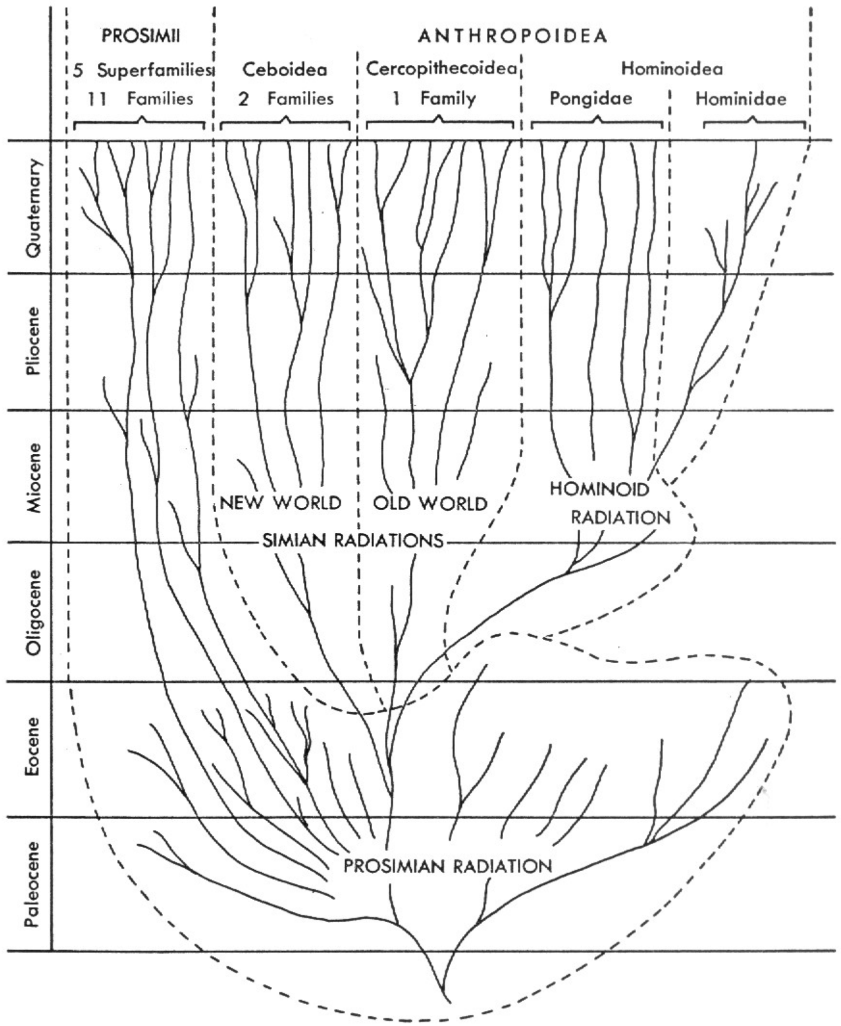


FIGURE 28. DIAGRAM OF PHYLOGENY AND CLASSIFICATION OF THE PRIMATES

The lineages shown are schematic or impressionistic of the general pattern and do not represent particular taxa. Some infraordinal taxa, at different levels as labeled above, are enclosed in broken lines.

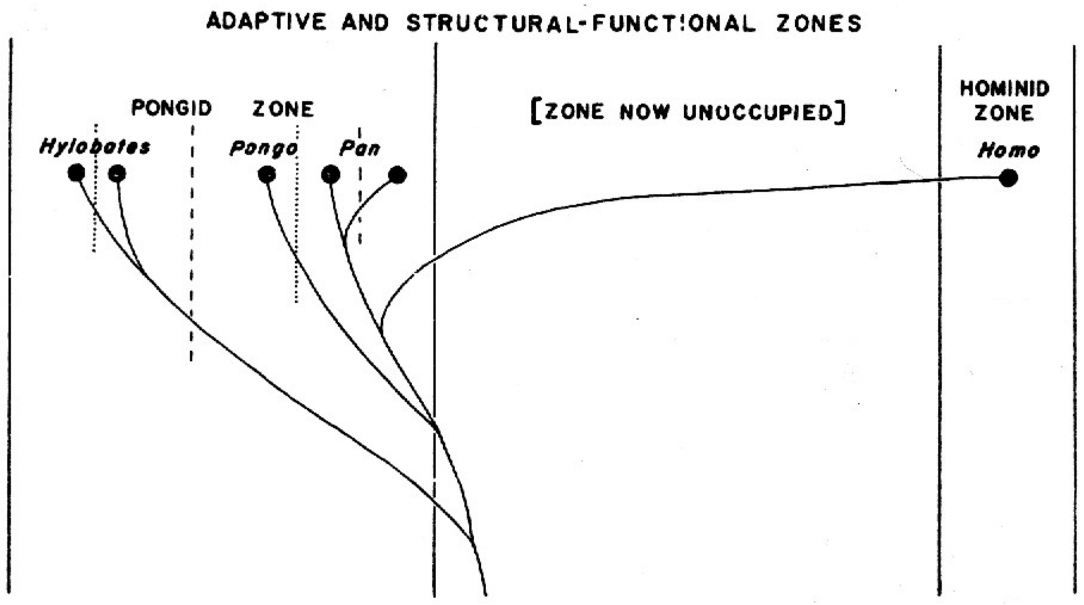
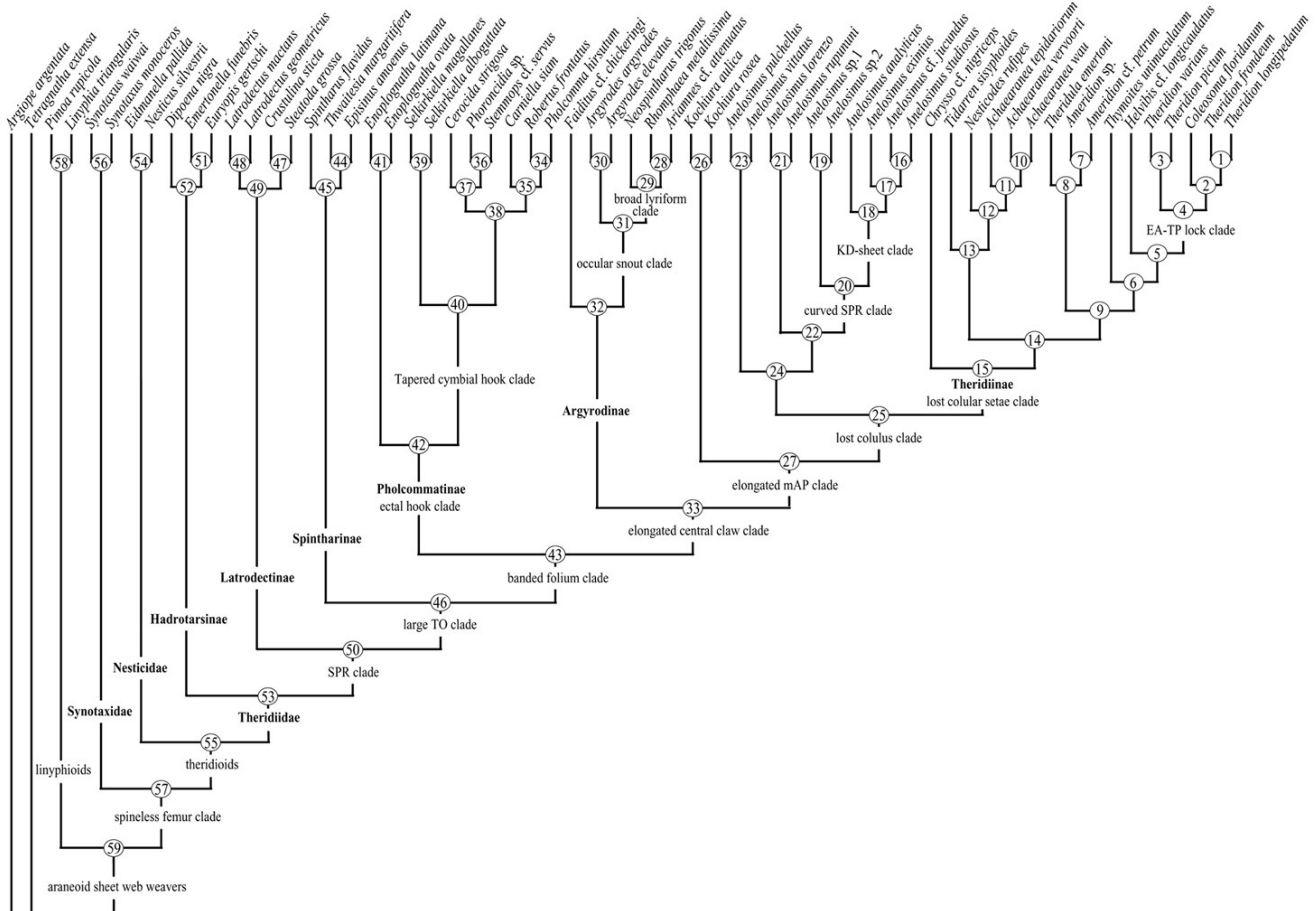
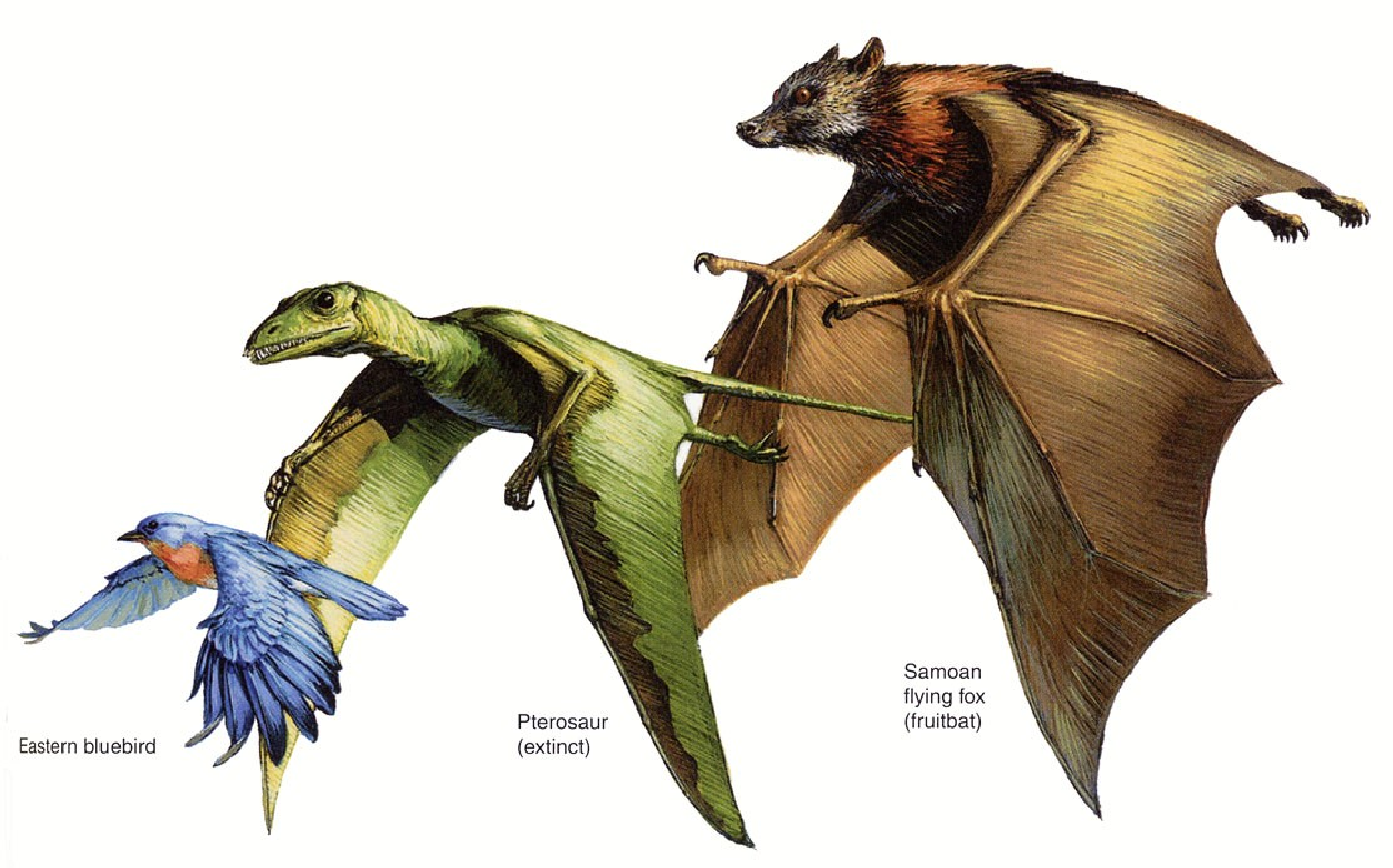
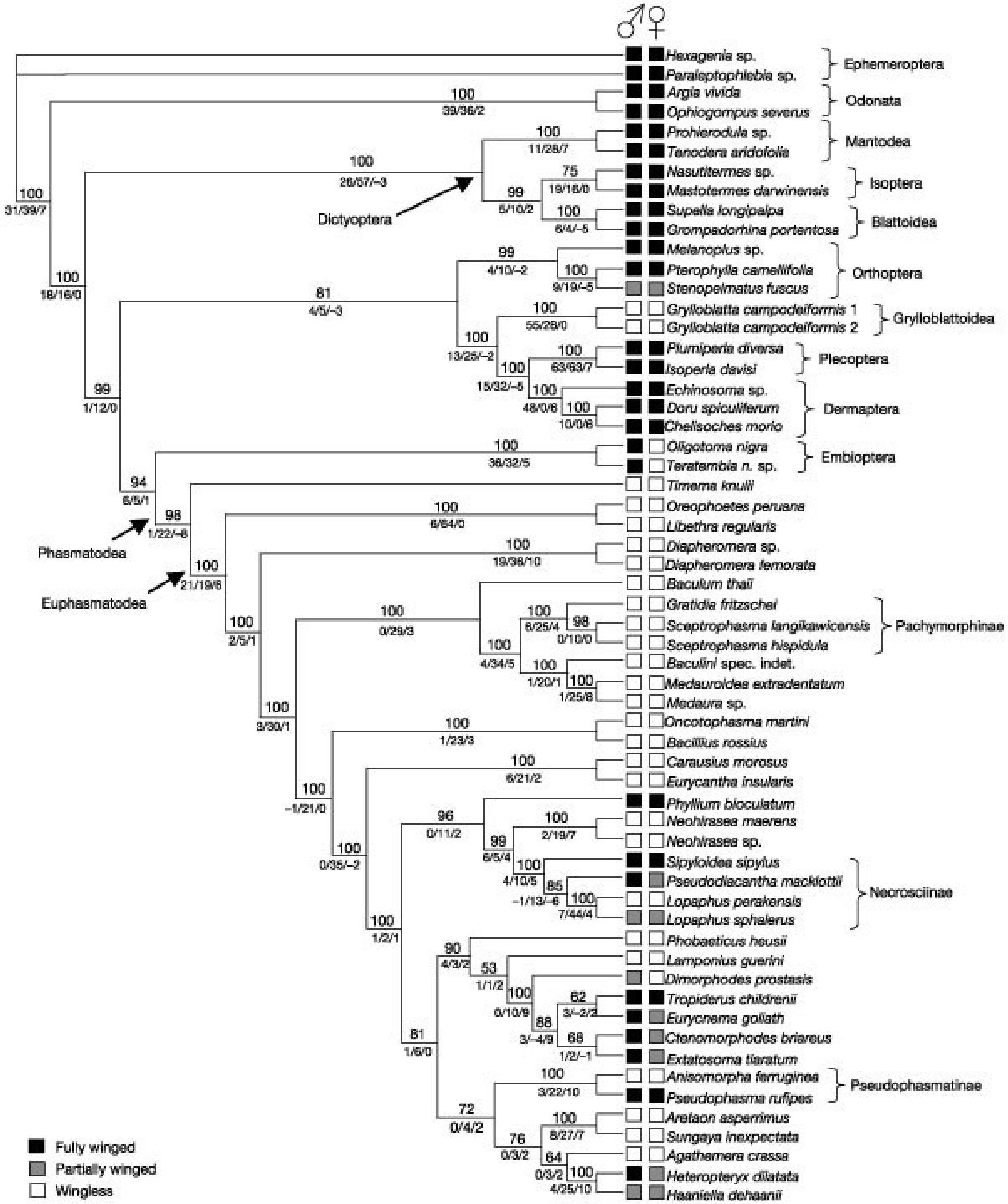


