Multivariační metody v taxonomii

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prezentácie dostupné na:

https://botany.natur.cuni.cz/brassiploidy

Fenetický prístup (multivariačné metódy; “pattern”; zhluková analýza, ordinačné metódy, diskriminačná analýza)

Kladistický prístup (parsimonická analýza)

Alternatívne prístupy k rekonštrukcii fylogenézy
(metóda spájania susedných objektov – *neighbour joining method*; metódy najväčšej pravdepodobnosti – *maximum likelihood*; Bayesovské metódy – *Bayesian statistical methods*)

Geometrická morfometrika (Booksteinove súradnice tvaru, Prokrustova analýza, metóda ohybných pásiek - *thin plate spline*)

Softvér: MorphoTools2, SYN-TAX 2000,
[PAUP* version 4.0, beta version 10 (http://paup.csit.fsu.edu/), ďalší špecializovaný softvér]

Fenetický prístup

Michel Adanson (1727-1806)

Familles des Plantes (1763)

65 rôznych klasifikácií, založených vždy na jednom znaku (napr. placentácia, typ súkvetia …)

PREFACE.

17e Classe.
Etamines sur le Calice & sur l'Ovare ensemble.
12. Elæagnus.
13. Onagres.
14. Mirtes.
15. Ombelliferes.
16. 2 Chevrefeuille.

18e Classe.
Etamines sur l'Ovare.
9. 6 Jenjembres.
11. 12 Aristoloches.

19e Classe.
Etamines sur le stil de l'Ovare.
32. Q. Pourpiers.
42. Q. Roseaux.

20e Classe.
Etamines sur la Corole.
9. 10 Jenjambres.
16. Composées.
17. Campanules.
18. Brionés.
19. Aparines.
20. Scabieuses.

21. P. Chevrefeuilles
22. Pl. Aircles.
23. Apocins.
24. Bourraches.
25. Labiées.
26. Verveines.
27. Personées.
28. Solanons.
29. Jasmens.
30. Anagallis.
31. Q. Pourpiers.
33. Q. Joubarbes.
34. Q. Alsines.

42. Système. Etamines; leur figure respective.

1re Classe.
Plantes sans Etamines.
1. Bisus.
2. Champignons.
3. 6 Fucus.

2e Classe.
Etamines distinctes les unes des autres.
4. Epurées.
5. Fougeres.
7. Cramens.
8. 72 Lilliacées.
9. Jenjambres.
10. Orchis.
11. 12 Aristoloches.
12. Elæagnus.
13. Onagres.
14. Mirtes.
15. Ombelliferes.
16. 6 Composées.
17. 6 Campanules.
18. 2 Brionés.
19. Aparines.
20. Scabieuses.
21. Chevrefeuilles.
22. Aircles.
23. 26 Apocins.
24. Bourraches.
25. Labiées.
26. Verveines.
27. Personées.
28. 9 Solanons.
29. Jasmens.
30. Anagallis.
31. Salsifiers.
32. Pourpiers.
33. Joubarbes.
34. Alsines.
35. Blitons.
36. Pervenches.
39. Garou.
41. Roseaux.
42. Jujubiers.
43. 22 Légumineuf.
44. 16 Pistachiers.
45. 12 Titimales.
46 Anones.
47. Chevriers.
48. Tilleuls.
52. 48 Crucifères.
53. 16 Pavots.
54. 64 Cistes.
55. Renoncules.
56. Acons.
58. Mouffes.

3e Classe.
Etamines réunies toutes ensemble par les filets en un faisceau.
3. 3 Fucus.
6. Palmiers.
8. 2 Lilliacées.
11. 4 Aristoloches.
36. Jalaps.
37. Amaranthes.
38. Espargoutes.
43. 26 Légumineuf.
44. 16 Pistachiers.
45. 11 Titimales.
49. Germions.
50. Mauves.
51. Capriers.
57. Pins.

4e Classe.
Etamines réunies par les filets en 2 corps.
48. 61 Légumineuf.

5e Classe.
Etamines réunies par les filets en plus de 2 corps.
41. 2 Légumineuf.
52. 2 Cruciferé.
54. 7 Cistes.

6e Classe.
Etamines réunies par les anteres seulement.
16. 212 Composées.
17. 3 Campanules.
18. 13 Brionés.
21. 2 Apocins.
28. 1 Solanon.
53. 1 Pavot.

7e Classe.
Etamines réunies par les filets & les anteres ensemble.
23. 2 Apocins.

Fin

Fenetický prístup

Department of Entomology, University of Kansas, Lawrence, U.S.A.

Michener, Ch.D. & Sokal, R.R. 1957. A quantitative approach to a problem in classification. *Evolution* 11: 130-162.

Department of Microbiology, University of Leicester, U.K.

Sneath, P.H.A. 1957. Some thoughts on bacterial classification. *J. Gen. Microbiol*. 17: 184-200.

Sokal, R.R. & Sneath, P.H.A. 1963. *Principles of numerical taxonomy*. W. H. Freeman and comp., San Francisco & London.

Sneath, P.H.A. & Sokal, R.R. 1973. *Numerical taxonomy, the principles and practice of numerical classification.* W. H. Freeman and comp., San Francisco.

