

# PBIO-162 ESSENTIAL CLADISTICS

3-5 ECTS

## Lectures 14-16 (preliminary program) room 6602

- 6.xi. Tue history, phylogenetic trees
- 8.xi. Thu parsimony, Wagner algorithm
- 9.xi. Fri homology, homoplasy
  
- 12.xi. Mon characters, indices describing trees
- 13.xi. Tue optimization
- 15.xi. Thu monophyly, consensus & compromise
- 16.xi. Fri tree search algorithms
  
- 19.xi. Mon evaluating results
- 20.xi. Tue fossils & missing information
- 22.xi. Thu optimality criteria & classification
- 23.xi. Fri applications

1 ECTS  
attendance  
required

## Computer demonstrations 14-16

infocenter room 138

- 26.xi. Mon Cladistic Primer
- 27.xi. Tue mesquite
- 29.xi. Thu winclada+nona
- 30.xi. Fri winclada+TreeBase
  
- 3.xii. Mon TNT
- 4.xii. Tue TNT +independent exercise

**FINAL EXAM**

Fri 7.xii. or 21.xii.

independent exercise due  
by 31.xii.2018 1 ECTS

# 6.xi.

1. introduction, history

2. trees

3. summary

SOUND basic principles

nuts & bolts of  
phylogenetic analysis

# TAXONOMY

systematics

description

nomenclature

enables our navigation in the ocean  
of biodiversity

**CLASSIFICATION of organisms**



**LAW &  
ORDER**





















# DE PLANTIS LIBRI XVI.

ANDREAE CAESALPINI  
ARETINI,

Medici clarissimi, doctissimiq; atque  
Philosophi celeberrimi, ac  
subtilissimi.

AD SERENISSIMUM FRANCISCUM  
Medicem, Magnum Aetruvia Ducem.

M



FLORENTIAE,  
Apud Georgium Marescottum.  
MDLXXIII.









UPPSALA  
UNIVERSITET

Listen

På svenska

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## Welcome!

[www.linnaeus.uu.se/online/index-en.html](http://www.linnaeus.uu.se/online/index-en.html)

On this website Uppsala University presents results of research relating to the work of one of the most famous professors throughout its history, namely Carl Linnaeus (Carl von Linné) (1707–1778).

## You can learn more about

### [The Life of Linnaeus](#)

– childhood, schools, career and family

### [Linnaeus and Pharmacy](#)

– a journey among the pharmaceuticals of Nature

### [Plants and Animals](#)

– biological diversity in the 18th century and today

### [Physics and the Cosmos](#)

– what Linnaeus did not know about the Cosmos

### [The History of Ideas](#)

– Linnaeus, his epoch, his view of nature and a journey through the history of ideas

### [Linnaeus and Ecology](#)

– Linnaeus' thoughts of "The Economy of Nature"

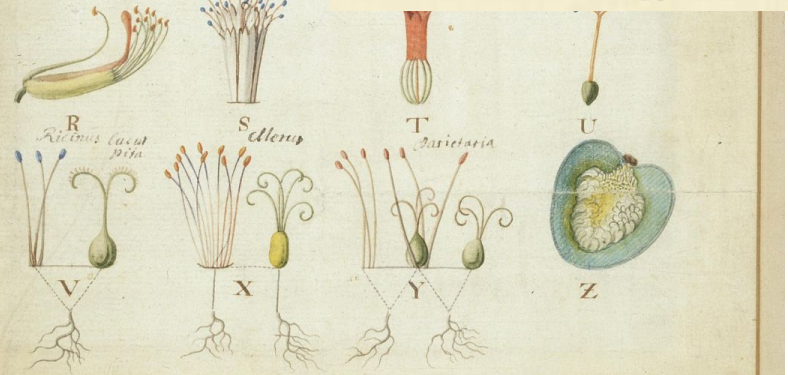
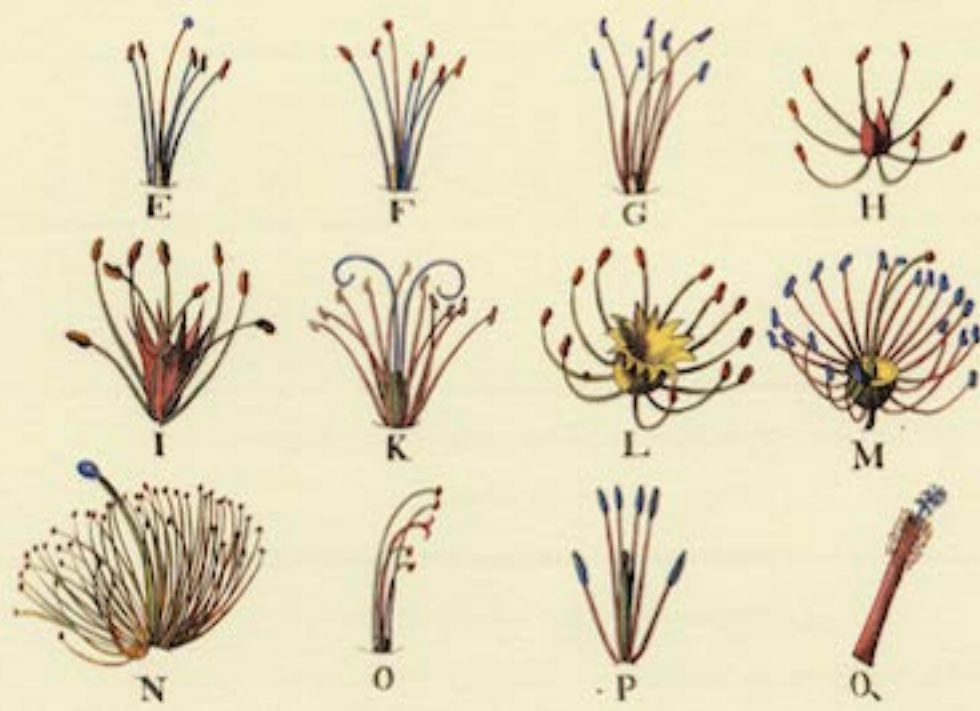
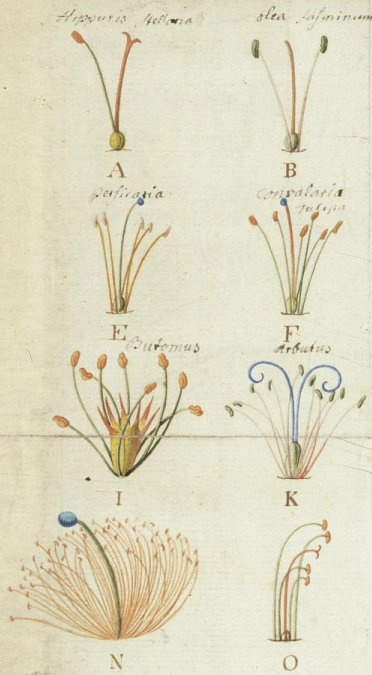
### [Mathematics in Linnaeus' time](#)

– Mathematics and mathematicians of the 18<sup>th</sup> century, with a special focus on Linnaeus' professorial colleague Samuel Klingenskierna

God created,  
Linnaeus classified

DOCT: LINNÆI M.D.  
 METHODUS plantarum SEXUALIS  
 in SYSTEMATE NATURÆ  
 deferipta

Est  
(G.H.)



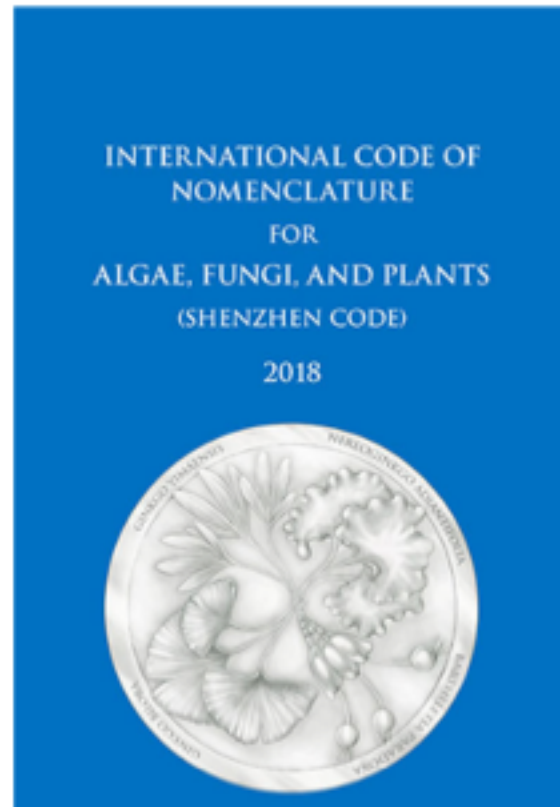
G.D.EHRET.  
 FECIT & EDIDIT  
 Lugd:bat: 1736.

"Sexual" system  
 - artificial  
 - convenient





[www.iapt-taxon.org/nomen/main.php](http://www.iapt-taxon.org/nomen/main.php)



## International Code of Nomenclature for algae, fungi, and plants

The *International Code of Nomenclature for algae, fungi, and plants* is the set of rules and recommendations that govern the scientific naming of all organisms traditionally treated as algae, fungi, or plants, whether fossil or non-fossil, including blue-green algae (*Cyanobacteria*), chytrids, oomycetes, slime moulds, and photosynthetic protists with their taxonomically related non-photosynthetic groups (but excluding *Microsporidia*). Before 2011 it was called the *International Code of Botanical Nomenclature* (ICBN).