Fig. 4-5. Recency of descent versus degree of adaptive divergence. Dendrogram of probable affinities of recent hominoids in relationship to their radiation into adaptive-structural-functional zones. The two major occupied adaptive zones are bordered by solid lines. Pongid radiation into sub- and sub-subzones is schematically suggested by broken and dotted lines (*from Simpson*, 1963).

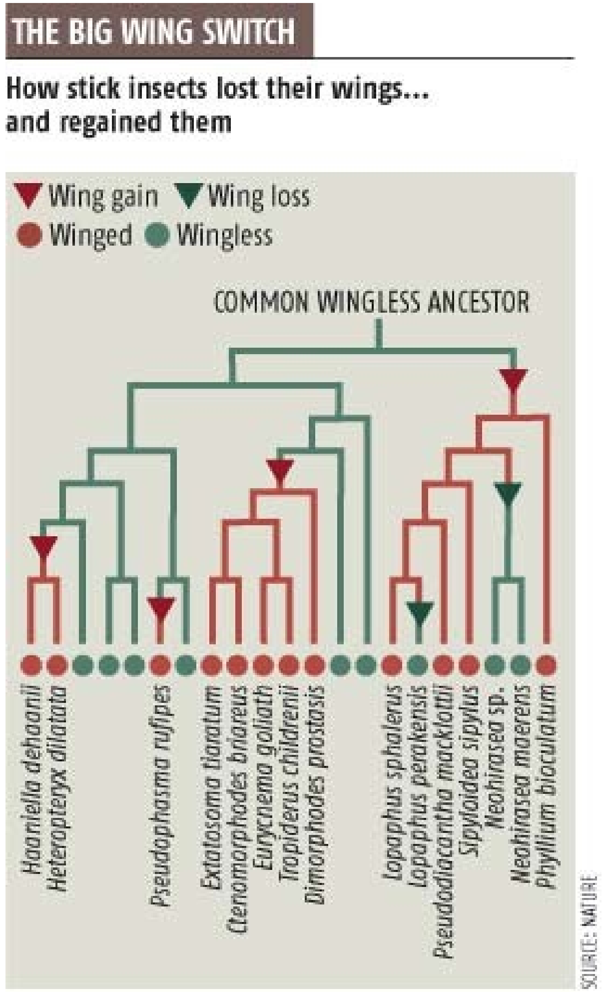

Argiope argentata
Tetragnatha extensa
Pimoa rupicola
Linyphia triangularis
Synotaxus waiwai
Synotaxus monoceros
Eidmanella pallida
Nesticus silvestrii
Dipoena nigra
Emertonella funebris
Euryopis gertschi
Latrodectus mactans
Latrodectus geometricus
Crustulina sticta
Steatoda grossa
Spintharus flavidus
Thwaitesia margaritifera
Episinus amoenus
Enoplognatha latimana
Enoplognatha ovata
Selkirkiella magallanes
Selkirkiella alboguttata
Cerocida strigosa
Phoroncidia sp.
Stemmops cf. servus
Carniella siam
Robertus frontatus
Pholcomma hirsutum
Faiditus cf. chickeringi
Argyrodes argyrodes
Argyrodes elevatus
Neospintharus trigonum
Rhomphaea metaltissima
Ariamnes cf. attenuatus
Kochiura aulica
Kochiura rosea
Anelosimus pulchellus
Anelosimus vittatus
Anelosimus lorenzo
Anelosimus rupununi
Anelosimus sp.1
Anelosimus sp.2
Anelosimus analyticus
Anelosimus eximius
Anelosimus cf. jucundus
Anelosimus studiosus
Chrysso cf. nigriceps
Tidarren sisyphoides
Nesticodes rufipes
Achaearanea tepidariorum
Achaearanea vervoori
Achaearanea wau
Theridula emertoni
Ameridion sp.
Ameridion cf. petrum
Thymoites unimaculatum
Helvibis cf. longicaudatus
Theridion varians
Theridion pictum
Coleosoma floridanum
Theridion frondeum
Theridion longipedatum
broad lyriform clade
EA-TP lock clade
occular snout clade
KD-sheet clade
curved SPR clade
Tapered cymbial hook clade
Theridiinae
lost colular setae clade
Argyrodinae
lost colulus clade
elongated mAP clade
Pholcommatinae
ectal hook clade
elongated central claw clade
Spintharinae
banded folium clade
Latrodectinae
large TO clade
Hadrotarsinae
SPR clade
Nesticidae
Synotaxidae
Theridiidae
linyphioids
theridioids
spineless femur clade
araneoid sheet web weavers



Wings have evolved more than once in vertebrates



♂ ♀
Hexagenia sp.
Paraleptophlebia sp.
Ephemeroptera
Argia vivida
Ophiogompus severus
Odonata
Prohierodula sp.
Tenodera aridofolia
Mantodea
Nasutitermes sp.
Mastotermes darwiniensis
Isoptera
Supella longipalpa
Grompadorhina portentosa
Blattoidea
Dictyoptera
Melanoplus sp.
Pterophylla camellifolia
Stenopelmatus fuscus
Orthoptera
Grylloblatta campodeiformis 1
Grylloblatta campodeiformis 2
Grylloblattoidea
Plumiperla diversa
Isoperla davisi
Plecoptera
Echinosoma sp.
Doru spiculiferum
Chelisoches morio
Dermaptera
Oligotoma nigra
Teratembia n. sp.
Embioptera
Timema knulli
Phasmatodea
Oreophoetes peruana
Libethra regularis
Euphasmatodea
Diapheromera sp.
Diapheromera femorata
Baculum thaii
Gratidia fritzschei
Sceptrophasma langkawicensis
Sceptrophasma hispidula
Pachymorphinae
Baculini spec. indet.
Medauroidea extradentatum
Medaura sp.
Oncotophasma martini
Bacillus rossius
Carausius morosus
Eurycantha insularis
Phyllium bioculatum
Neohirasea maerens
Neohirasea sp.
Sipyloidea sipylus
Pseudodiacantha macklottii
Lopaphus perakensis
Lopaphus sphalerus
Necrosciinae
Phobaeticus heusii
Lamponius guerini
Dimorphodes prostasis
Tropiderus childrenii
Eurycnema goliath
Ctenomorphodes briareus
Extatosoma tiaratum
Anisomorpha ferruginea
Pseudophasma rufipes
Pseudophasmatinae
Aretaon asperrimus
Sungaya inexpectata
Agathemera crassa
Heteropteryx dilatata
Haaniella dehaanii
Fully winged
Partially winged
Wingless

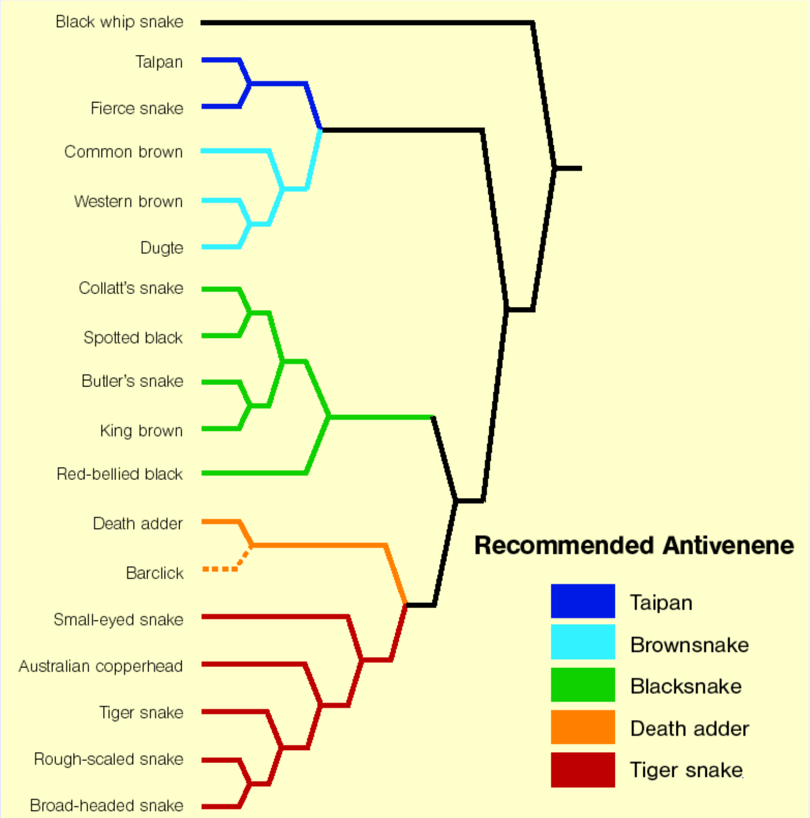


THE BIG WING SWITCH
How stick insects lost their wings... and regained them
Wing gain
Wing loss
Winged
Wingless
COMMON WINGLESS ANCESTOR
Haaniella dehaanii
Heteropteryx dilatata
Pseudophasma rufipes
Extatosoma tiaratum
Ctenomorphodes briareus
Eurycnema goliath
Tropiderus childrenii
Dimorphodes prostasis
Lopaphus sphalerus
Lopaphus perakensis
Pseudodiacantha macklottii
Sipyloidea sipylus
Neohirasea sp.
Neohirasea maerens
Phyllium bioculatum
SOURCE: NATURE