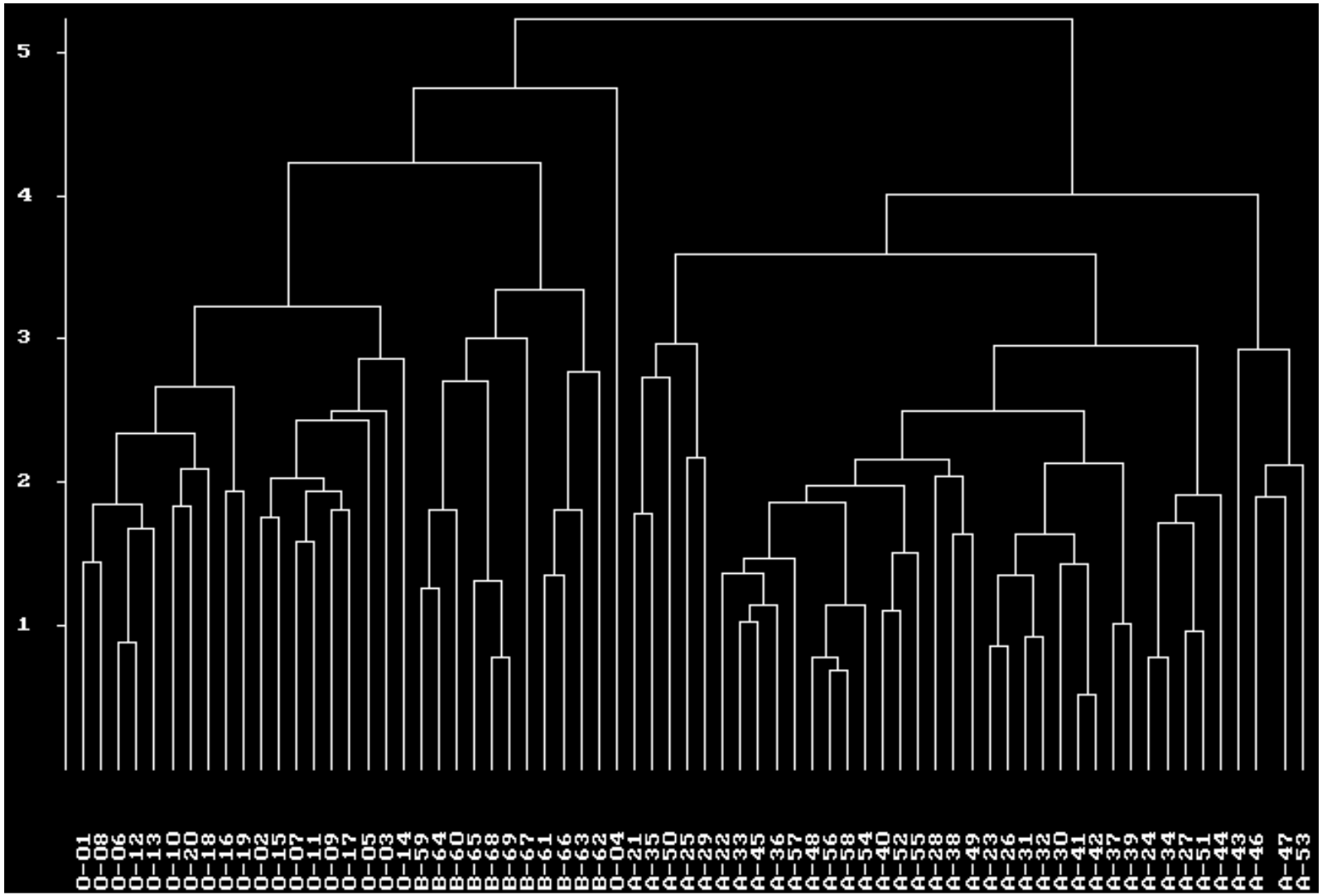
Neo-adansonovské princípy

- Čím väčší je obsah informácie v taxónoch a na čím väčšom počte znakov je klasifikácia založená, tým je táto klasifikácia lepšia.
- Každý znak má pri tvorbe taxónov rovnakú váhu.
- Celková podobnosť medzi akýmikoľvek dvomi jednotkami je funkciou podobností v jednotlivých znakoch.
- Taxóny sa rozoznávajú na základe toho, že sa korelácie medzi znakmi v rôznych skupinách líšia.
- Úsudky o fylogenéze sa môžu robiť z taxonomickej štruktúry skupiny a z korelácií medzi znakmi. Berú sa pritom do úvahy určité predpoklady (premisy) o evolučných cestách a mechanizmoch.
- Taxonómia sa považuje za praktickú a empirickú vedu.
- Klasifikácie sa zakladajú na empirickej podobnosti.

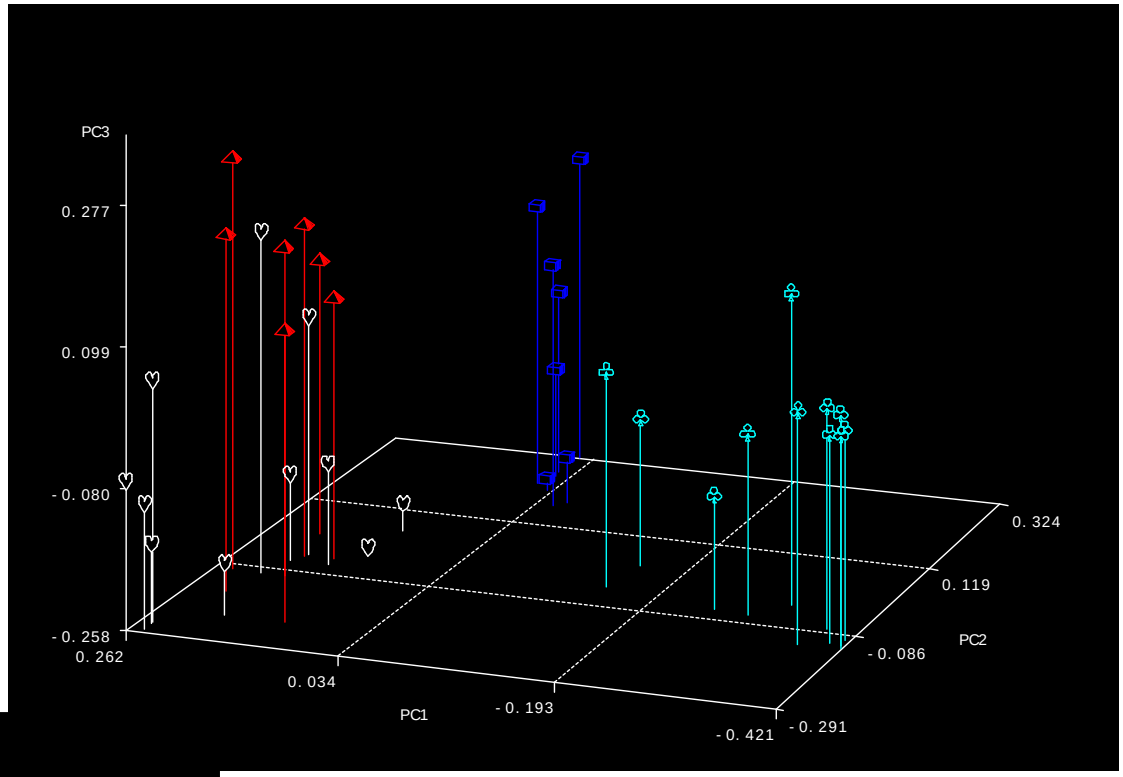
Fenetický prístup

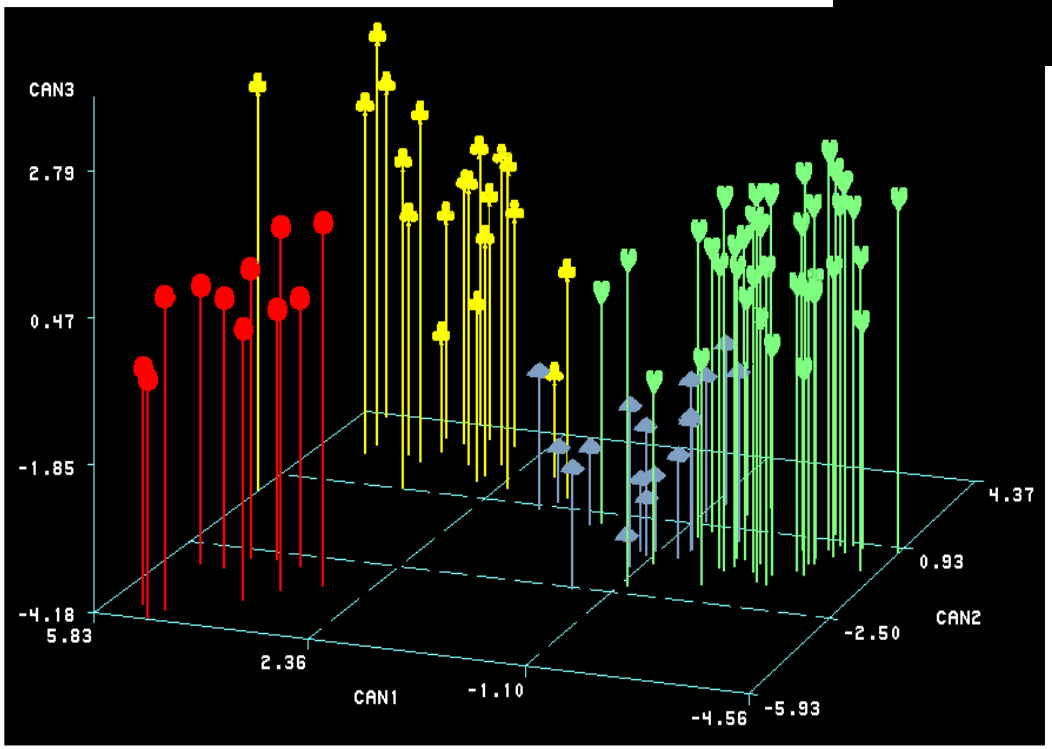
- Termíny: numerical taxonomy (Sokal & Sneath), statistical systematics (Solbrig), numerical phenetics (Duncan & Baum), multivariate morphometrics (Blackith & Reyment)
- Operačné taxonomické jednotky (OTU)
- Znaky, primárna matica, počet znakov, korelácie
- Koeficienty vyjadrujúce vzťahy medzi znakmi alebo objektmi, sekundárna matica
- Multivariačné metódy (zhlukovacie metódy, ordinačné metódy, diskriminačná analýza)
- Rôzne metódy môžu priniesť rôzne výsledky
- Využitie metód v minulosti a v súčasnej taxonomickej praxi (infrašpecifická variabilita, polyploidné komplexy, štúdium morfologickej variability v rozsiahlych areáloch, molekulárne dáta)