This edition of the *Code* embodies the decisions of the Nomenclature Section of the XIX International Botanical Congress (IBC), which took place in Shenzhen, China in July, 2017. This *Shenzhen Code* supersedes the *Melbourne Code* (McNeill & al. in *Regnum Veg.* 154. 2012), published after the XVIII IBC in Melbourne, Australia in 2011. The rules of the *Shenzhen Code* became effective immediately upon acceptance of the resolution at the closing plenary session of the XIX IBC on 29 July 2017, that the decisions and appointments of its Nomenclature Section be approved. The *Shenzhen Code* in its final form was published on 26 June 2018 (printed version). This electronic version was made available on 27 June 2018.

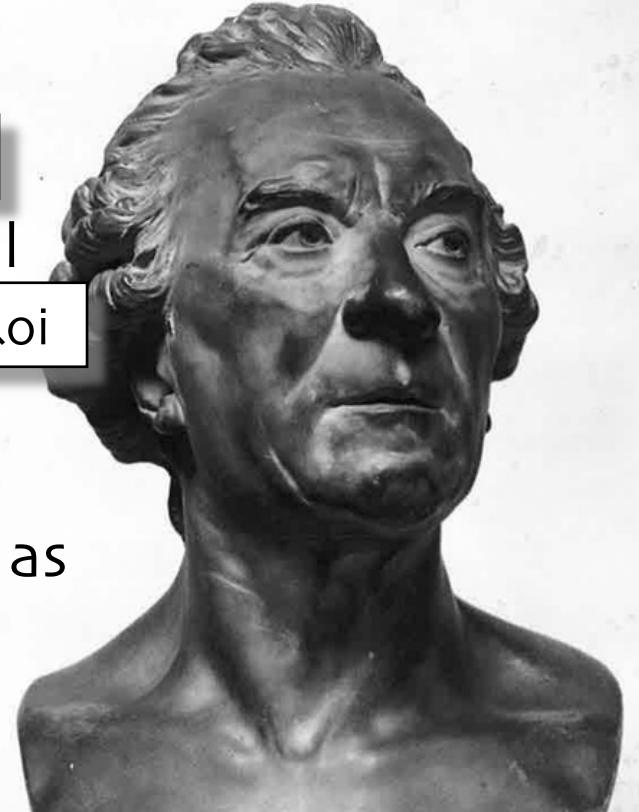


# ... meanwhile in France

Georges Louis Leclerc 1707-1788

Comte de Buffon

- director of the Royal Botanical Garden in Paris Jardin de Roi
- Histoire naturelle, générale et particulière 1749-1804
- opposed Linné's classification as artificial



Buffon's point .... the species .... are not the abstract universals of logic of the taxonomists but are rather systems of concrete relationship between real creatures at the level of physical truth.

Sloan, P.R. 1976. The Buffon-Linnaeus controversy.  
Isis 67: 356-375

# Jean-Baptiste de Lamarck

- 1<sup>st</sup> broad theory of evolution
- inheritance of acquired characters
- theory disproved but stimulated large no. of later studies





# CHARLES DARWIN 1857

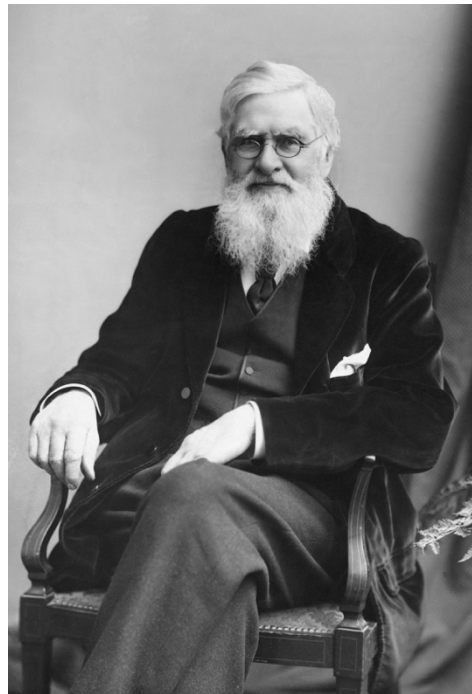
... the time will come I believe, though I shall not live to see it, when we shall have fairly true genealogical (*phylogenetic*) trees of each great kingdom of nature...

letter to Thomas Huxley

# CHARLES DARWIN 1859

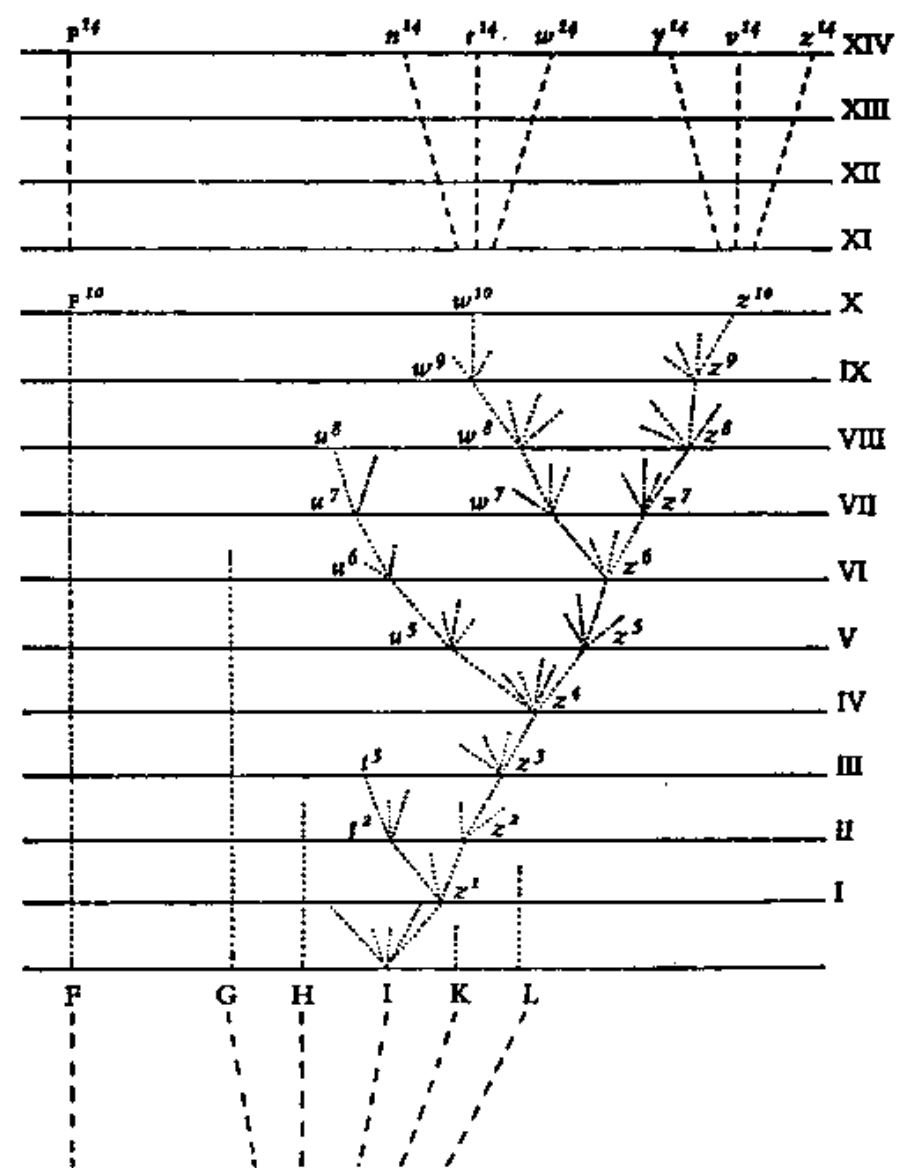
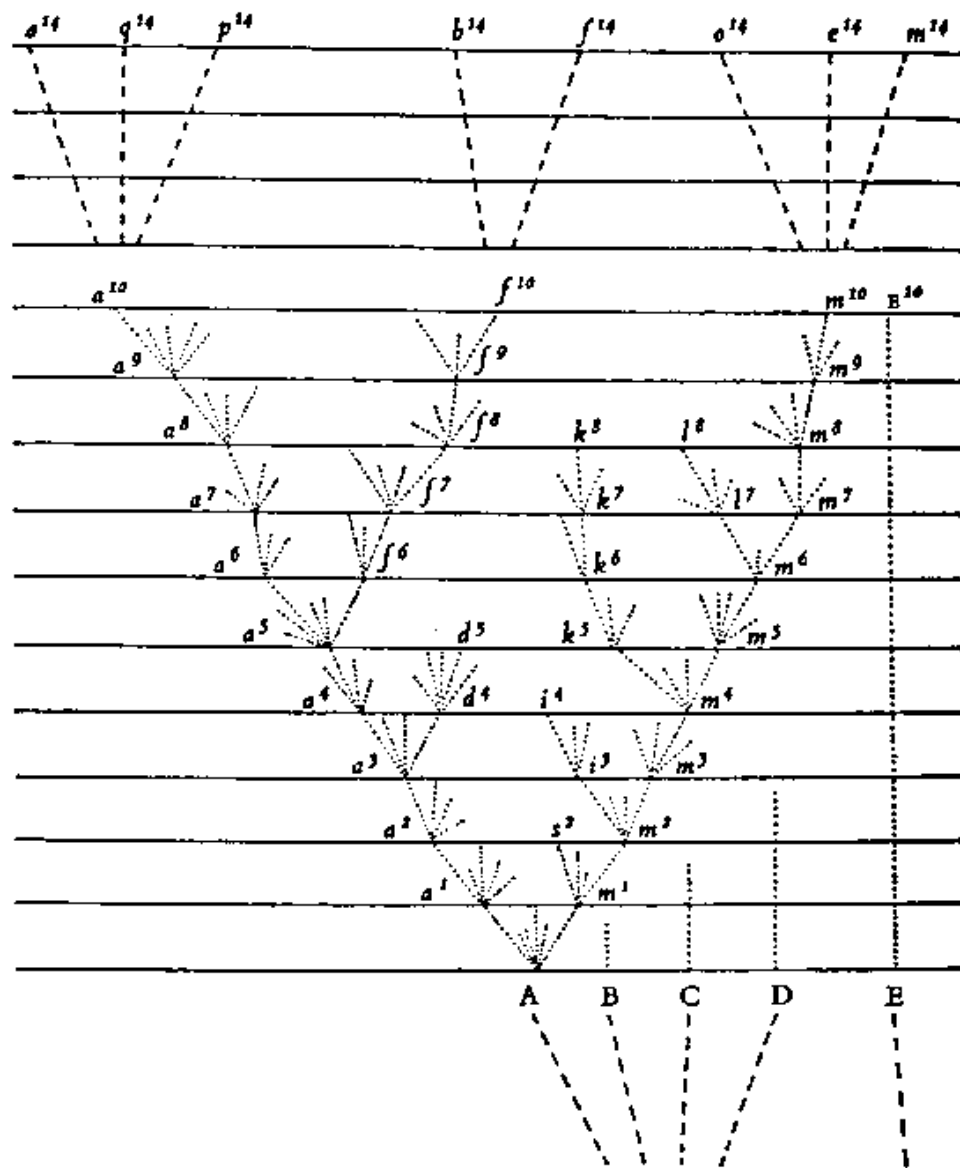
On the origin of species by means of natural selection