Filogenias como instrumentos preditivos

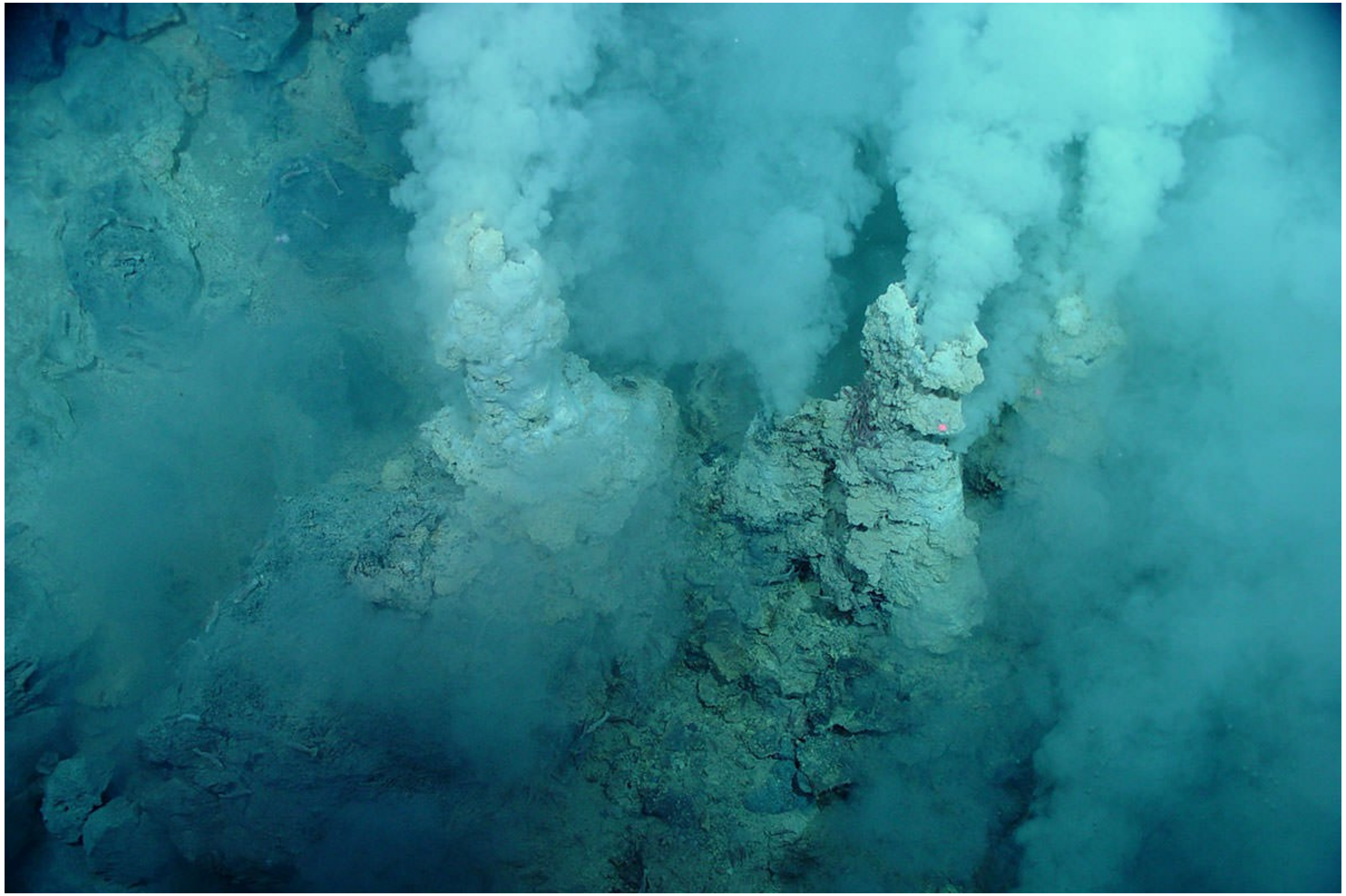
Qual soro usar contra uma picada de king brown?

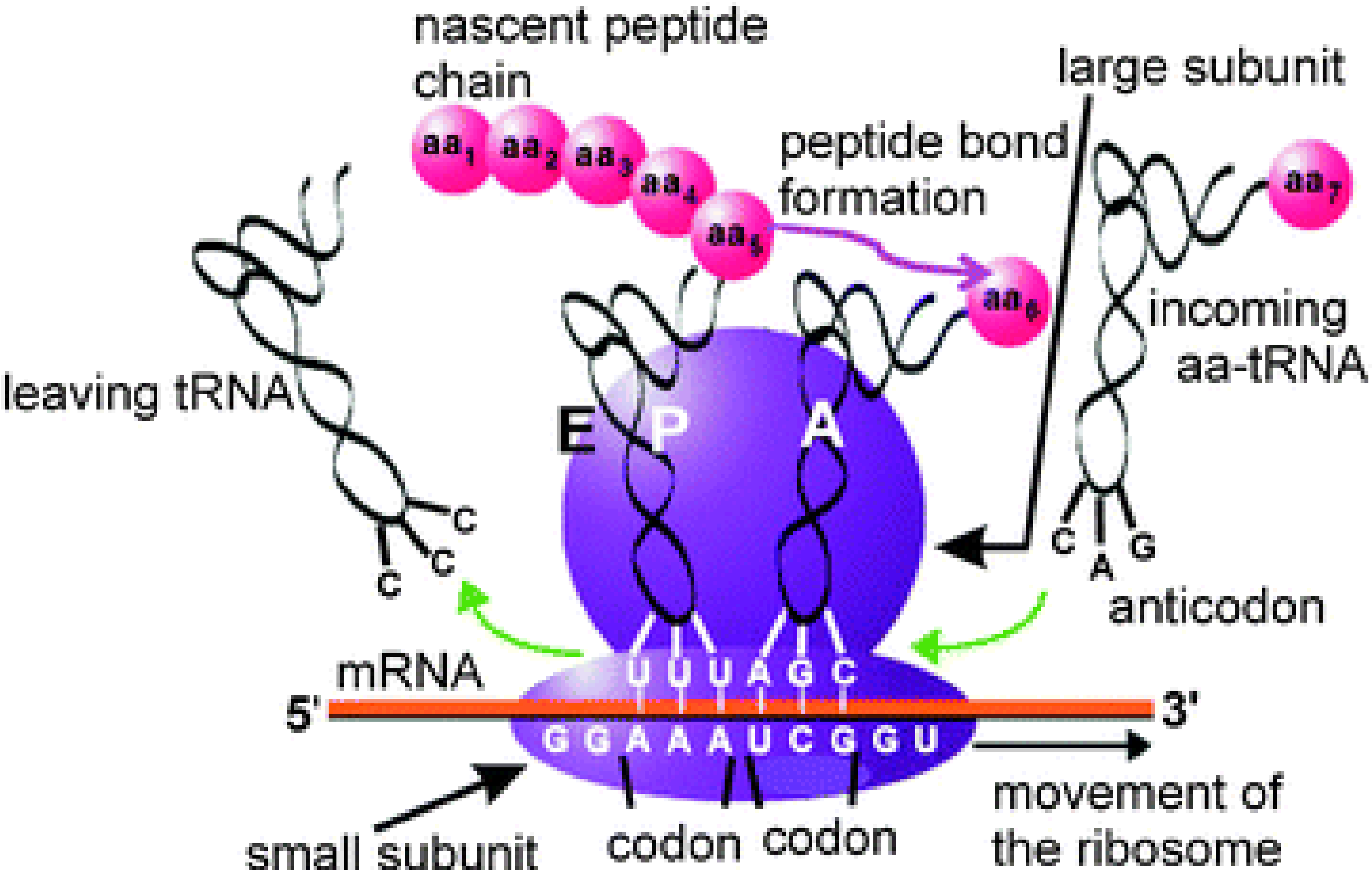


The physiology and habitat of the last universal common ancestor

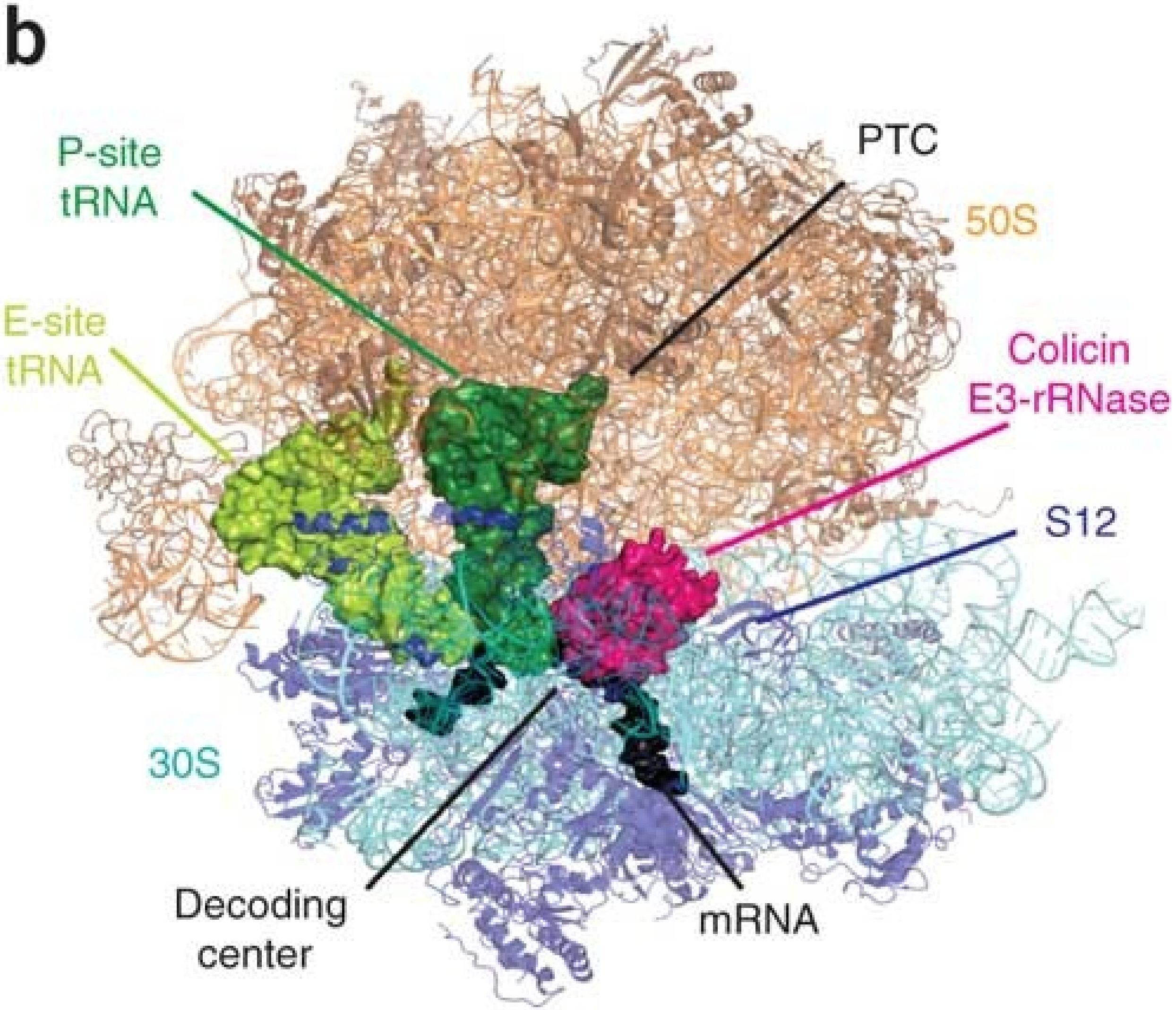
Madeline C. Weiss, Filipa L. Sousa, Natalia Mrnjavac, Sinje Neukirchen, Mayo Roettger, Shijulal Nelson-Sathi & William F. Martin