Zhlukovacia analýza



Analýza hlavných komponentov



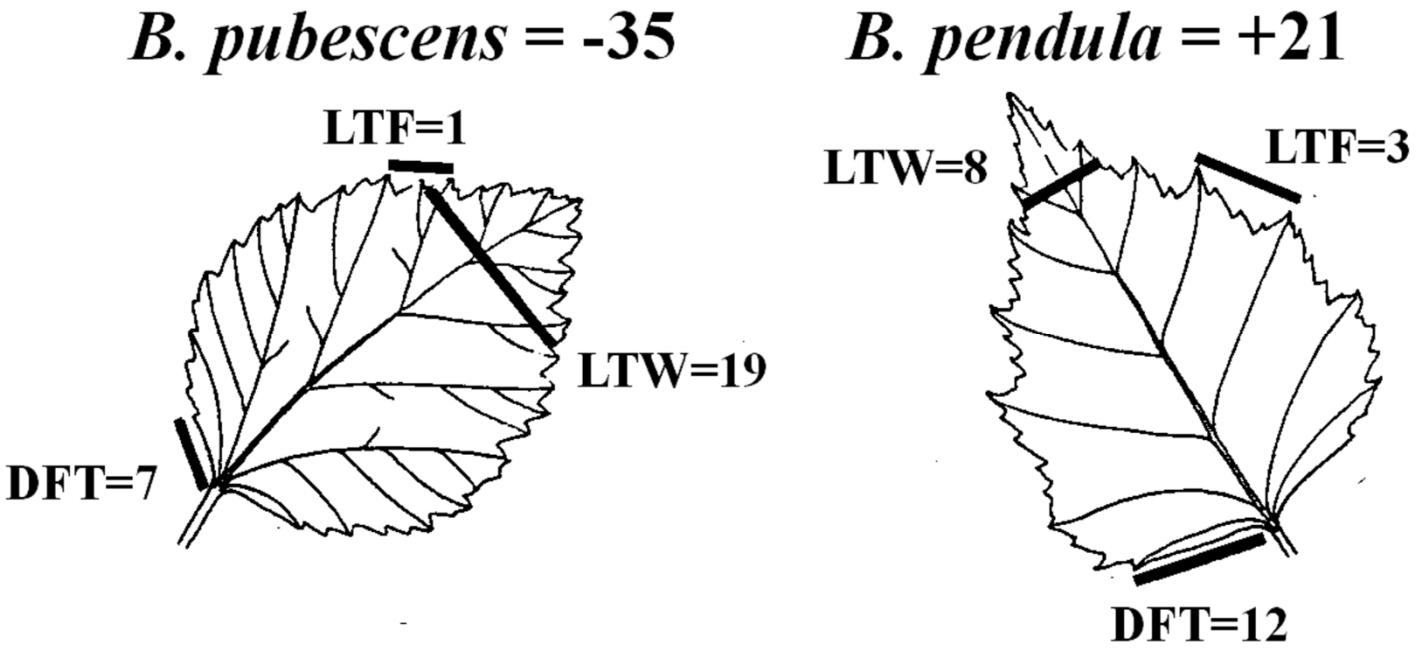


Kanonická diskriminačná analýza

Klasifikačná diskriminačná analýza

skupina — príslušnosť rastlín k stanoveným skupinám predpovedaná na základe vytvoreného klasifikačného kritéria (absolútny počet a percento rastlín klasifikovaných do jednotlivých skupín)

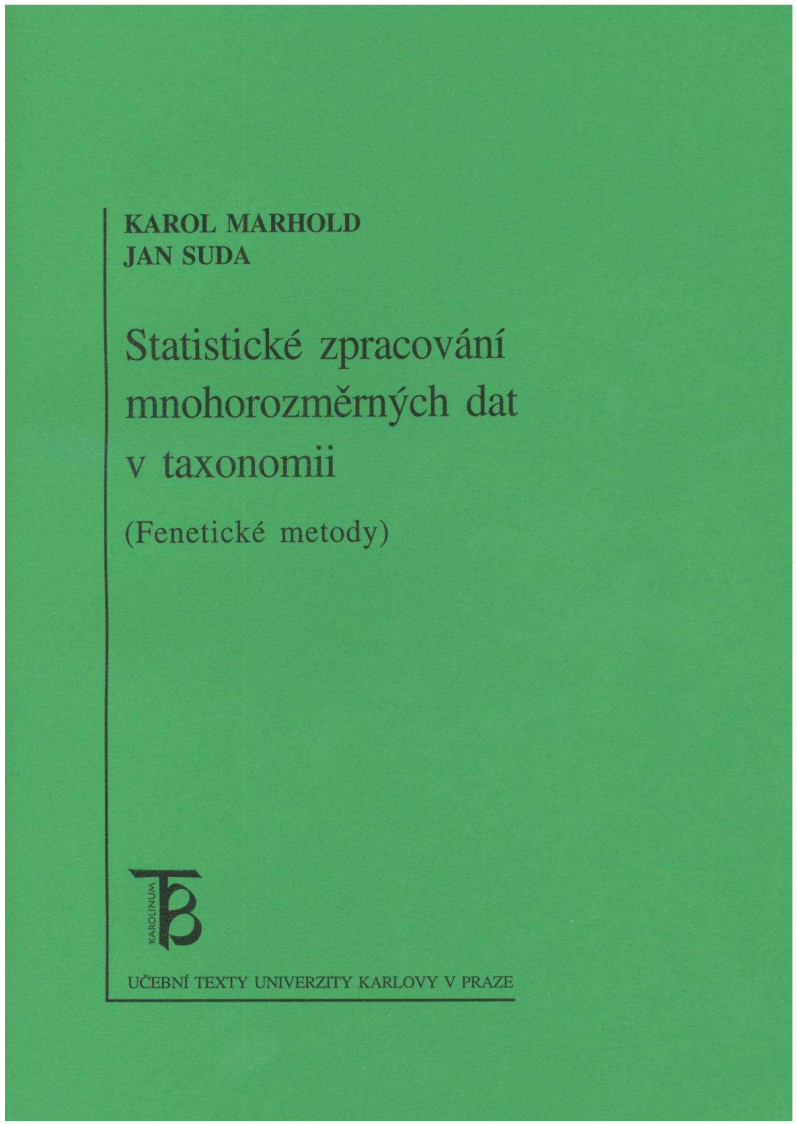
	amara	**austr.**	**olot.**	**opicii**	**pyren.**	Celkom
amara	**349**	20	3	1	7	380
	91.84	5.26	0.79	0.26	1.84	100.00%
austriaca	51	**302**	1	6	8	368
	13.86	**82.07**	0.27	1.63	2.17	100.00%
olotensis	2	0	**99**	0	0	101
	1.98	0.00	**98.02**	0.00	0.00	100.00%
opicii	1	9	0	**326**	42	378
	0.26	2.38	0.00	**86.24**	11.11	100.00%
pyrenaea	1	11	0	19	**207**	238
	0.42	4.62	0.00	7.98	**86.97**	