## DESCENT WITH MODIFICATION

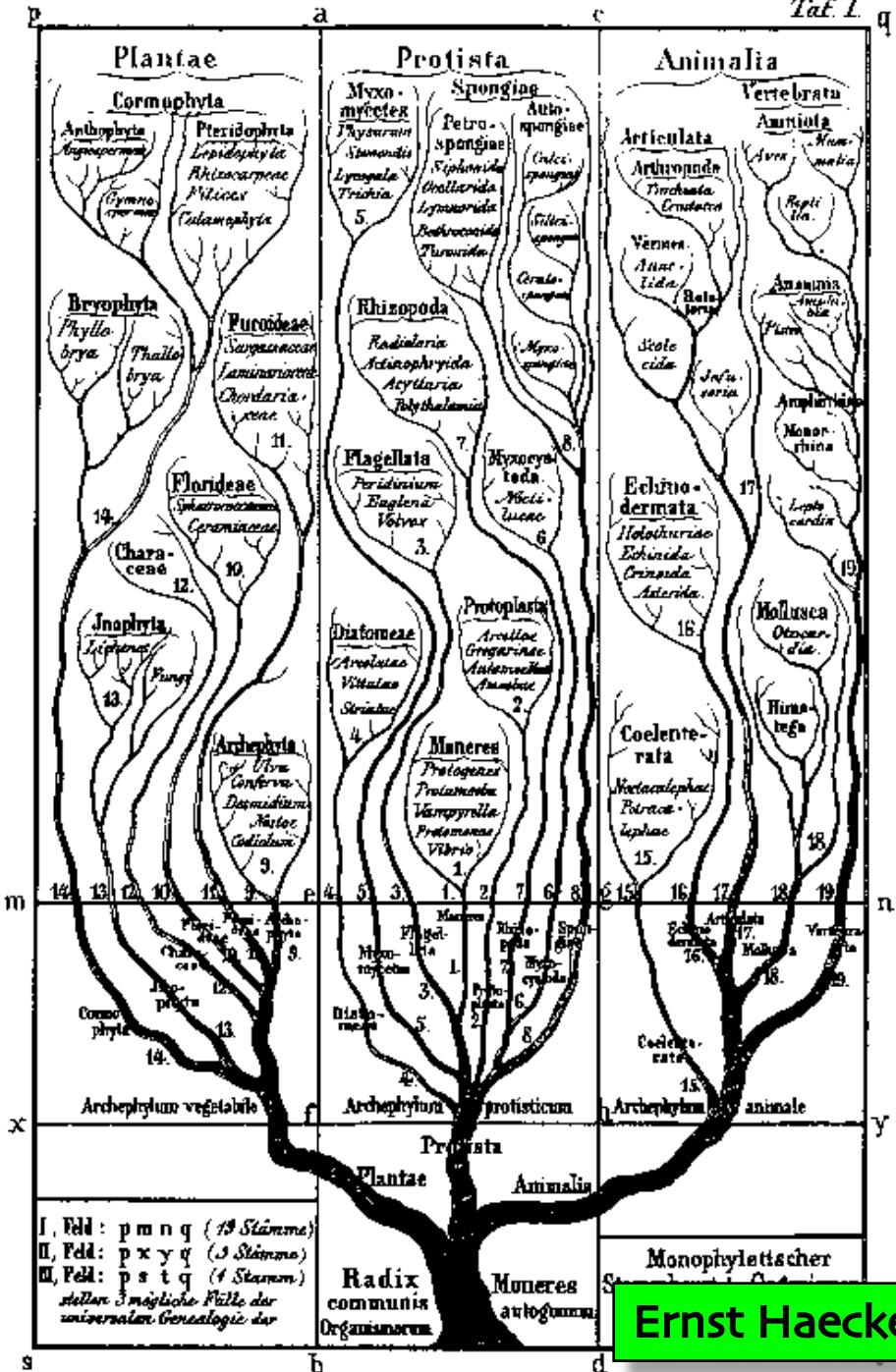


Alfred Russell  
Wallace





Darwin, C. 1859. The origin of species by means of natural selection, or the preservation of favoured races in the struggle for life. John Murray, London.



I, Feld: p m n q (19 Stämme)  
 II, Feld: p x y q (3 Stämme)  
 III, Feld: p s t q (4 Stämme)  
 stellen 3 mögliche Fälle der  
 universalen Genealogie dar