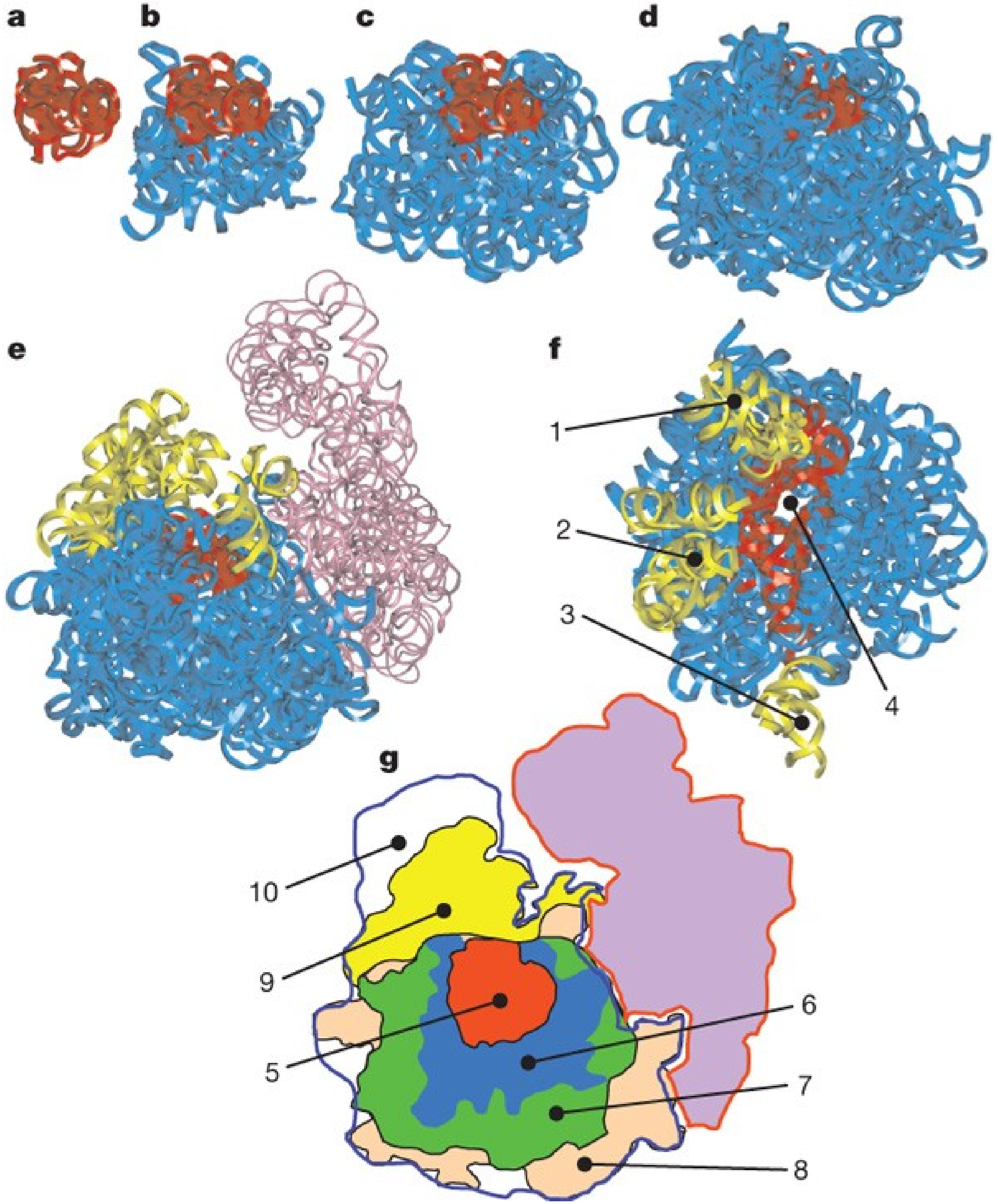
Nature Microbiology 1, Article number: 16116 (2016)

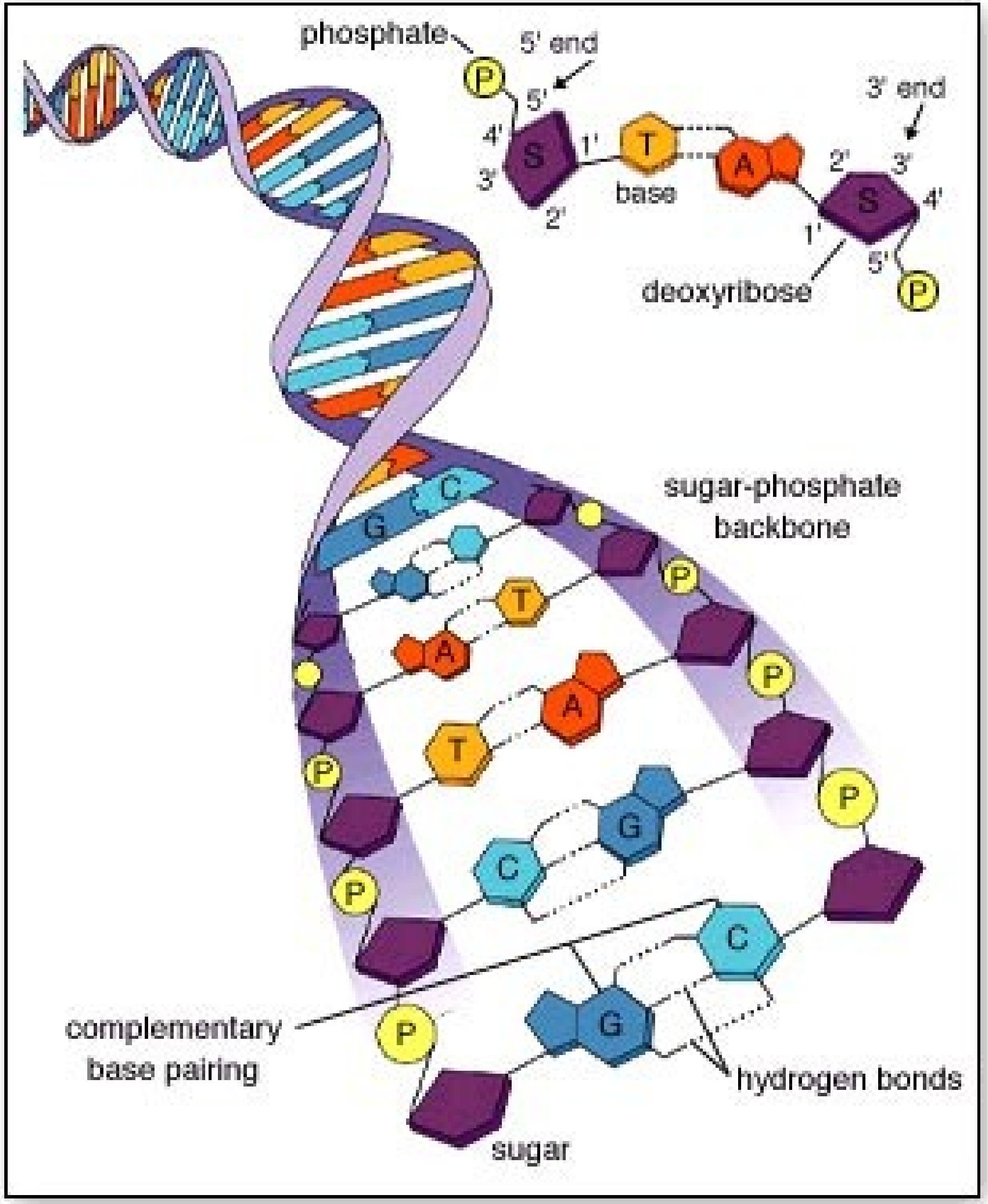


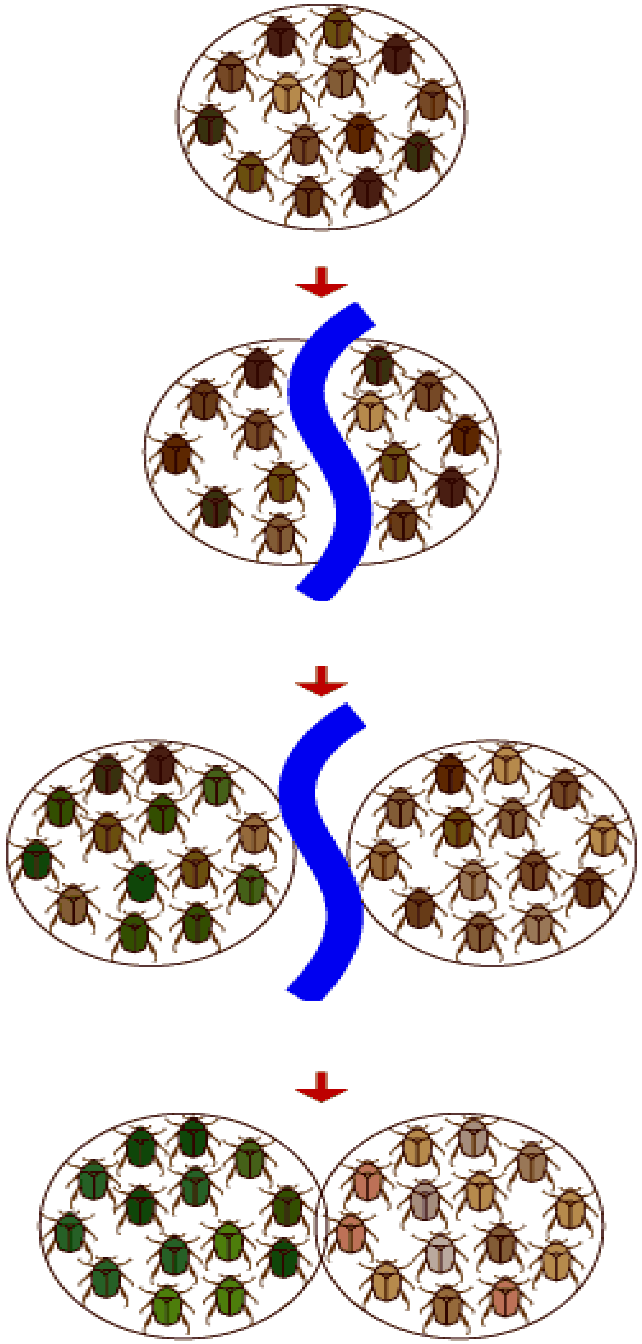


nascent peptide chain
aa1
aa2
aa3
aa4
aa5
peptide bond formation
aa6
large subunit
aa7
incoming aa-tRNA
leaving tRNA
E
P
A
C
C
C
C
A
G
anticodon
mRNA
U U U A G C
5'
3'
G G A A A U C G G U
small subunit
codon
codon
movement of the ribosome


b
P-site
tRNA
PTC
50S
E-site
tRNA
Colicin
E3-rRNase
S12
30S
Decoding
center
mRNA


a
b
c
d
e
f
1
2
3
4
g
10
9
5
6
7
8


phosphate
5' end
3' end
P
5'
4'
S
1'
3'
2'
T
base
A
2'
3'
S
4'
1'
5'
deoxyribose
P
sugar-phosphate
backbone
G
C
T
A
A
T
G
C
C
G
P
complementary
base pairing
hydrogen bonds
sugar