Diskriminačná funkcia na určenie druhov *Betula pubescens* a *B. pendula*
12LTF + 2DFT – 2LTW – 23
kladné hodnoty *B. pendula*
záporné hodnoty *B. pubescens*
pravdepodobnosť správneho určenia 93%

(Stace, C. A., 1991, New Flora of the British Isles)

Marhold, K. & Suda, J. 2002: *Statistické zpracování mnohorozměrných dat v taxonomii*. Karolinum, Praha.

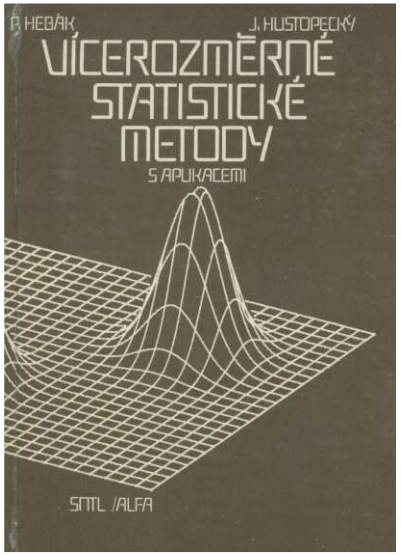


Hebák, P. & Hustopecký, J. 1987: *Vícerozměrné statistické metody s aplikacemi*. SNTL – nakladatelství technické literatury, Alfa, vydavateľstvo technickej a ekonomickej literatúry, Praha.

Hebák, P., Hustopecký, J., Jarošová, E. & Pecáková, I. 2007. *Vícerozměrné statistické metody (1)*. Ed. 2. Informatorium, Praha.

Hebák, P., Hustopecký, J. & Malá, I. 2005. *Vícerozměrné statistické metody (2)*. Informatorium, Praha.

Hebák, P., Hustopecký, J., Pecáková, I., Průša, M., Řezanková, H., Svobodová, A. & Vlach, P. 2007. *Vícerozměrné statistické metody (3)*. Ed. 2. Informatorium, Praha.

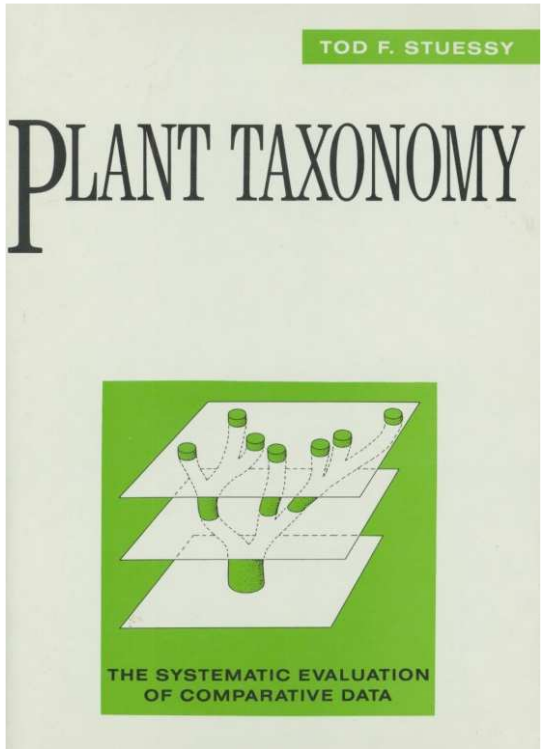


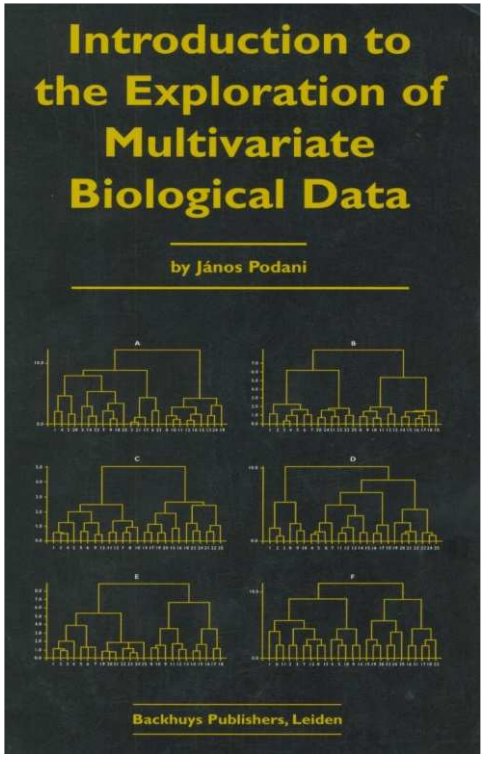
Legendre, P. & Legendre, L. 1998. *Numerical ecology*. Second English edition. Elsevier, Amsterdam.

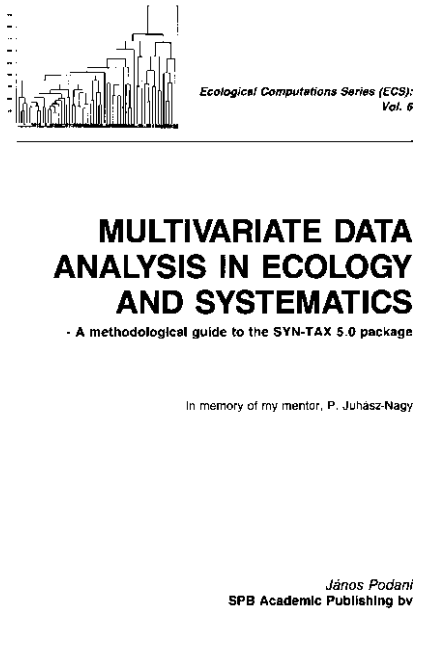
Podani, J. 1994. *Multivariate data analysis in ecology and systematics*. SPB Academic Publishing bv, The Hague.