Radix  
 communis  
 Organismorum

Monophyletischer

Ernst Haeckel, Jena, 1866

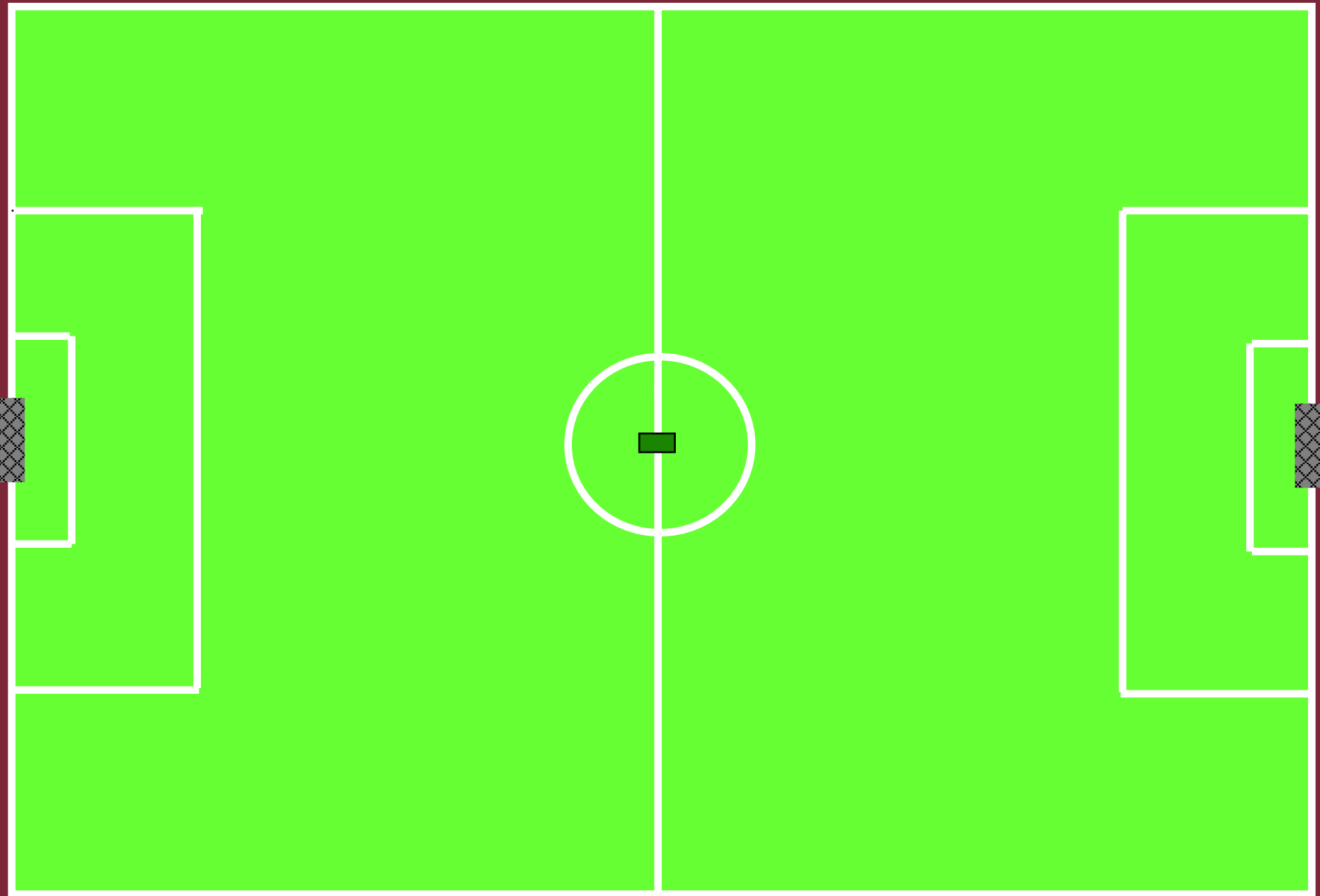


# EVOLUTIONARY HISTORY

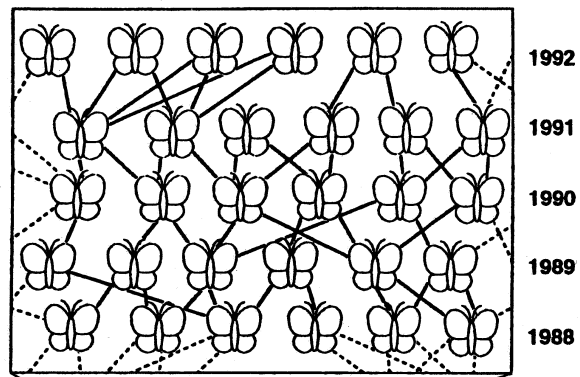
E. A. Vainio 1880:

...Descendensi-teorian kannalta ei systematiikin tehtäväksi enään tule järjestää organismia niin että ne, joilla on enimmin yhtäläisyyttä, tulevat rinnatusten, tai niin että vasta-alkavainen vähimmällä vaivalla saapi selkoa eli yleisen katsahduksen niistä; sen tehtäväksi tulee etsiä niiden geneetillistä yhteyttä, -- se muuttuu, toisilla sanoilla, genealogiaksi....

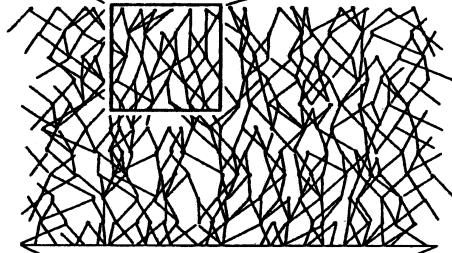
however, in practical terms, Darwin's revolutionary ideas did NOT alter contemporary classifications much – simply a novel explanation for groups distinguished



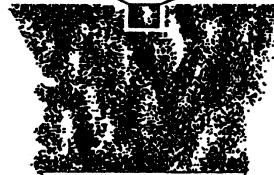




INDIVIDUALS



POPULATIONS



SPECIES



PHYLOGENY

# EVOLUTIONARY HISTORY

from evolutionary process >

traces of evolution

process > pattern

**EXTREME** scale difference

10-100 a > 10 ka - 100 ka - 100 Ma



# Emil Hans WILLI HENNIG

\*20.4.1913 †5.11.1976

Hennig, W. 1950. Grundzüge einer Theorie der phylogenetischen systematik

Hennig, W. 1966. Phylogenetic systematics

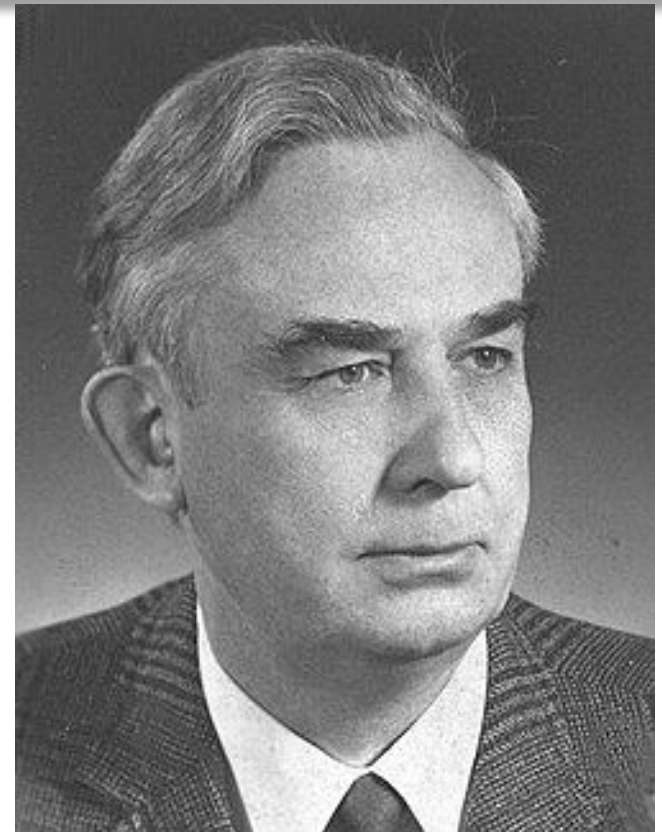
## CLADISTIC **REVOLUTION**

CLEAR, EXPLICIT &  
LOGICAL presentation of  
basic principles of  
phylogenetic analysis

SYNAPOMORPHY

MONOPHYLY

PARAPHYLY



# Emil Hans WILLI HENNIG

\*20.4.1913 †5.11.1976

[http://rapinidep1.webs.com/origin/Hennig\\_1965.pdf](http://rapinidep1.webs.com/origin/Hennig_1965.pdf)

Hennig's (1965) 3 primary questions:

1. What is phylogeny?
2. How is it established?
3. How to describe it explicitly?

and his 3 precise answers:

1. Phylogeny is GENEALOGICAL relationship where two taxa are more closely related to each other than they are to a third one
2. Relationships are established by SYNAPOMORPHIES
3. Relationships can be presented using branching diagrams (=cladograms)



www.cladistics.org/

www.cladistics.org/willi-hennig/

# the Willi Hennig Society




The Hennig Society was founded in 1980 with the expressed purpose of promoting the field of Phylogenetic Systematics. Hennig's idea that groups of organisms, or taxa, should be recognized and formally named only in cases where they are "monophyletic", at first was a radical approach to modern systematics. The Society has a strong tradition of publishing, typically only every other year, a journal which is the official publication of the Society.


# HENNIG XXXIX

# HELSINKI 2020

### Announcements

[All](#) / [Awards](#) / [Meetings](#)

- 

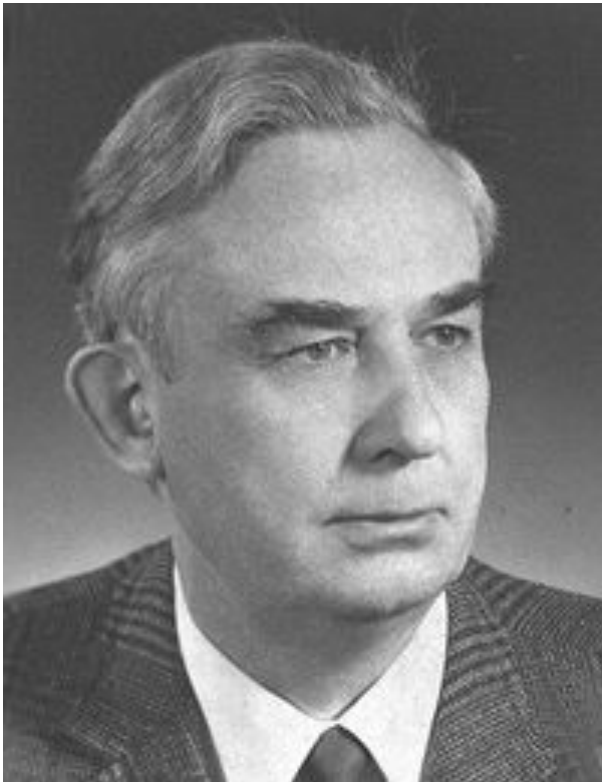
APRIL 15, 2016  
**Call for WHS 2016 Travel Award**
- 