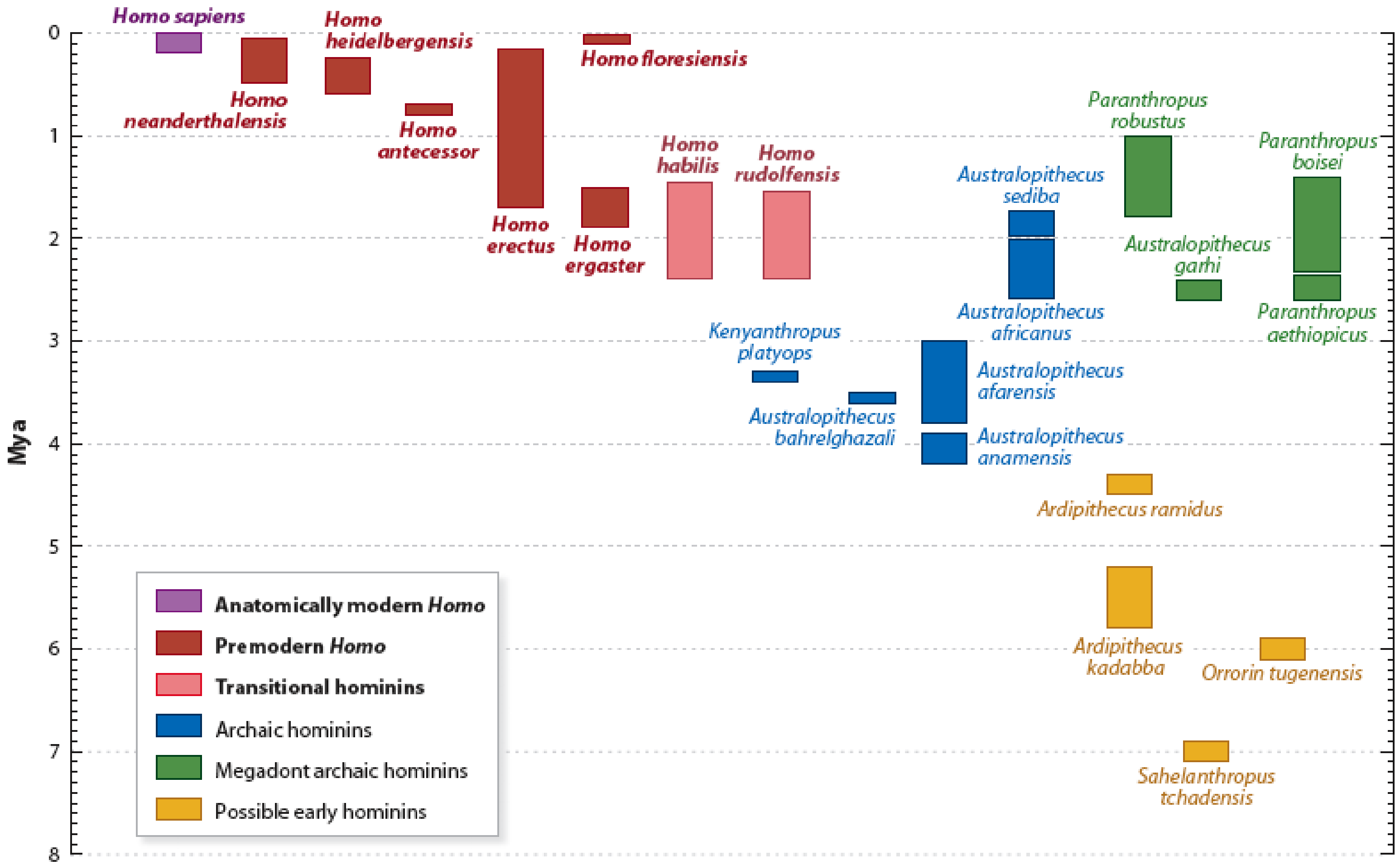


Figure 1

The taxa recognized in a typical speciose hominin taxonomy; the species conventionally included within *Homo* are emphasized in bold. The taxa are sorted into grades (see Wood 2010a for details); the three grades that contain *Homo* taxa are in bold. The height of the columns reflects either uncertainties about the temporal age of a taxon, or in cases in which there are well-dated horizons at several sites, it reflects current evidence about the earliest, called the first appearance datum (FAD), and the most recent, called the last appearance datum (LAD), fossil evidence of any particular hominin taxon. However, the time between the FAD and the LAD is likely to be represent the minimum time span of a taxon, for it is highly unlikely that the fossil record of a taxon, and particularly the relatively sparse fossil records of early hominin taxa, include the earliest and most recent fossil evidence of a taxon.

BONOBO: The Forgotten Ape by F.B.M. de Waal & Fran Lanting (Photographer)
Paperback: 234 pages - U California Press: 1997 List price: $27.50 ISBN 0-520216512

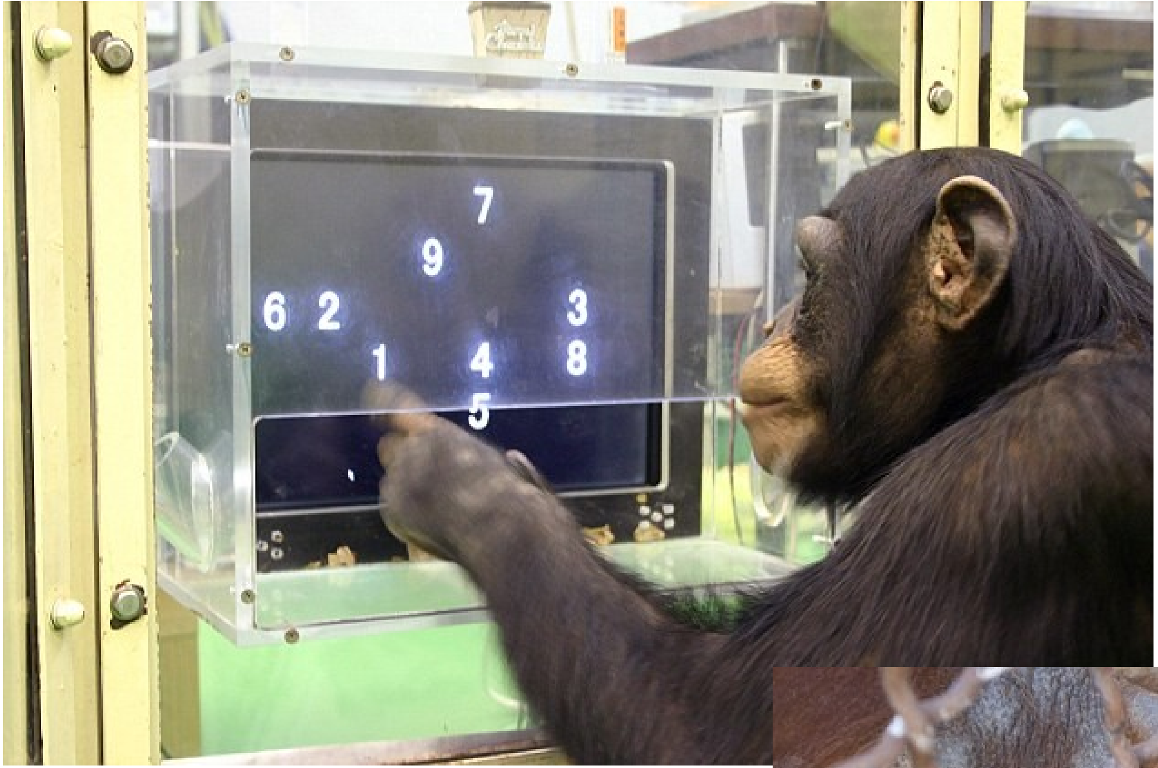

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Foto di Rocco Mussat Sartor
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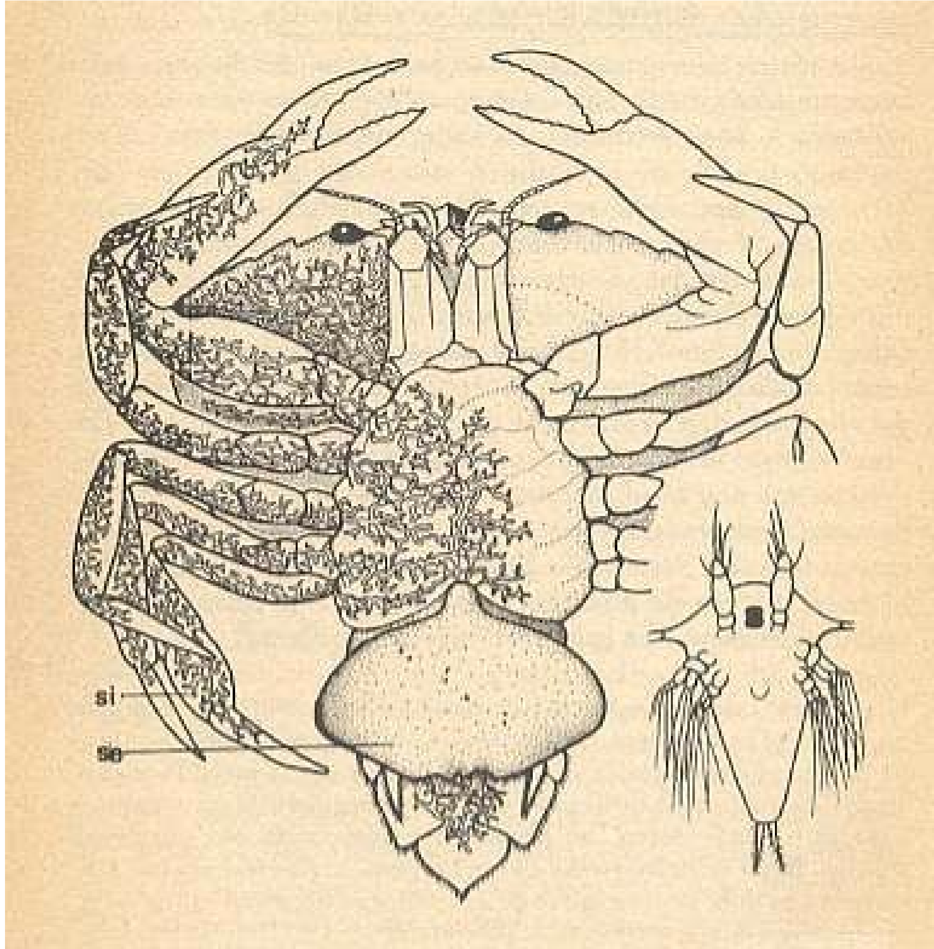
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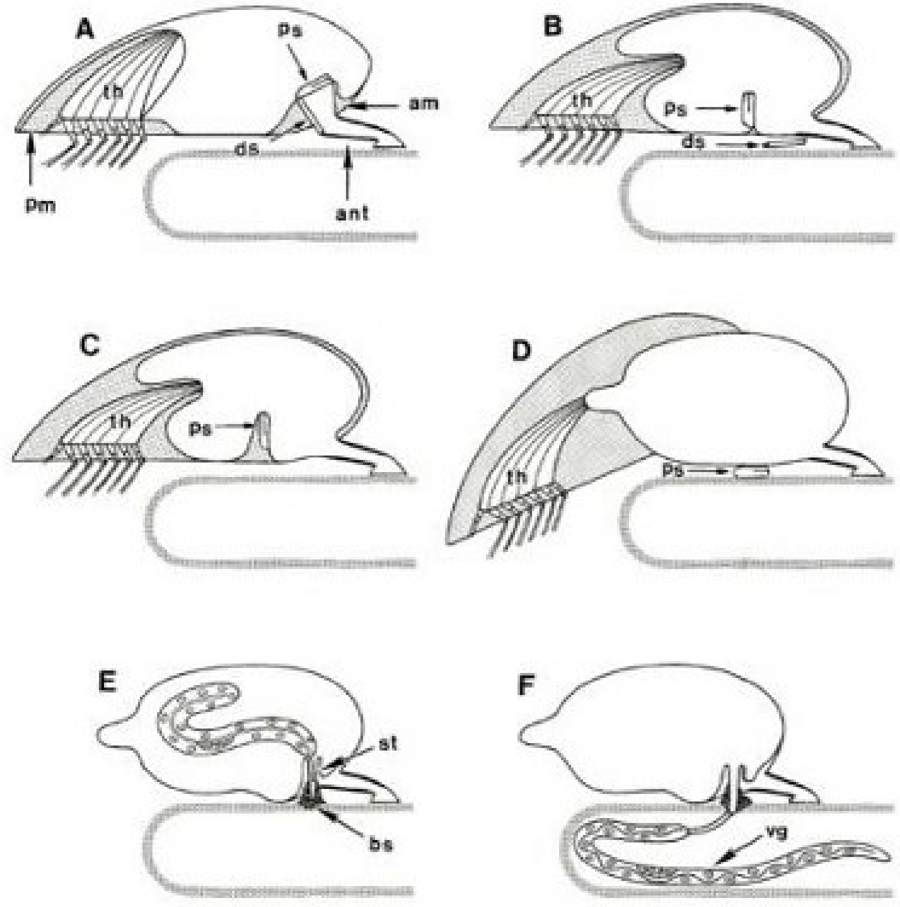
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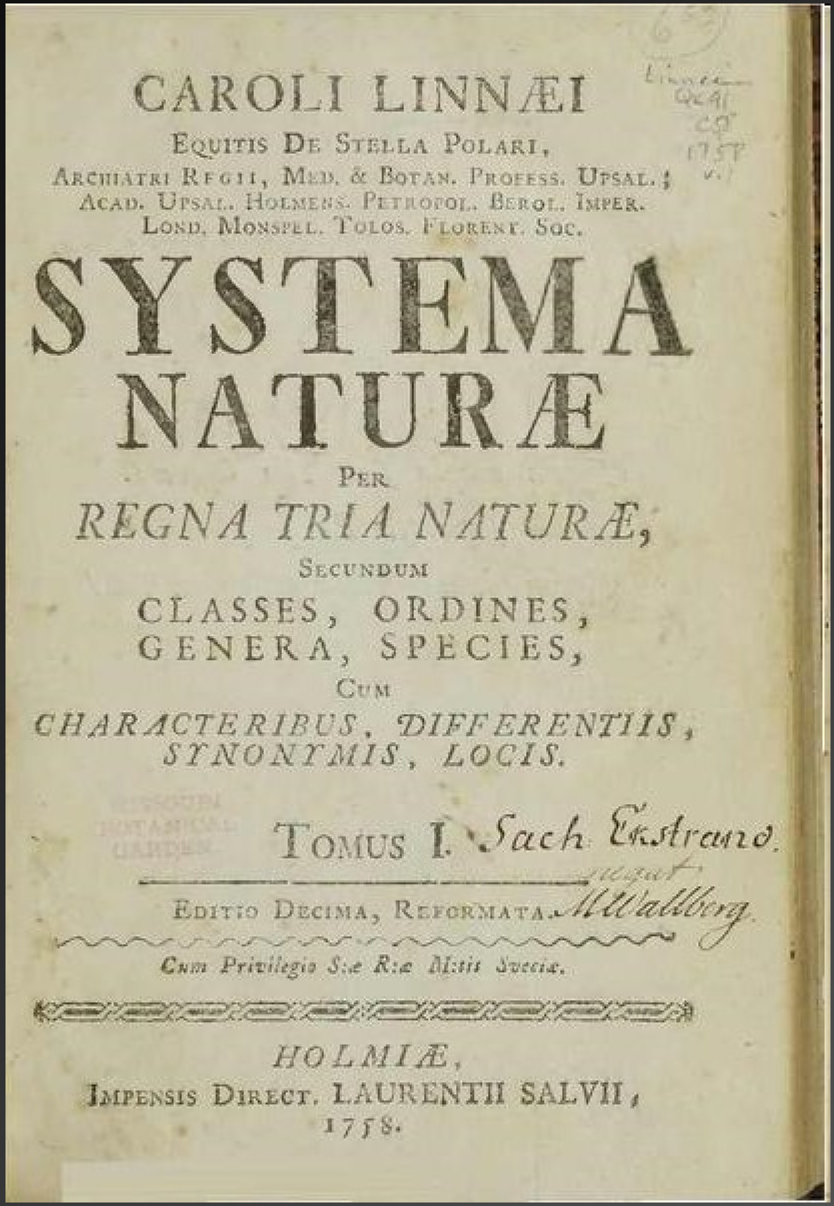