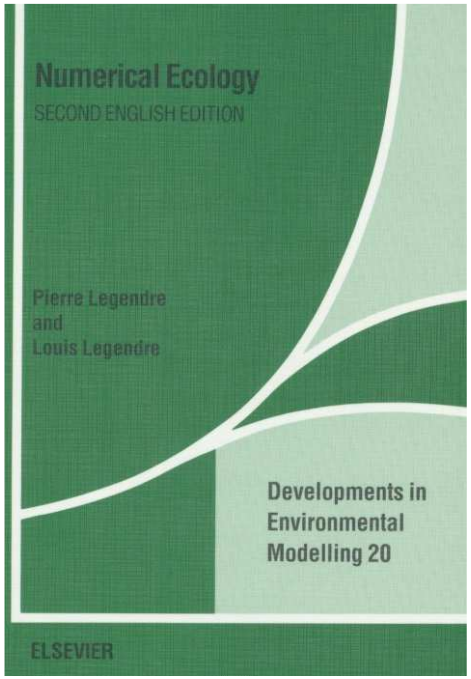
Podani, J. 2000. *Introduction to the exploration of multivariate biological data*. Backhuys Publishers, Leiden.

Stuessy, T. F. 1990. *Plant taxonomy: the systematic evaluation of comparative data*. Columbia University Press, New York.









Kladistický prístup

Hennig, W.

1950: *Grundzüge einer Theorie der phylogenetischen Systematik*. Deutsche Zentralverlag, Berlin.

1965: Phylogenetic systematics. *Annual Review of Entomology* 10: 97-116.

1966: *Phylogenetic systematics*. University of Illinois Press, Urbana.

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Koponen, T., 1968: Generic revision of Mniaceae Mitt. (Bryophyta). *Ann. Bot. Fenn.* 5: 117-151.

Funk, V. & Stuessy, T. F. 1978: Cladistics for practicing plant taxonomist. *Syst. Bot.* 3: 159-178.

Bremer, K. & Wantorp, H.- E. 1978: Phylogenetic systematics in botany. *Taxon* 27: 317-329.

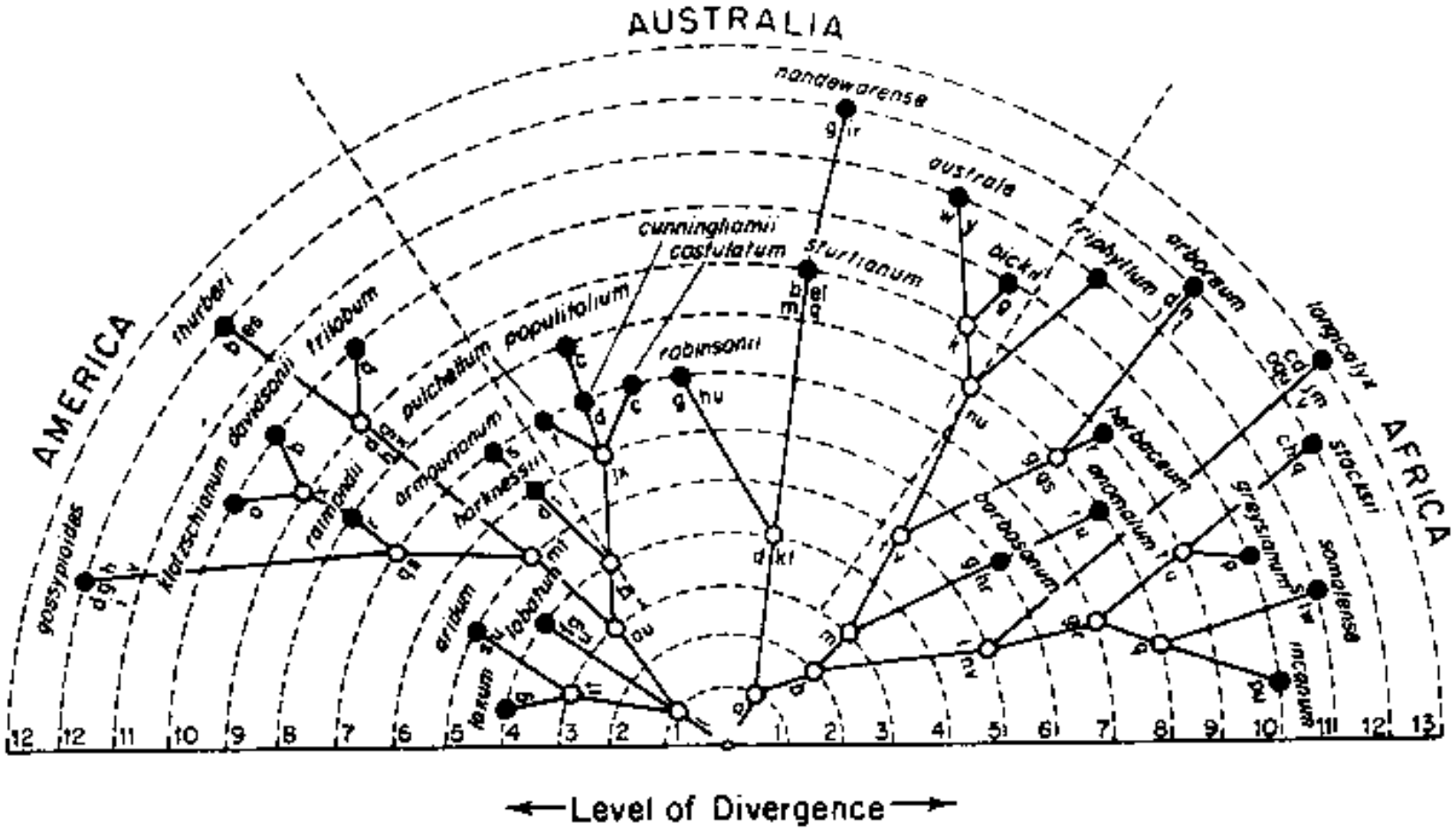


Fig. 2.17 Cladogram (Wagner tree) of 30 species of *Gossypium* (Malvaceae), modified from Frywell[142].

W.H. Wagner, University of Michigan - Groundplan/divergence method

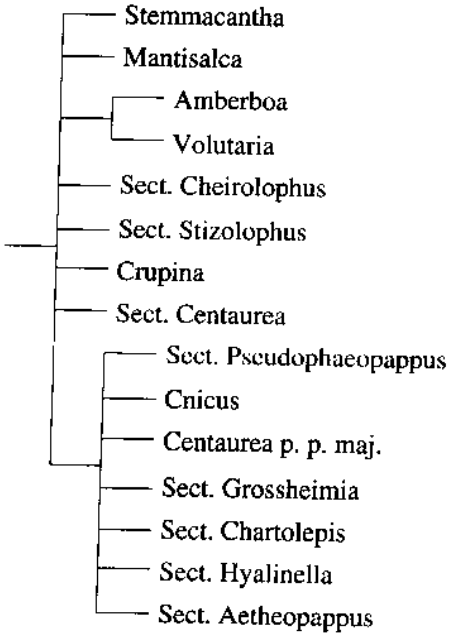


FIGURE 8-4. Strict consensus tree of six equally parsimonious cladograms of *Centaurea* sections and related genera based on cypsela characters from Dittrich (1966, pp. 138–139). The data matrix is given in Table 8-4.