APRIL 14, 2016  
**The XXXV Annual Meeting of the Willi Hennig Society**

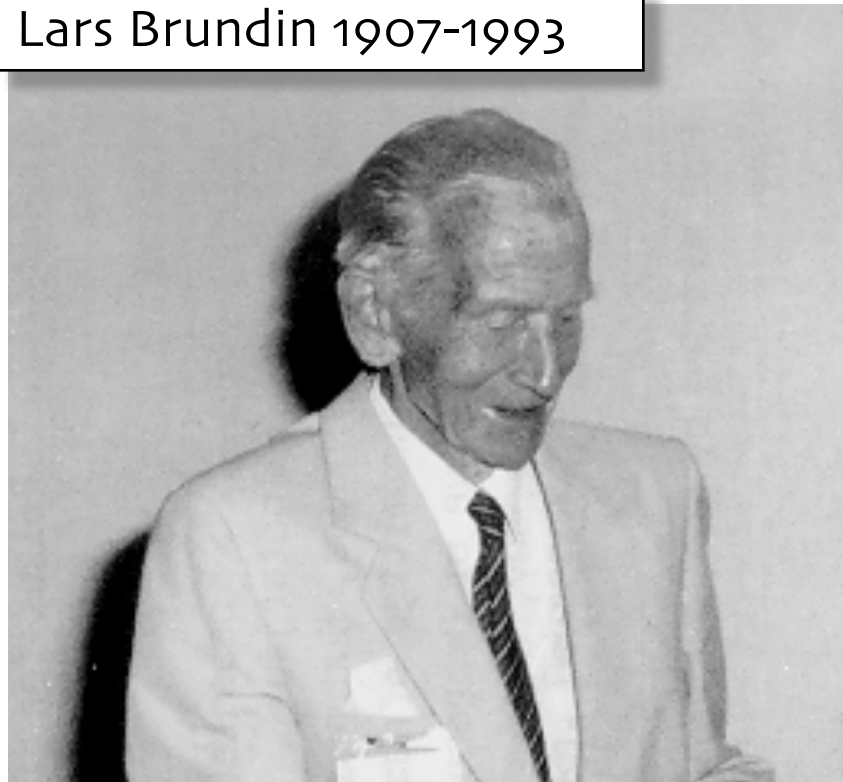
# Emil Hans WILLI HENNIG

\*20.4.1913 †5.11.1976

Willman, R. 2003. From Haeckel to Hennig: the early development of phylogenetics in German-speaking Europe. *Cladistics* 19: 449-479



Lars Brundin 1907-1993







Risto Tuomikoski 1911-1989

[www.luomus.fi/fi/suomalaiset-sammaltutkijat](http://www.luomus.fi/fi/suomalaiset-sammaltutkijat)



# Generic revision of Mniaceae Mitt. (Bryophyta)

TIMO KOPONEN

Department of Botany, University of Helsinki

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## Preface

The need for monographic studies in the taxonomy of bryophytes has been stressed in so many connections (V. F. BROTHERUS according to KOTILAINEN 1950, MALTA 1926, VERDOORN 1934, 1950, MEIJER 1951, STERRE 1955, TUOMIKOSKI 1958, ANDERSON 1963, WATSON 1967) that there is no need to discuss it further. Another field which is no less important but has been almost completely neglected is the revision of the supraspecific taxa, such as families and genera. One of the pioneers in this field was LOSKKE who paid attention to generic revision in a number of papers (e.g. 1907 a, 1907 b, 1911, 1932) and even reviewed the delimitation of several European genera (1910). Later STERRE (1947) and TUOMIKOSKI (1958), in particular, underlined the importance of such studies. However, rather few revisions have been made (e.g. HILPERT 1933, LAWTON 1957, ROBINSON 1962).

The writer began to study *Mnium* with some intensity in 1964. The original aim of the research was to make a monograph of the genus *Mnium* covering all the species. From the very beginning special attention was paid to characters which, though neglected earlier, might be of value not only for the specific but also for the supraspecific taxonomy of the group. In the field of hepatic taxonomy, K. MULLEN (1948, 1951, cf. also RICHARDS 1959) met with considerable success in corresponding studies. In the genus *Mnium* the neglected stem characters (p. 122) appeared to be useful. In the course of the study it became more and more obvious that a generic revision could not be avoided. In addition to the genus *Mnium* in its customary delimitation, the other genera of the traditional *Mniaceae* were included in the revision. It was thought most suitable to publish this revision as the first part of the study.

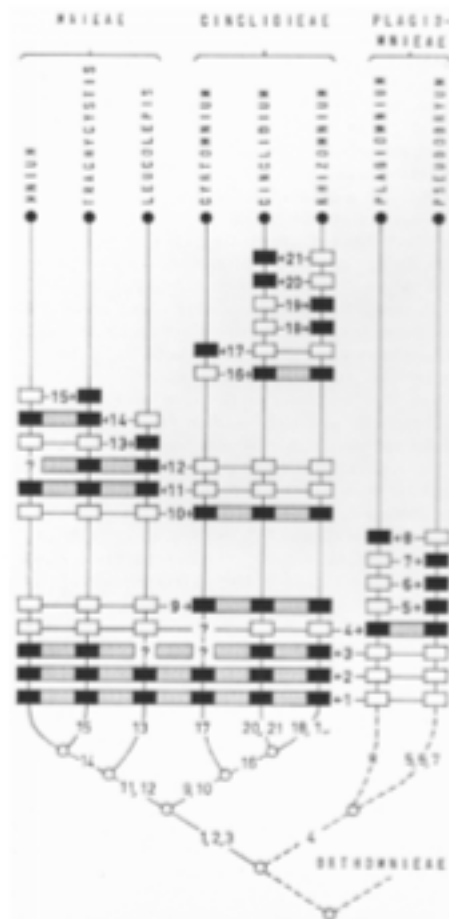


Fig. 107. The assumed phylogeny of Mniaceae. The black squares indicate derived (apomorphic) characters and the open squares the corresponding original (plesiomorphic) characters present in the basic type. Question-marks are used to show the deviations in this scheme, and thus may also indicate characters which appear to be derived when compared with those of the sister group. The tribe Orthomniaceae, whose location is somewhat uncertain, has been left out. The numbers indicate the following derived characters (in the columns of *Rhizomnium* at the bottom, after 18, read 19):

- 1 = stem epidermis of *Mnium* type
- 2 = absence of microstroma, except in certain species of *Rhizomnium*
- 3 = bistratose or multistratose leaf border, except in *Cyrtomnium* and *Leucolepis*
- 4 = absence of reddish coloring in the gametophyte (only in *Cyrtomnium*)
- 5 = complete reduction of steroids in costa
- 6 = branched midrib

It seems rather probable that *Cinclidium* and *Rhizomnium* together constitute a monophyletic branch, to which possibly also *Cyrtomnium* belongs.

**Tribe Orthomniaceae.** - The two species of *Orthomnium* have so many unique sporophyte characters in common (cf. p. 130) that their monophyly is fairly certain. The only *Orthomniopsis* species examined in this study differs from them in several sporophyte characters, e.g. the peristome is not as rudimentary, the calyptra is not hairy, an annulus is present and the seta is shorter. It is hardly possible to decide which of these characters are original and which are derived. The growth-form, the rhizoid topography, and the stem epidermis are similar in both genera and seem to unite them with *Plagiomnium*. KASZASCH (1936; cf. also Fig. 108) suggested that they have developed from *Plagiomnium* sect. *Rastrata*. However, the bistratose, entire leaf border, the structure of the costa, and the reddish colour present in *Orthomnium bryoides* seem to point in the direction of *Rhizomnium*, as was supposed by BORNEMANN (1905).

Although *Orthomnium* is probably monophyletic, any conclusions regarding its phylogenetic relationships can hardly be drawn on the basis of the present data. The possibility cannot be ruled out that the tribe suggested, although in part phenetically uniform, is polyphyletic in origin. The characters of the sporophyte, not only those of the capsule but also those of the seta, are very different from the common type in *Mniaceae*. This may indicate that the two genera are not very close phyletic relatives of the other groups now under discussion. Accordingly, the tribe *Orthomniaceae* is not included in the dendrogram in Fig. 107.

**Tribe Plagiomniaceae.** - The other main phyletic branch (Fig. 107), *Plagiomnium* - *Pseudobryum*

- 7 = stem epidermis of *Pseudobryum* type
- 8 = plagiotropic shoots
- 9 = complete reduction of ventral steroid band
- 10 = entire border
- 11 = costa toothed at the back apically
- 12 = frequent subapical branching (rare in *Mnium*)
- 13 = differentiation of basal leaves
- 14 = complete or partial reduction of ventral steroid band
- 15 = multiseptate leaf cells
- 16 = cryptopore stomata
- 17 = black colour in the leaves
- 18 = extremely narrow and long decurrent leaf bases
- 19 = complete reduction of steroids, except in sect. *Mitracium*
- 20 = dove-shaped lower peristome
- 21 = elongated area of macrostromous initials