CAROLI LINNÆI

EQUITIS DE STELLA POLARI,

ARCHIATRI REGII, MED. & BOTAN. PROFESS. UPSAL.; ACAD. UPSAL. HOLMENS. PETROPOL. BEROL. IMPER. LOND. MONSPEL. TOLOS. FLORENT. SOC.

SYSTEMA NATURÆ

PER

REGNA TRIA NATURÆ,

SECUNDUM

CLASSES, ORDINES, GENERA, SPECIES,

CUM

CHARACTERIBUS, DIFFERENTIIS, SYNONYMIS, LOCIS.

TOMUS I. Sach Ekstrand

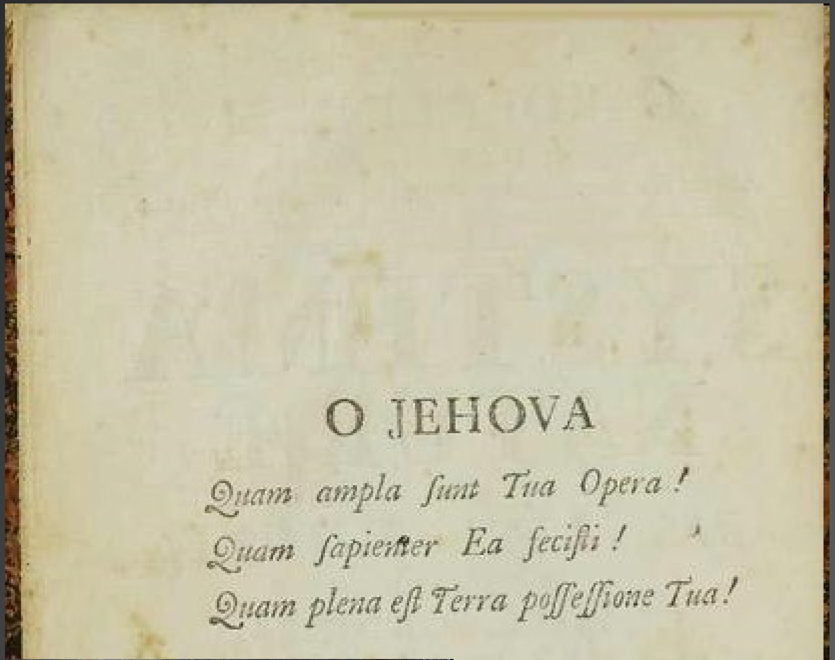
EDITIO DECIMA, REFORMATA. M Wallberg

Cum Privilegio S:æ R:æ M:tis Sveciæ.

HOLMIÆ,

IMPENSIS DIRECT. LAURENTII SALVII,

1758.



O JEHOVA

Quam ampla sunt Tua Opera!

Quam sapienter Ea fecisti!

Quam plena est Terra possessione Tua!

IMPERIUM NATURÆ.

DEUM *sempiternum*, *omniscium*, *omnipotentem* a tergo transeuntem vidi & obstupui! legi aliquot Ejus *vestigia* per creata rerum, in quibus omnibus, etjam minimis, ut fere nullis, quæ Vis! quanta Sapientia! quam inextricabilis Perfectio! Observavi *Animalia* inniti vegetabilibus, *Vegetabilia* terrestribus, *Terrestria* telluri; *Tellurem* dein ordine inconcusso volvi circa solem, a quo vitam mutuatur; *Solem* demum circa axin gyrari cum reliquis *Astris*, systemaque *Siderum*, spatio & numero vix definiendum, mediante motu in vacuo nihilo suspensum teneri ab incomprehensibili *Movente primo*, ENTE ENTIUM (a), *Caussa caussarum*, *Custode Rectoreque universi*, *mundani hujus operis Domino & Artifice*. *Vis illud* FATUM *vocare, non errabis, est ex quo suspensa sunt omnia. Vis illud* NATURAM *vocare, non errabis, est ex quo nata sunt omnia. Vis illud* PROVIDENTIAM *vocare, recte dices, est cujus consilio mundus actus suos explicat* (b); *totus est* SENSUS, *totus* VISUS, *totus* AUDITUS, *totus* ANIMÆ, *totus* ANIMI, *totus* SUI; *hujus* EXTERA *indagare non capit humanæ conjectura mentis* (c); NUMEN *esse credi par est, æternum, immensum, neque genitum neque creatum* (d). *Hoc sine quo nihil est, quod totum hoc fundavit & condidit, quodque oculos nostros & implet & effugit, cogitatione tantum visendum est; in sanctiore enim secessu Majestas tanta delituit, nec ulli dat aditum nisi animo.* (e)

MUNDUS complectitur omnia sub jove, quæ in notitiam nostram per sensus cadere possunt; sunt hæc *Astra*, *Elementa*, *Tellusque* inenarrabili velocitate circumacta; *horum inoffensam velocitatem procedere videmus æternæ legis imperio, nec esse temere errantis hunc ordinem, neque quæ temere coiverunt tanta arte pendere, ut terrarum gravissimum pondus sedeat (quasi) immotum & circum se properantis cœli fugam spectet.* (f)

 ASTRA

(a) *Aristoteli.* (b) *Senec. quæst. II: 45. hoc respectu, sed caute, ne effectus sumatus pro caussa.* (c) *Exod. XX: 4.* (d) *Plin. Nat. II. 17.* (e) *Senec. VII: 31.* (f) *Senec. I: 1.*

ASTRA sunt remotissima corpora lucida, quæ gyrantur motu perpetuo; sunt hæc aut SIDERA propria luce radiantia, ut *Sol*, remotioresque *Stellæ fixæ*; aut PLANETÆ a sideribus lucem mutuantes, quorum primarii Solares: *Saturnus*, *Jupiter*, *Mars*, *Tellus*, *Venus*, *Mercurius*; secundarii obsecundantes Planetis, ut *Luna* Telluri, aliique; *nec posse sine Custode tantum opus stare, nec hunc siderum discursum fortuiti impetus esse, nam quæ casus incitat sæpe turbari & cito arietare.* (g)

ELEMENTA sunt corpora simplicissima, atmosphæram Planetarum constituentia, spatia inter Astra forte replentia:
TERRA *opaca*, *fixa*, *frigida*, *quiescens*, *sterilis*.
AQUA *diaphana*, *fluida*, *humida*, *penetrans*, *concipiens*.
AËR *pellucidus*, *elasticus*, *siccus*, *obvolitans*, *generans*.
IGNIS *lucidus*, *resiliens*, *calidus*, *evolans*, *vivificans*.
Omnium Elementorum alterni recursus sunt, quidquid alteri perit in alterum transit; alternæ sunt vices rerum. (h)

TELLUS est globus planetarius horis 24 rotatus, circum solem quotannis in orbem actus, *Elementorum* atmosphæra obvelatus, rerum *Naturalium* stupendo cortice tectus, cujus cognoscendæ superficiei studemus. Globus hic terraqueus est, cujus depressiorem partem Aquæ inundant & *Mare* lente coarctandum; elatiorem vero aquæ fugiunt sensim dilatandam in *Continentem* siccam habitabilem. Hæc Aquarum halitu, vi Aëris in *nubes* acto, irroratur, ut summi montes perennique nive Alpini *Scaturigines* in *Fluvios* perennes concurrentes, camque permeantes, potum terrestri cibo addant in alimentum incolarum, dum *Venti* motum excitant *Ignis* calore vivificatis corporibus. *Sic omnia adjuvabunt Naturam, ut naturæ opera peragantur* (i).

NATURALIA sunt corpora cuncta Creatoris manu composita, corticem Telluris constituentia, in Regna Naturæ tria divisa, quorum limites concurrunt in Lithophytis.
LAPIDES corpora *congesta*, nec viva, nec sentientia.
VEGETABILIA corp. *organisata* & *viva*, non sentientia.
ANIMALIA corp. *organisata* & *viva* & *sentientia*, sponteque se moventia. *Tota enim hujus mundi concordia ex discordibus constat* (k); *Nec ad unam Natura formam opus suum præstat, sed in ipsa varietate se jactat* (l).

HOMO

(g) *Senec.* (h) *Senec. III: 10.* (i) *Senec. III: 29.* (k) *Senec.* (l) *Senec. VII: 27.*

MAMMÆ lactantes feminis omnibus, etiam Maribus (excepto Equo) numero determinatæ: *Pectorales* (Primatibus, Cetis); *Abdominales* (Didelphibus, Phocis); *Inguinales* (Pecoribus, Belluis); *Abdominales Pectoralesque* ſimul (Gliribus pluribus); *longitudinaliter* digeſtæ (Suibus aliisque), at ſæpius binæ pro ſingulo fœtu ordinario.

COLUNTUR varia inprimis Pecora ob *Carnes*, *Lac*, *Corium*, *Vellera*, *Pinguedinem*; ad *Onera* verò Equus, Camelus, Elephas; inſtituuntur Feræ variæ pro *venatu*, *muribus*, *ſerpentibus*; vivariis aſſervantur rariora.

ORDINES imprimis a dentibus deſumuntur:

MAMMALIA	Quadrupedia, (*unguibus armata*) Dentibus Primoribus	nullis utrinque	—	—	*Bruta*. 2.
		— ſuperioribus, inferioribus pluribus	—	—	*Pecora*. 6.
		duobus; laniariis nullis	—	—	*Glires*. 5.
			uno pluribus	—	*Beſtiæ*. 4.
		pluribus; laniariis	ſolitariis; primoribus ſuperioribus	quatquor	*Primates*. 1.
				ſex obtuſis	*Belluæ*. 7.
				— acutis	*Feræ*. 3.
	Pinnata (*mutica abſque unguibus*) pinnis loco pedum inſtructa	—	—	—	*Cete*. 8.

I. PRIMATES.
Dentes primores ſuperiores *IV paralleli*. Laniarii *ſolitarii*.
Mammæ *pectorales, binæ*.
Palmæ *Manus ſunt*.
Brachia *diducta claviculis, inceſſu tetrapodo valgo*.
Scandunt *arbores earumque gazas legunt*.

II. BRUTA.
Dentes primores *nulli ſuperius aut inferius*.
Inceſſus *ineptior*.

III. FERÆ.
Dentes primores *utrinque: ſuperiores VI, omnes acutiores*.
Laniarii *ſolitarii*.
Ungues *pedum acuti*.
Victus *ore ſævientium e cadaveribus, rapina*.

IV. BE-

I. PRIMATES.

Dentes Primores ſuperiores IV, paralleli.
Mammæ Pectorales II.