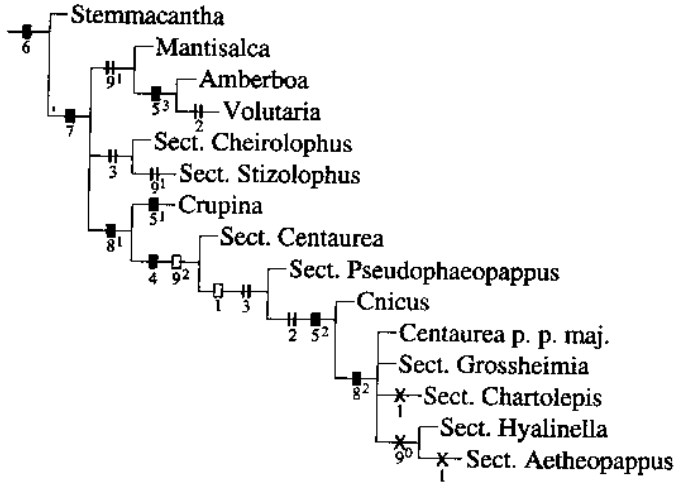


FIGURE 8-5. One of six equally parsimonious cladograms of *Centaurea* sections and related genera based on cypsela characters from Dittrich (1966, pp. 138–139). The characters are given in Table 8-3 and the data matrix in Table 8-4. Solid bars indicate nonhomoplastic synapomorphies; open bars indicate homoplastic synapomorphies with reversals; double bars indicate parallelisms; crosses indicate reversals.

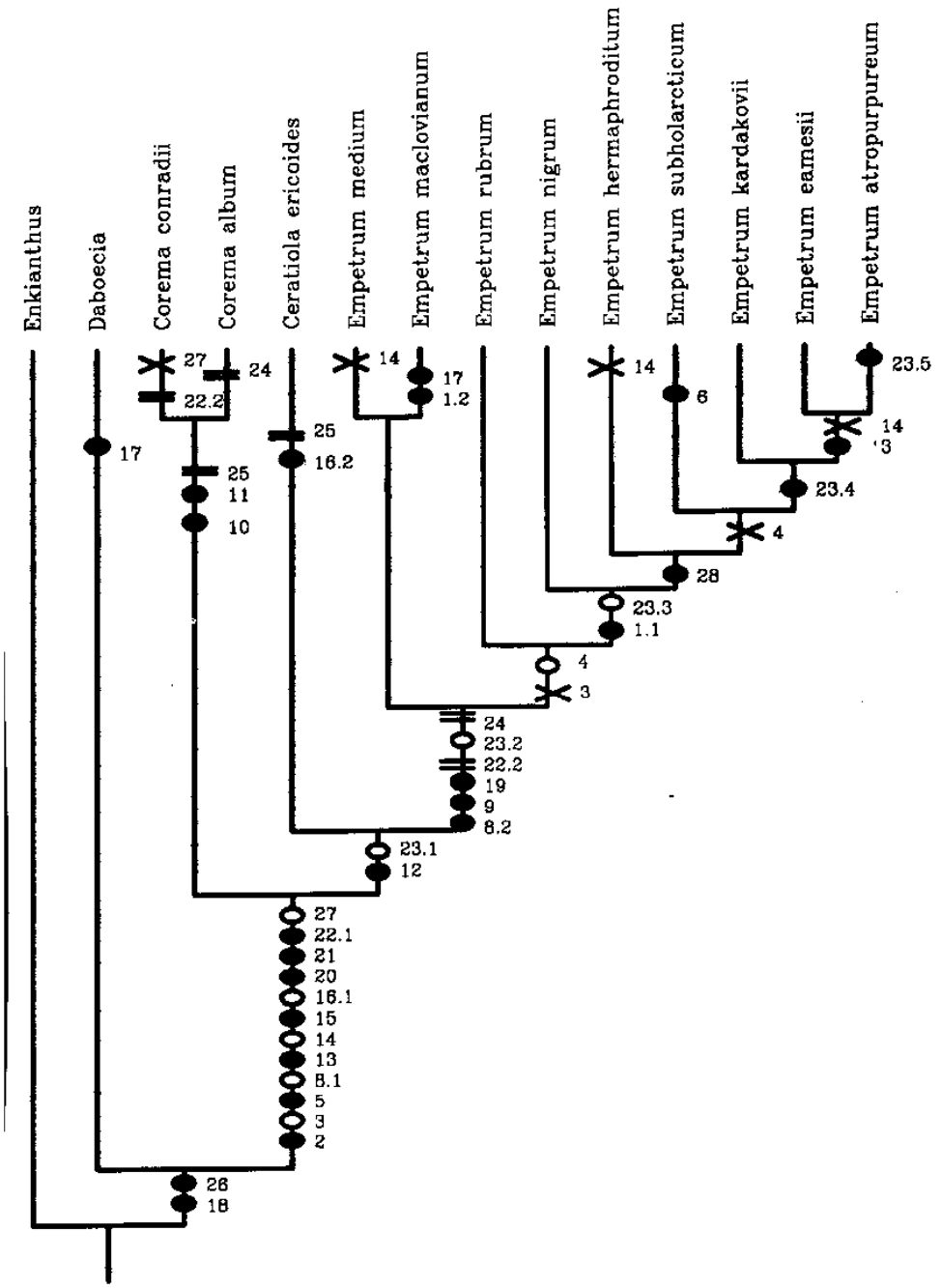


FIG. 2. One of five equally parsimonious cladograms of the Empetraceae. *Enkianthus* and *Daboecia* are outgroup taxa. Characters are numbered in accordance with the text, Appendix 1, and with Table 1. Black dots = synapomorphies (ci = 1), white dots = synapomorphies (ci < 1), parallel lines = parallelisms, crosses = reversals.