# The Future of Phylogenetic Systematics

The Legacy of Willi Hennig



EDITED

David Williams, Michael Schmitt  
and Quentin Wheeler

CAMBRIDGE

3

## Willi Hennig's legacy in the Nordic countries

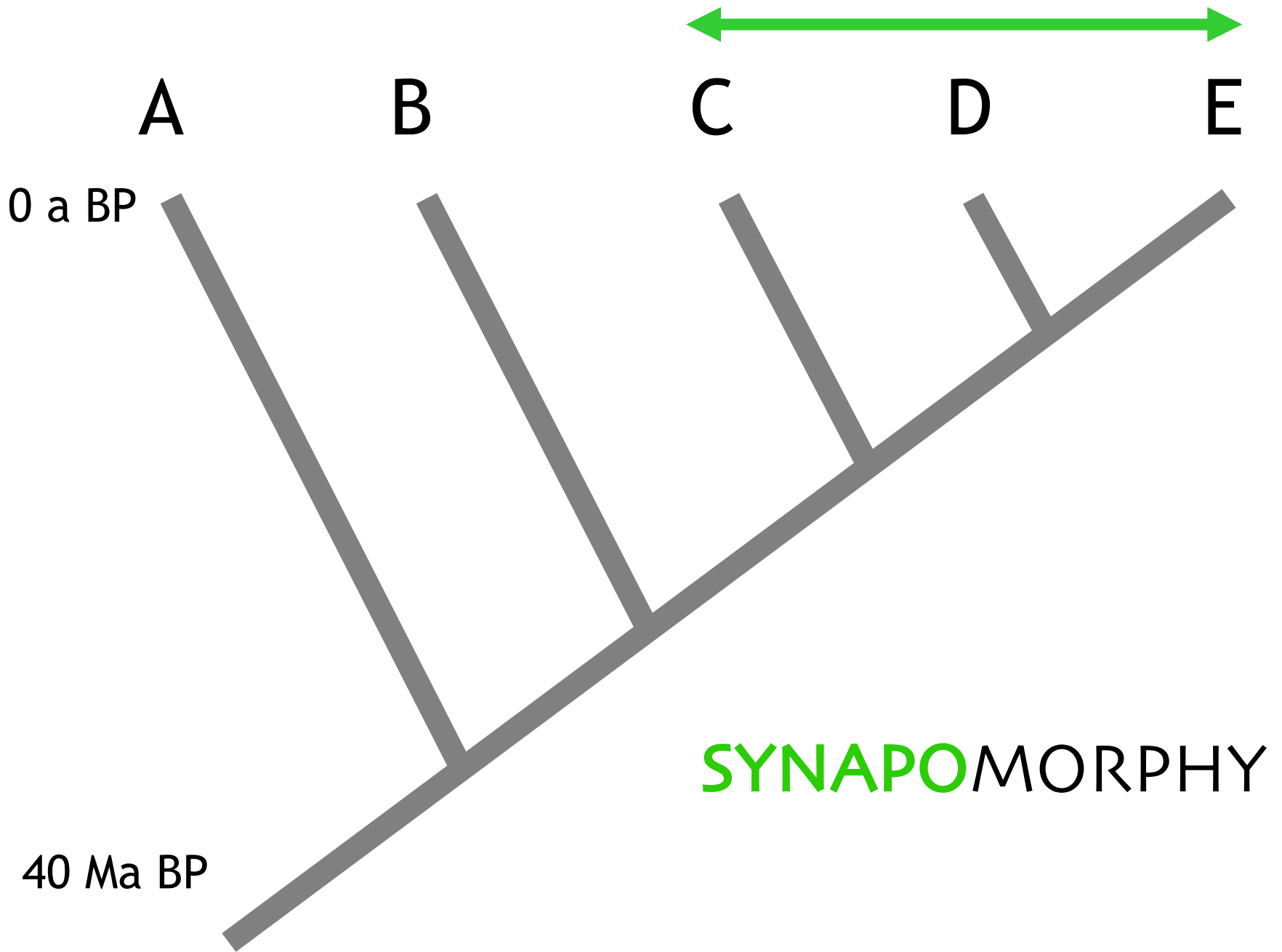
OLE SEBERG, TORBJØRN EKREM,  
JAAKKO HYVÖNEN and PER SUNDBERG

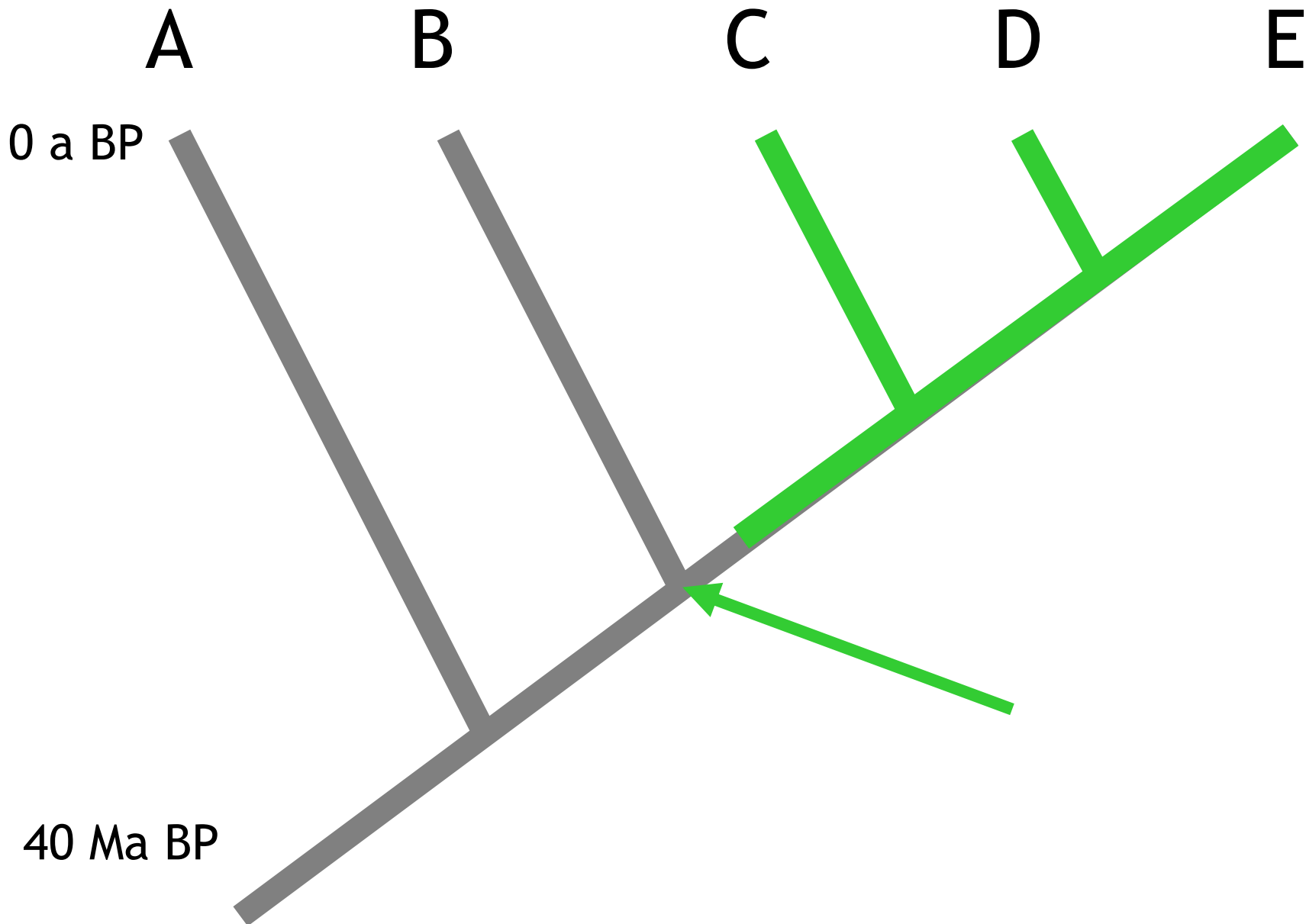
### 3.1 Introduction

Writing about historical events, about the major paradigm shift in systematics since Darwin, is not necessarily easy, even if the record appears to be relatively good. Evidently, it becomes even more difficult when the authors, and nearly all the sources, have been involved in the events. Some biases are easy to define, some more subtle. Going through parts of the recent literature there are obvious contradictions, omissions and errors – and there is no reason to believe that this chapter will be any different. To some extent, interpretation of events is in the eye of the beholder.

This chapter is about the introduction of phylogenetic systematics into the Nordic countries and the key persons involved. It does not, however, attempt to follow the subsequent rather rapid spread in different disciplines in each respective Nordic country. Inevitably some may perhaps understandably wonder why they are not mentioned. However, the decision not to do so is solely the responsibility of the authors.

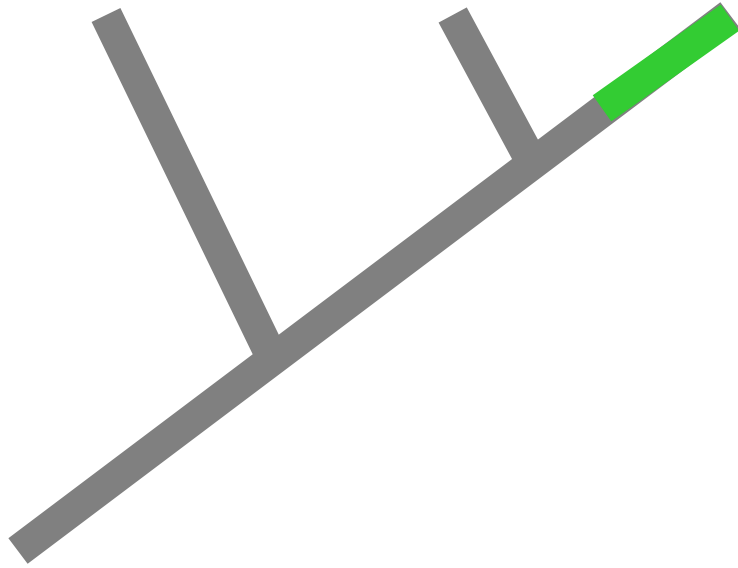
Throughout this chapter the two terms 'phylogenetic systematics' and 'cladistics' are used interchangeably.