1. HOMO noſce Te ipſum. (*)

Sapiens. 1. H. diurnus; *varians cultura, loco.*
Ferus. tetrapus, mutus, hirſutus.
Juvenis Urſinus lithuanus. 1661.
Juvenis Lupinus heſſenſis. 1544.
Juvenis Ovinus hibernus. Tulp. obſ. IV: 9.
Juvenis Hannoveranus.
Pueri 2 Pyrenaici. 1719.
Johannes Leodicenſis.

Americanus. α. rufus, cholericus, rectus.
Pilis nigris, rectis, craſſis; *Naribus* patulis; *Facie* ephelitica, *Mento* ſubimberbi.
Pertinax, hilaris, liber.
Pingit ſe lineis dædaleis rubris.
Regitur Conſvetudine.

β al-

(*) Noſſe Se ipſum gradus eſt primus ſapientiæ, dictumque *Solonis*, quondam ſcriptum literis aureis ſupra *Dianæ* Templum. *Muſ. ADOLPH. FRID. Præfat.*

Phyſiologice: Te contextum Nervis, intertextum Fibris, Machina tenella, ſed adoleſcentem in perfectiſſimam, ſenſationibus inſtructam fere omnibus pluribusque, quam reliqua cuncta. *Nudum in nuda humo, natali die, abjicit natura ad vagitus ſtatim & ploratum, manibus pedibusque devinciendum Animal cæteris imperaturum; cui ſcire nihil ſine doctrina; non fari, non ingredi, non veſci, non aliud naturæ ſponte. Plin. Vides itaque qualem vitam nobis rerum natura promittat, quæ primum naſcentium omen fletum eſſe voluit. Seneca.*

Diætetice: Te ſanitate & tranquillitate, ſi noveris, felicem: *Moderatis* conſervandum, *Nimiis* deſtruendum, *Variatis* afficiendum, *Infectis* frangendum, *Confectis* indurandum; polyphagum Culina inſtructiſſima, per errores gratiſſima, igne vinoque horrenda. *Parvo fames conſtat, magno faſtidium. Seneca.*

Pathologice: Te tumidam usque dum crepueris bullam, piloque pendulam in puncto fugientis temporis. *Nihil enim homine imbecillius terra alit. Homer. Nulli vita fragilior; nulli tot Morbi, tot Curæ, tot Pericula. Breve universum usque ævi tempus: Pars æqua morti ſimilis exigitur; nec reputantur Infantiæ anni, qui ſenſu carent; nec Senectæ in pœnam vivaces: hebeſcunt Senſus, torpent Membra, præmoriuntur Viſus, Auditus, Inceſſus, Dentes, Ciborum inſtrumenta. Plin. Sic magna pars mortis jam præteriit, quidquid ætatis retro eſt Mors tenet. Totum denique hunc, quem vides populum, quantus quantus eſt, cito natura revocarit & condet; Mors omnes æque vocat; iratis Diis propitiisque moriendum. Senec. II: 19.*

Differt itaque a reliquis Corpore erecto nudo, at piloso Capite, Superciliis, Ciliisque, tandem Pube, Axillis, Maribusque Mento. Feminis Nymphæ & Clitoris; Mammæ 2 pectorales. Caput Cerebro omnium maximo; Uvula; Facies abdomini parallela, nuda; Naso prominente, compresso, breviore; Mento prominente. Cauda nulla. Pedes Talis incedentes.

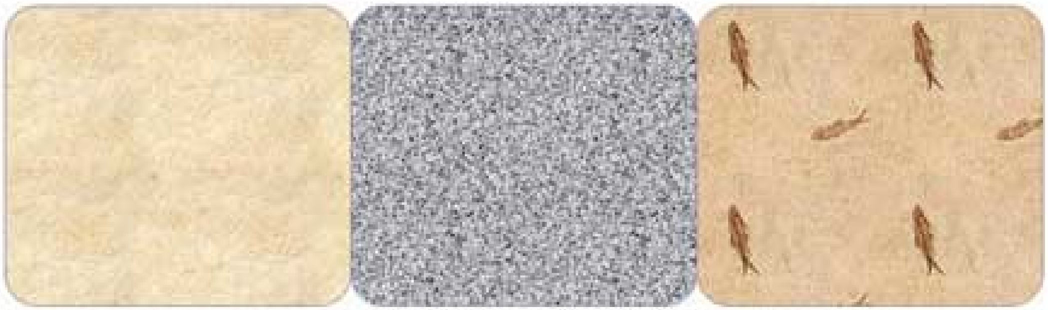
Troglo-dytes. 2. H. nocturnus. (*)
Homo sylvestris Orang Outang. *Bont. jav.* 84. *t.* 84.
Kakurlacko. *Kjæp. itin. c.* 86. *Dalin. orat.* 5.
Habitat in Æthiopiæ *conterminis* (*Plin.*), *in* Javæ, Amboinæ, Ternatææ *speluncis.*
Corpus *album*, *incessu erectum*, *nostro dimidio minus.* Pili *albi*, *contortuplicati.* Oculi *orbiculati*: iride pupillaque *aurea.* Palpebræ *antice incumbentes cum Membrana nictitante.* Visus *lateralis*, *nocturnus.* Aetas *XXV annorum.* Die *caecutit*, *latet*; Noctu *videt*, *exit*, *furatur.* Loquitur *sibilo*; Cogitat, *credit sui caussa factam tellurem*, *se aliquando iterum fore imperantem*, *si fides peregrinatoribus.*

2. SI-

(*) *Genus* Troglodytæ ab Homine distinctum, adhibita quamvis omni attentione, obtinere non potui, nisi assumerem notam lubricam; in aliis generibus non constantem. Nec Dentes laniarii, minime a reliquis remoti; nec Nymphæ Caffræ, quibus carent Simiæ, hunc ad simias reducere admittebant. Inquirant autoptæ in vivo, qua ratione, modo notæ aliquæ exstant, ab hominis Genere separari queat, *nam inter simias versantem oportet esse brutum. Apuleius.*
Speciem Troglodytæ ab Homine sapiente distinctissimam, nec nostri generis illam nec sanguinis esse, statura quamvis simillimam, dubium non est, ne itaque varietatem credas, quam vel sola Membrana nictitans absolute negat.
Afri Pilos contortuplicatos, quamvis albos, in hoc miratus sum, collatis imprimis Varietatum caussis in Plantis, in Pullo Gallinaceo, nec tamen quidquam de Mauris albis ex nigris statui.
Troglodytas nec dixi hos Troglodytas Plinii, quamvis nos ultimum simus Creationis opus.
Homo caudatus hirsutus, *Marpert. epist.* 7. *Kiop. it.* 79. *Bont. jav.* 85. *an Aldr. digit.* 249? incola orbis antarctici, nobis ignotus, ideoque utrum ad Hominis aut Simiæ genus pertineat, non determino. Mirum quod ignem excitet, carnesque alat, quamvis & crudas voret testimonio Peregrinantium.

It does not please [you] that I've placed Man among the Anthropomorpha, perhaps because of the term 'with human form', but man learns to know by himself. Let's not quibble over words. It will be the same to me whatever name we apply. But I seek from you and from the whole world a generic difference between man and simian that [follows] from the principles of Natural History. I absolutely know of none. If I had called man a simian or vice versa, I would have brought together all the theologians against me. Perhaps I ought to have so in respect of the laws of our discipline.

Letter from Linnaeus to Gmelin, 1747



condição precursora:
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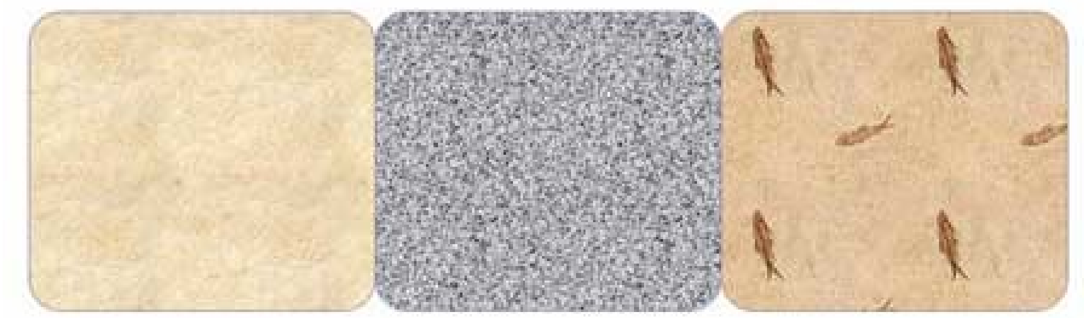
pedras



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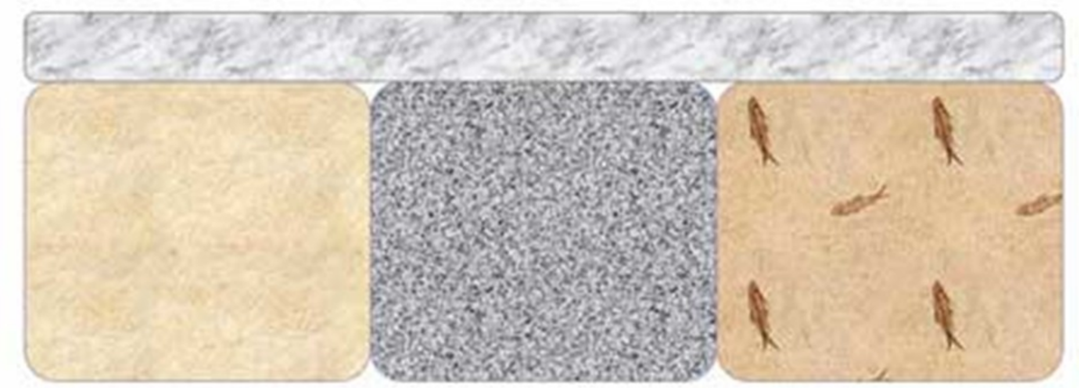
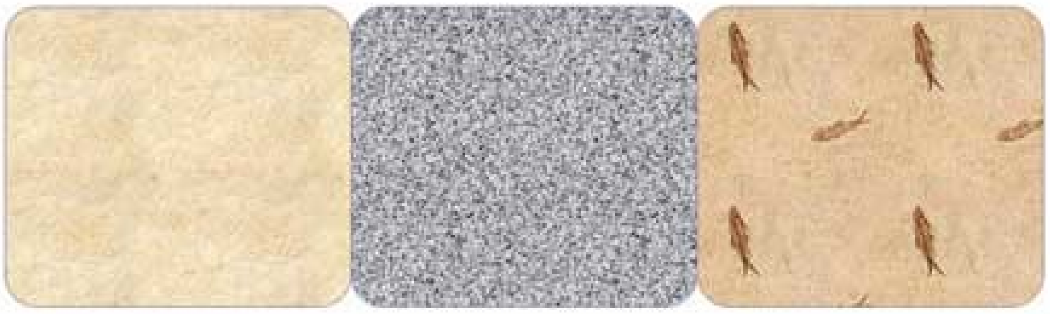


passo 1: adição de uma
pedra contínua por cima



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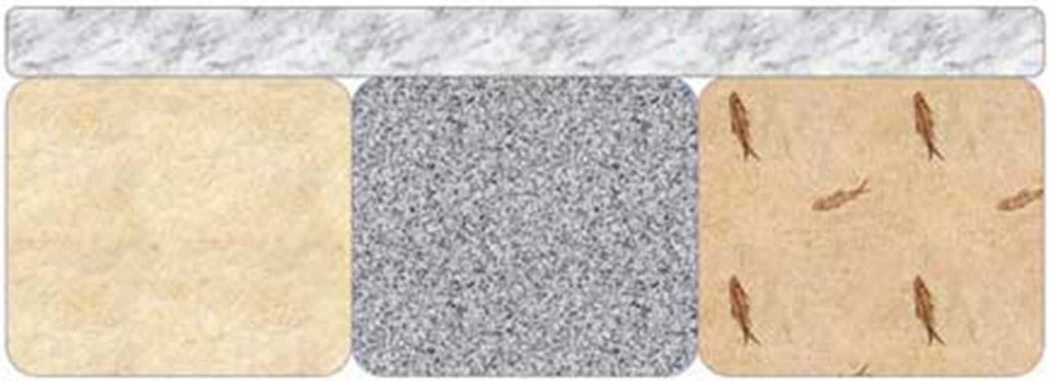

passo 1: adição de uma
pedra contínua por cima

passo 2: retirada da
Pedra intermediária

resultado: **complexidade irredutível!**

Nenhuma pedra pode ser retirada sem perda de funcionalidade. Cada um dos três elementos é indispensável para a funcionalidade do sistema.