A Y-Z, X-Y-Z
monofyletické skupiny

B X-Y parafyletická
skupina

C X-Y polyfyletická
skupina, paralelizmus

D X-Y polyfyletická
skupina, konvergencia

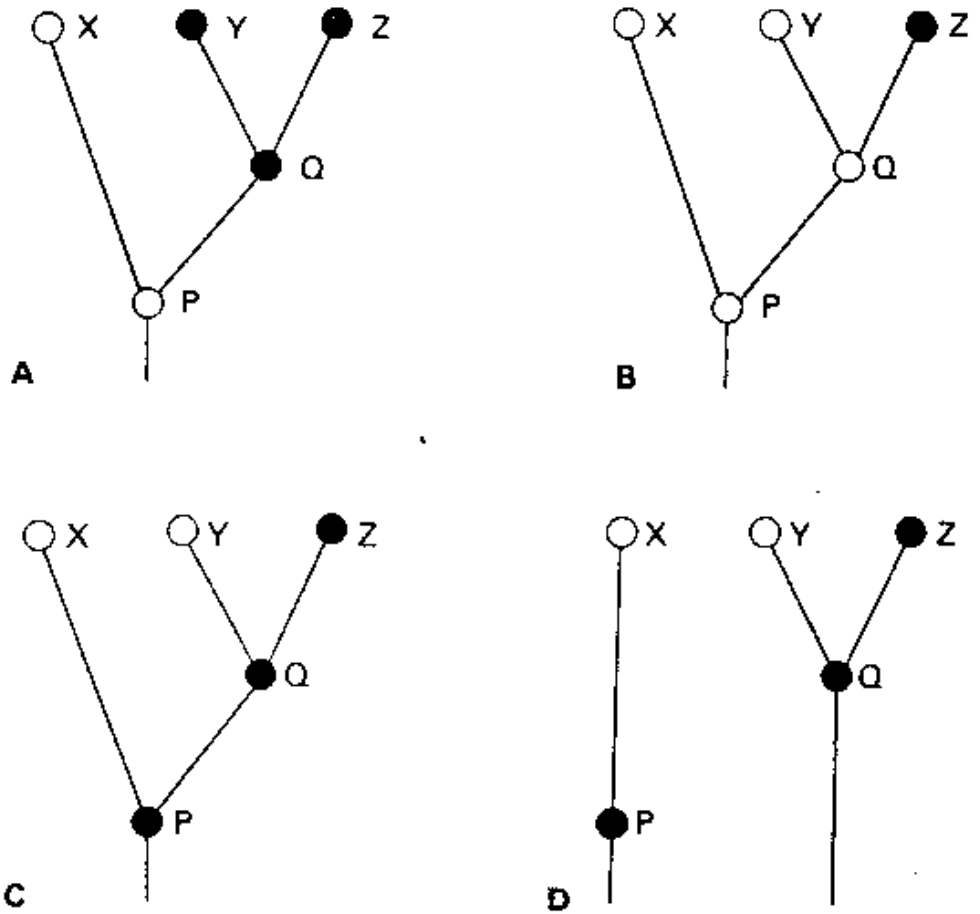


Fig. 2.6 Four diagrams showing different origins of three species (X, Y, Z) from the ancestral taxa P and Q in order to illustrate the concepts of monophyly, paraphyly, polyphyly, parallelism and convergence. The possession of one or other of two contrasting character-states by each of the five taxa is indicated by an open or closed circle respectively. **A.** Groups YZ and XYZ are both monophyletic; the similarity between Y and Z is a synapomorphy; the difference between X and YZ is due to divergence. **B.** Group XY is paraphyletic; group XYZ is monophyletic; the similarity between X and Y is a symplesiomorphy; the difference between Y and Z is due to divergence. **C.** Group XY is polyphyletic; group XYZ is monophyletic; the similarity between X and Y is a false synapomorphy caused by parallelism. **D.** Groups XY and XYZ are both polyphyletic; group YZ is monophyletic; the similarity between X and Y is a false synapomorphy caused by convergence.