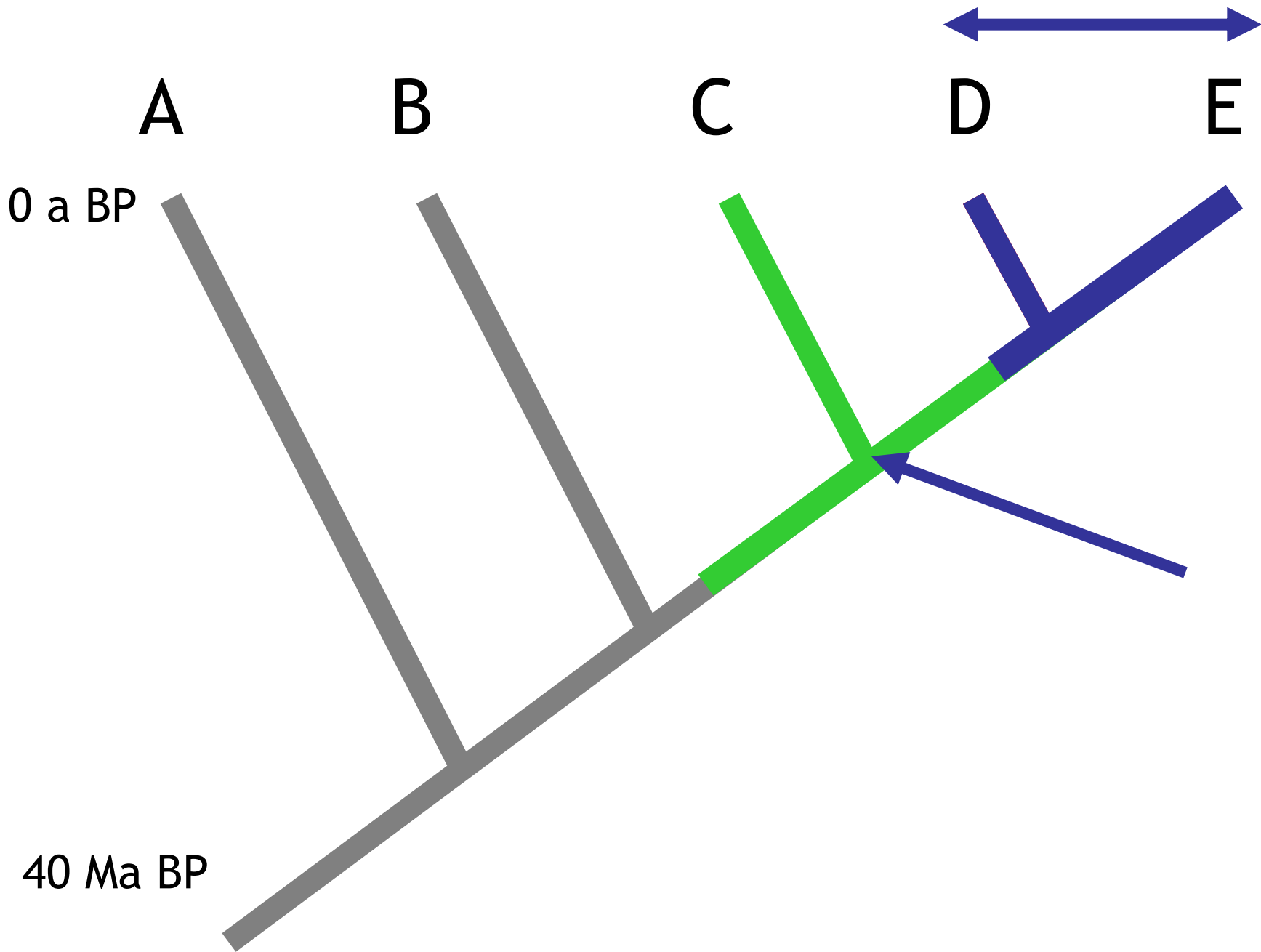


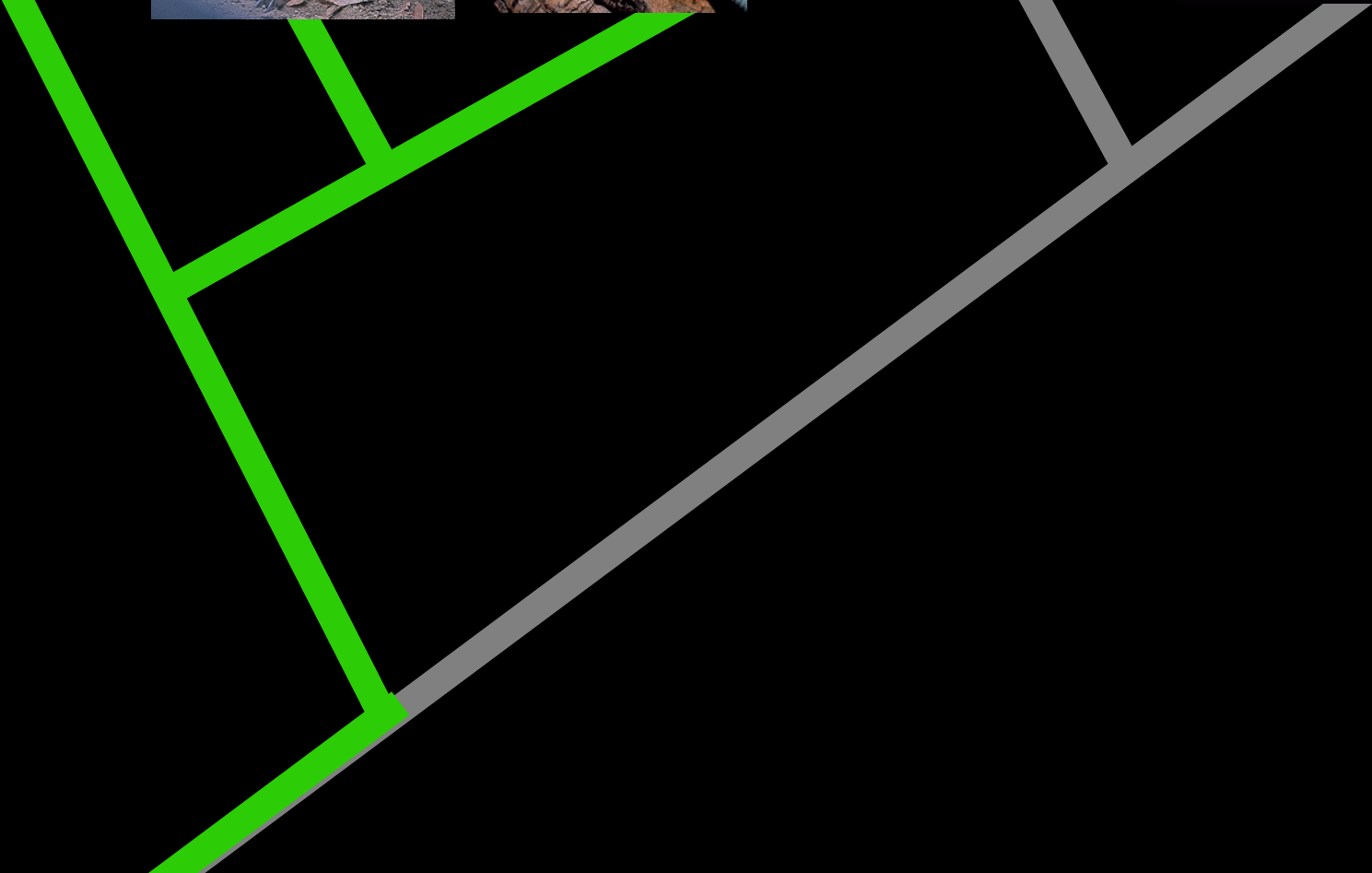


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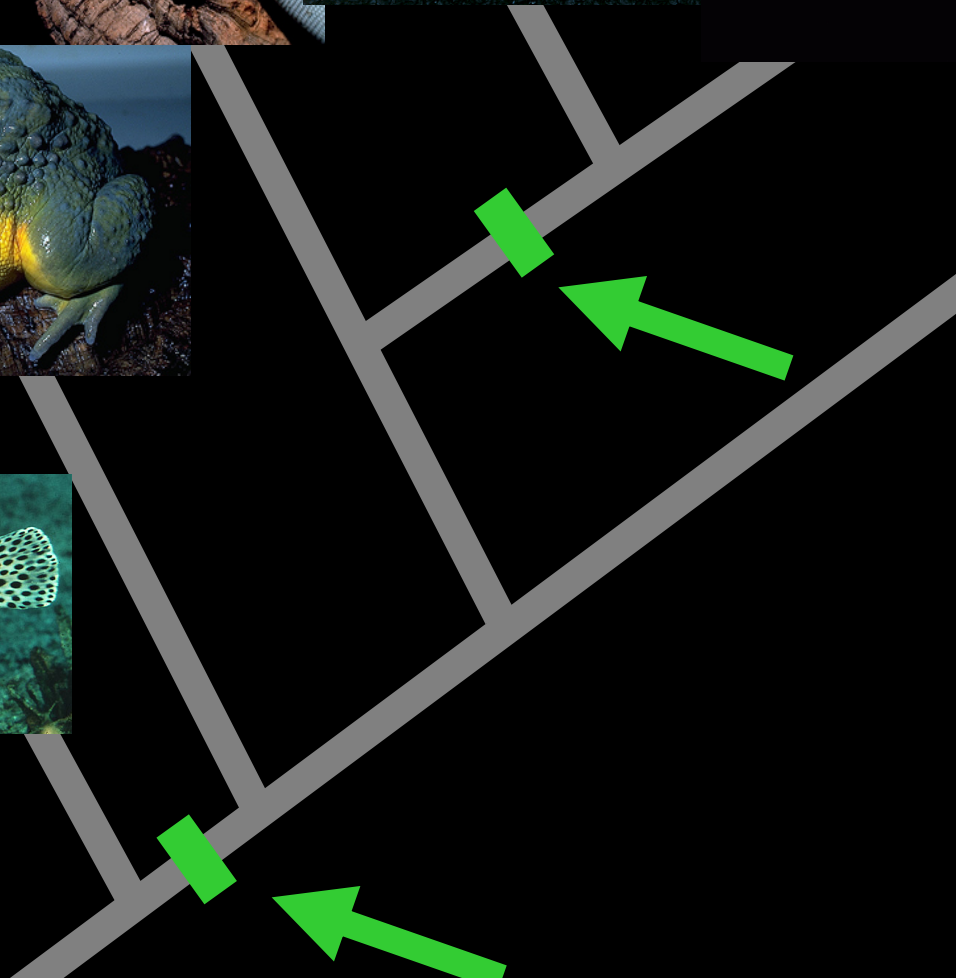
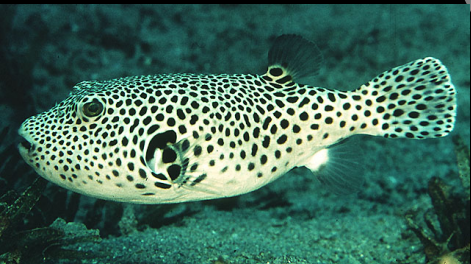