GENETIC VARIABILITY, TWIN HYBRIDS AND CONSTANT HYBRIDS, IN A CASE OF BALANCED LETHAL FACTORS

HERMANN J. MULLER
The Rice Institute, Houston, Texas.

[Received January 14, 1918]

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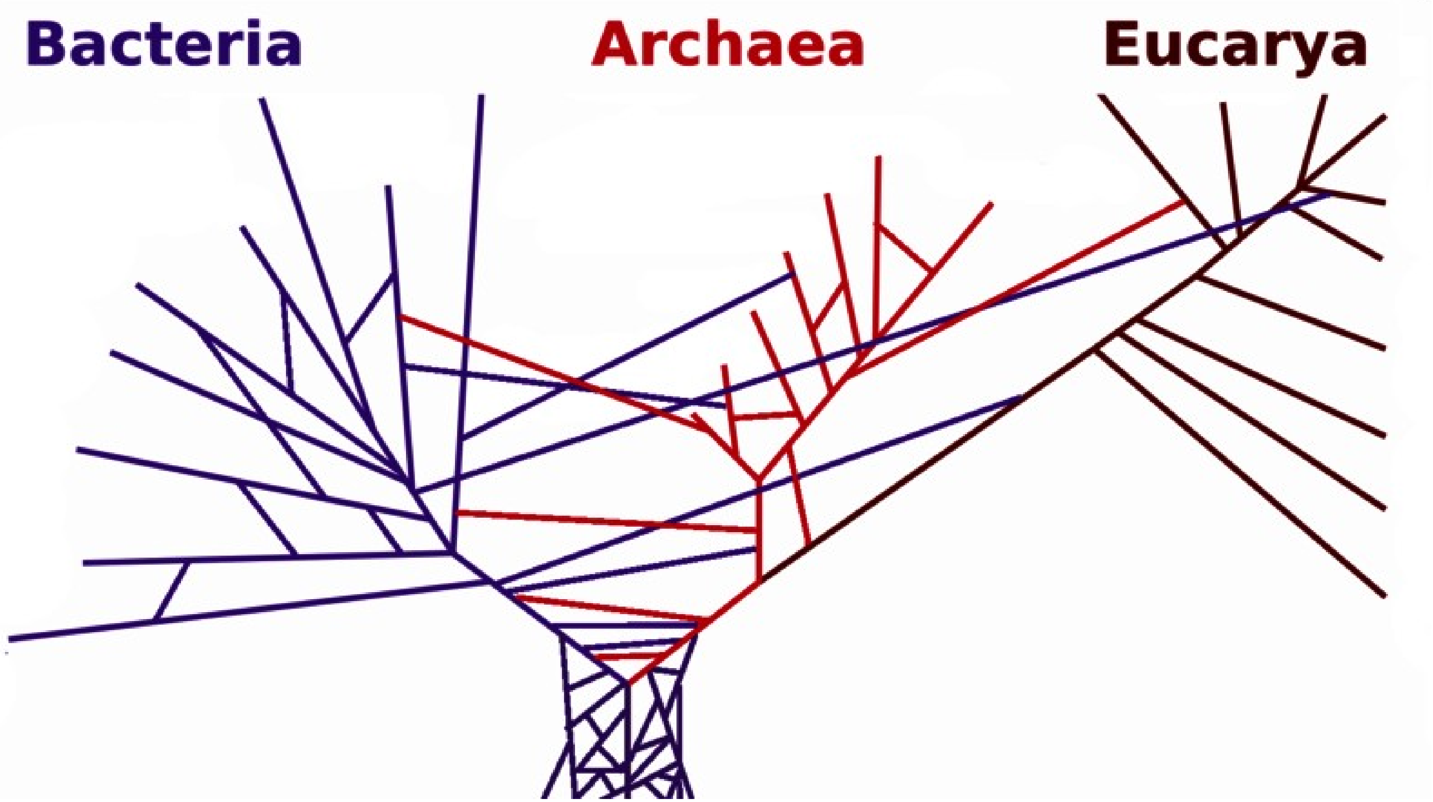
THE PROBLEM OF FACTOR VARIABILITY AND THE CASE OF BEADED WINGS

In numerous breeding experiments there is positive evidence that the factors concerned undergo no sensible fluctuation, nor sensible contamination during segregation. But, unfortunately for a clear and simple proof or disproof of the generality of these principles, Mendelian theory demands, and experiment has proved, that not infrequently multiple factors and other complications quite consistent with factor constancy

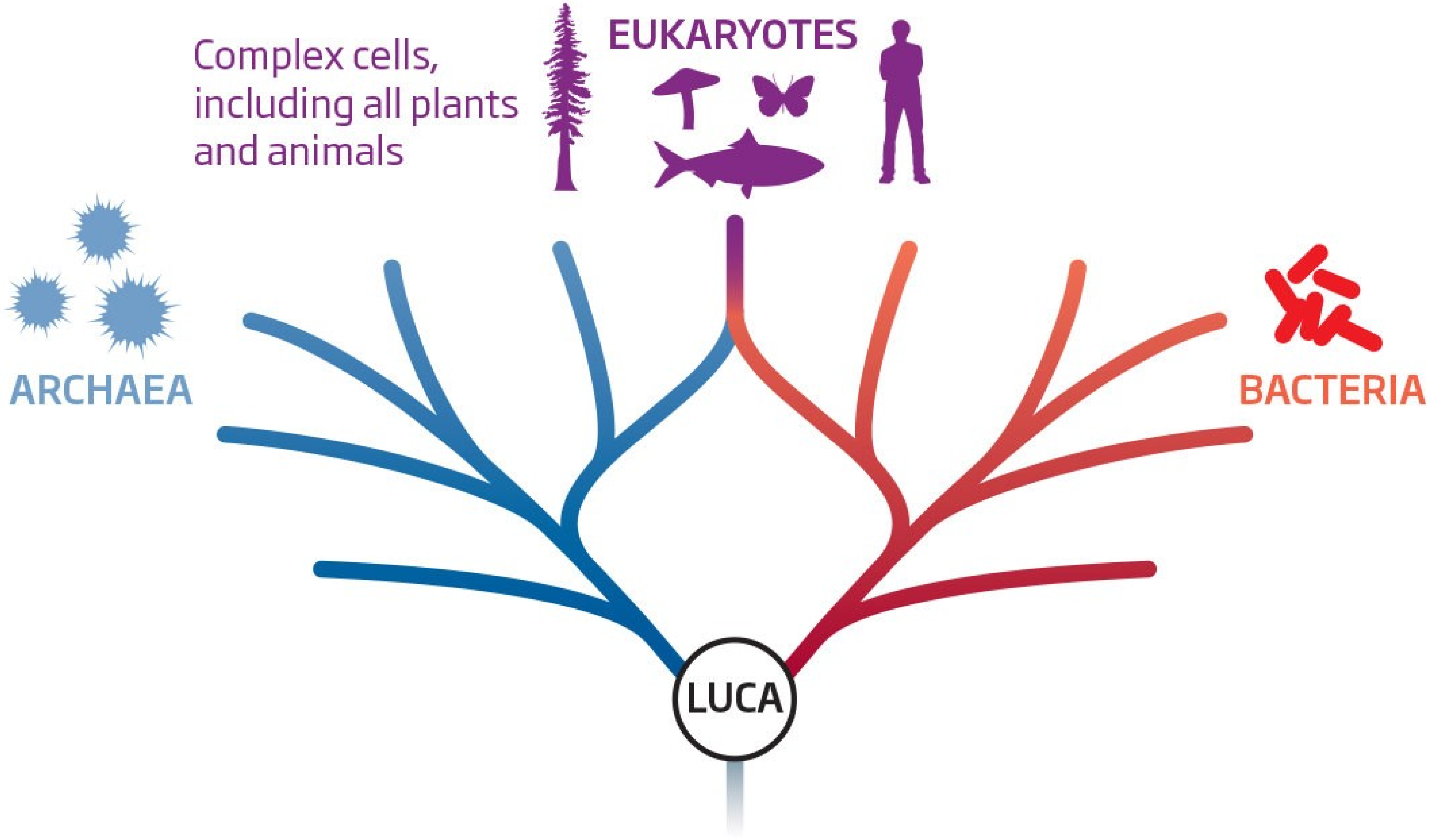
O criacionista é uma pessoa religiosa falsa e que, curiosamente, não tem nenhum senso de religião. Na linguagem da religião, são os fatos que observamos no mundo ao nosso redor que deveriam ser vistos como a palavra de Deus. Documentos, sejam a Bíblia, o Corão ou outros, são somente palavras de homens. Preferir as palavras do homem sobre as de Deus é o que pode chamar de blasfêmia. Este é o ponto de vista instintivo da maioria dos cientistas que, de novo curiosamente, têm uma compreensão mais profunda da verdadeira natureza da religião que os muitos que se iludem em uma crença frenética nas palavras, frequentemente sem sentido, dos homens. Na verdade, quanto menor o sentido, maior o frenesi”

Our Place in the Cosmos (1993), p.14


Bacteria
Archaea
Eucarya

Meet your maker

We're getting closer to understanding what the last universal common ancestor of all life on Earth, LUCA, was like and where it lived



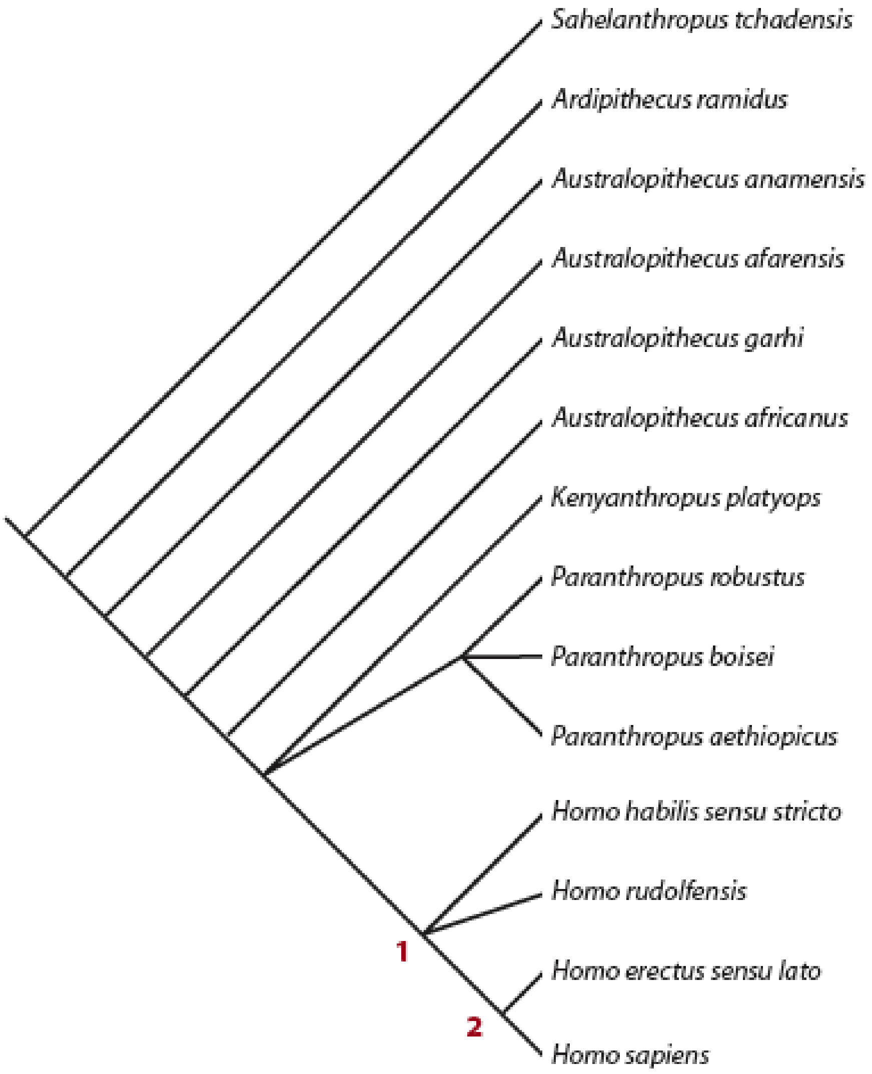


Figure 2

A cladogram presenting one hypothesis regarding the relationships among early hominins. The nodes 1 and 2 represent two hypotheses for the lower boundary of the *Homo* clade. If *Homo* were to include node 1, it would embrace the species presently included in early *Homo* (i.e., *H. habilis sensu stricto* and *H. rudolfensis*). If *Homo* was defined so as to exclude node 1, and to include just node 2, then it would be confined to early African *H. erectus* and temporally later, more derived *Homo* species (adapted from Wood 2009).


BIZLEY