40 Ma BP









(SYN)APOMORPHY = (shared) evolutionary  
NOVELTY

PLESIOMORPHY = OLD, inherited character state

always RELATIVE concepts attention should always be paid  
at the level of observation

ALL apomorphies become plesiomorphies

ALL plesiomorphies have been apomorphies

# Emil Hans WILLI HENNIG

\*20.4.1913 †5.11.1976

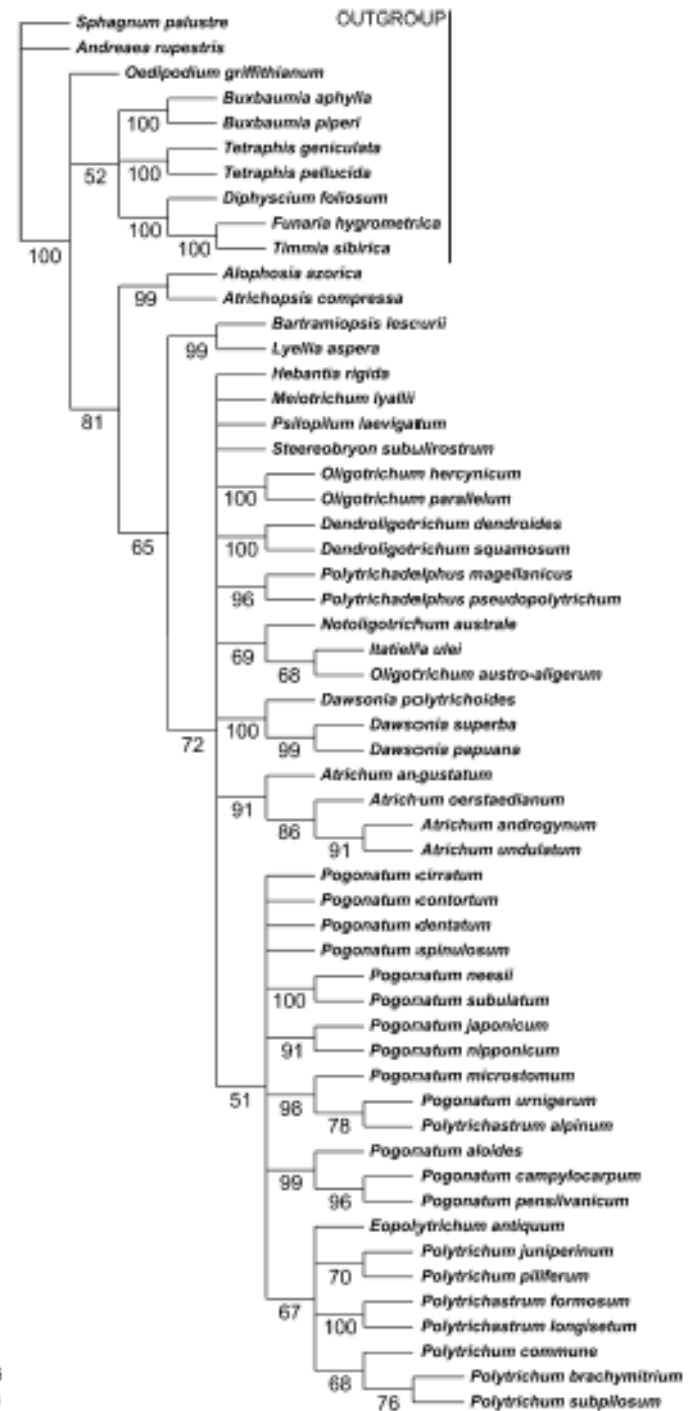
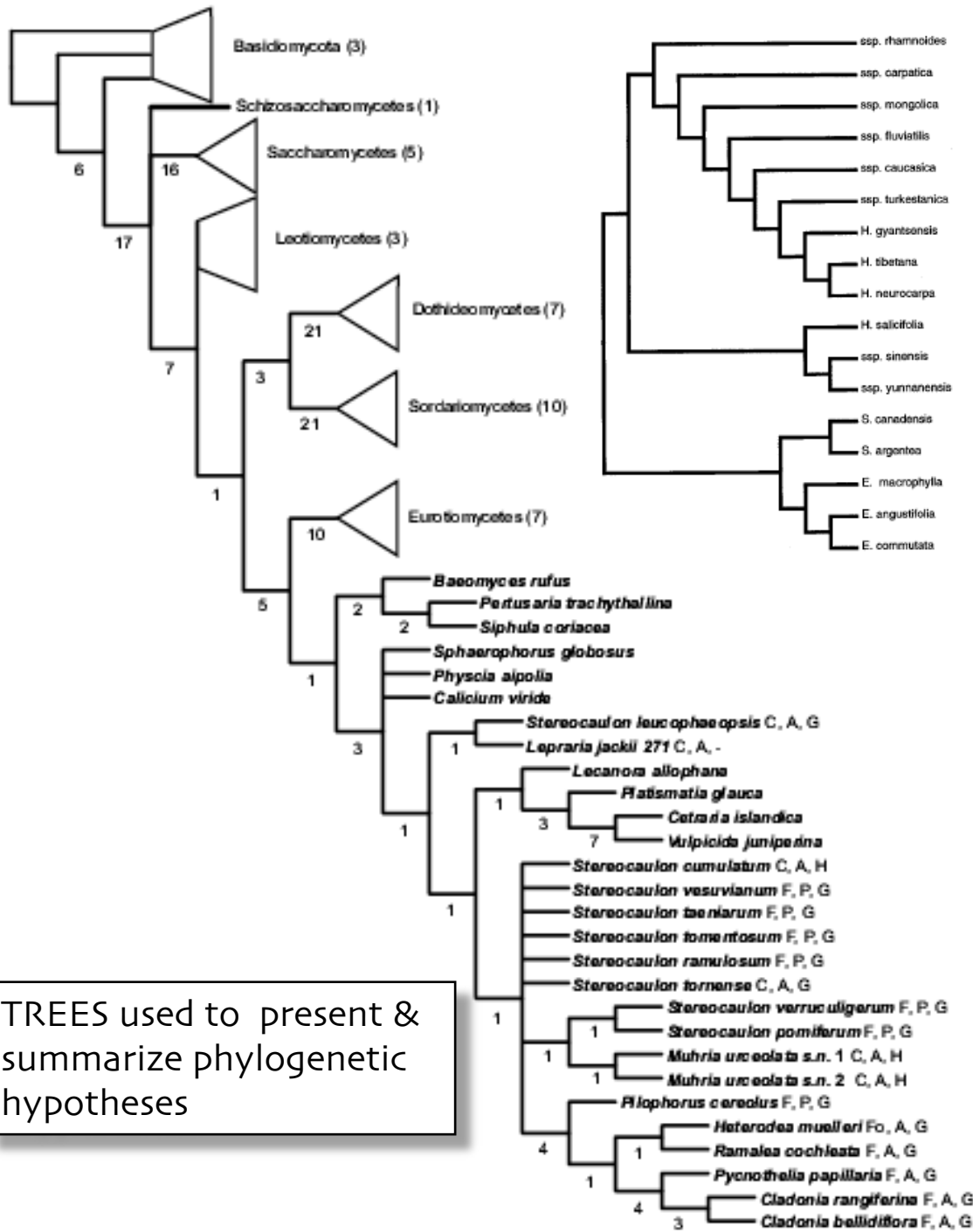
Hennig's (1965) 3 primary questions:

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and his 3 precise answers:

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2. Relationships are established by SYNAPOMORPHIES
- 3. Relationships can be presented using branching diagrams (=cladograms)**





TREES used to present & summarize phylogenetic hypotheses

# SUMMARY

ALL organisms share common ancestor

descent with modification

only **SYNAPOMORPHIES** inform about history

hypotheses about evolutionary history can be presented as  
phylogenetic **trees**