Primitívny stav znaku

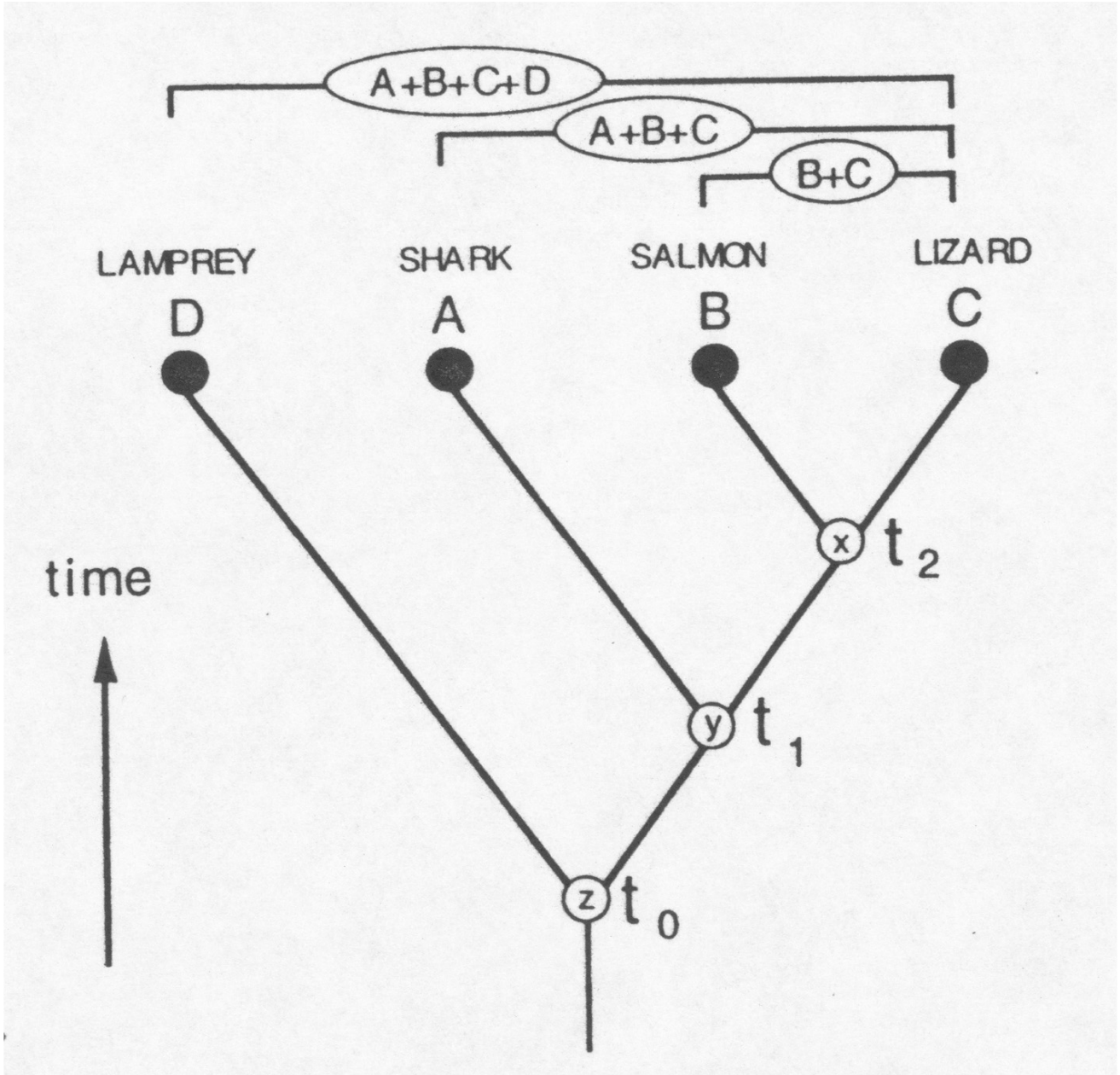
Pleziomorfia
Sympleziomorfia

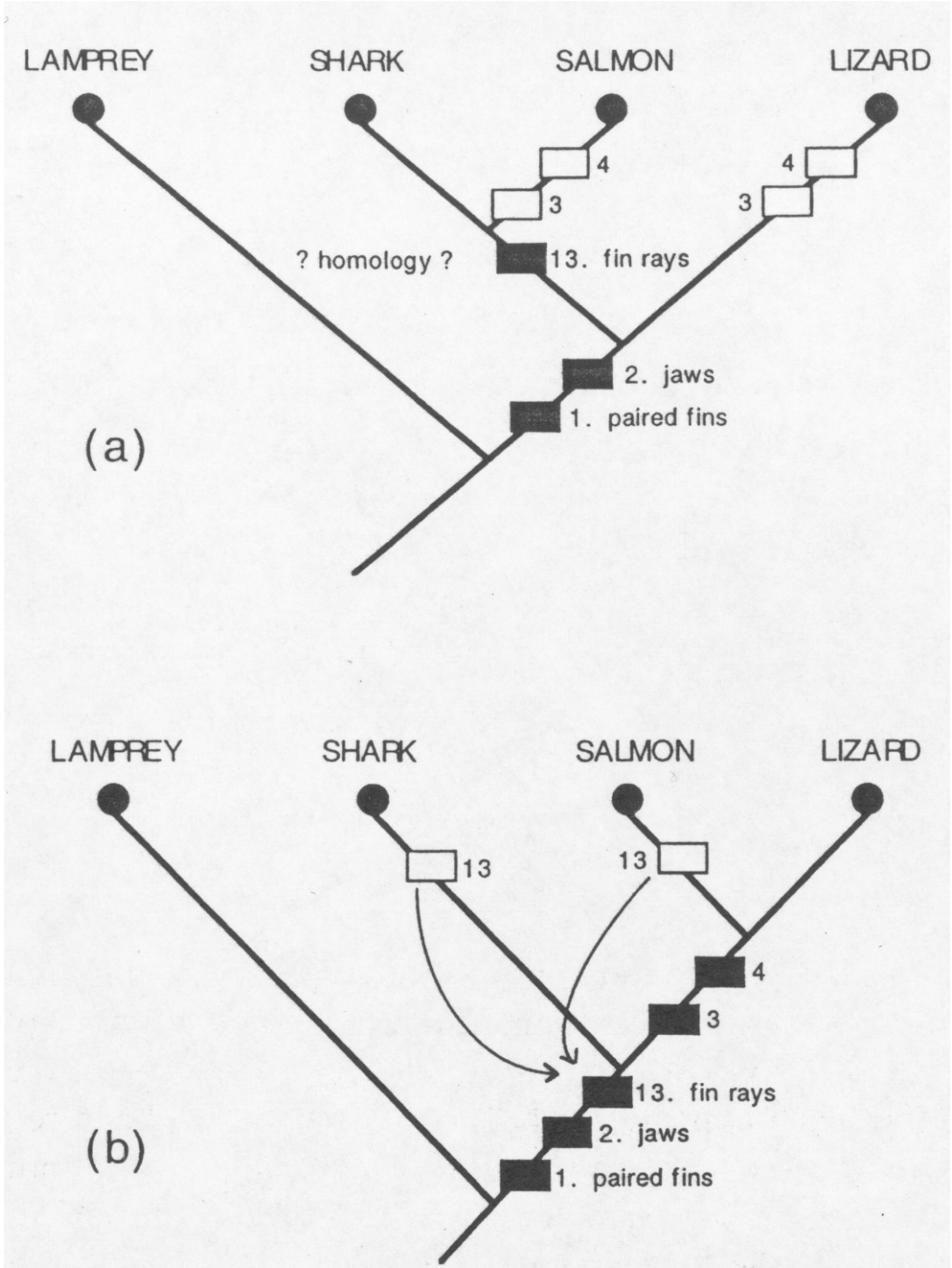
Odvodený stav znaku

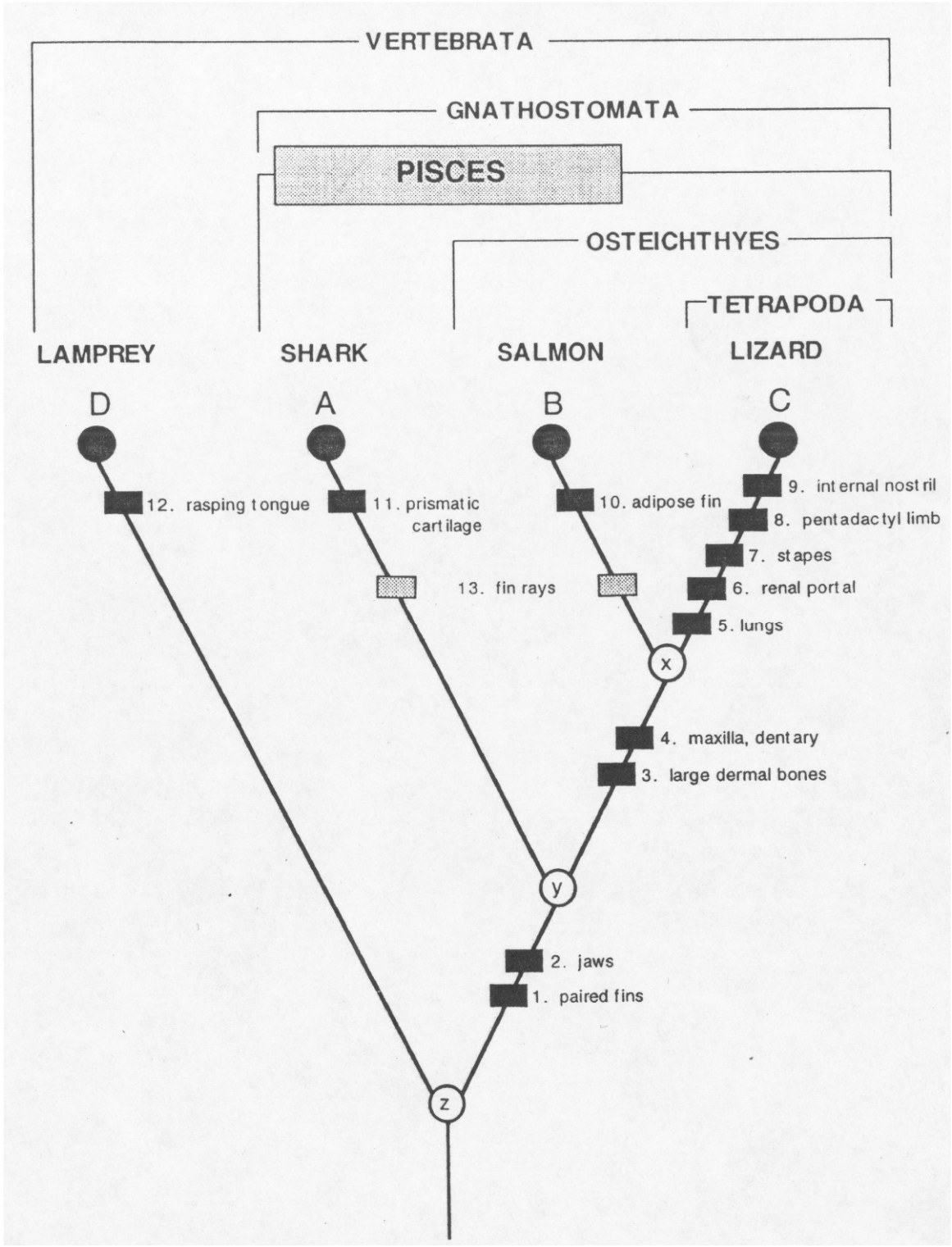
Apomorfia
Autapomorfia
Synapomorfia

Homoplázia = konvergencia + paralelizmus

Mimoskupinové porovnanie (outgroup comparison)


A+B+C+D
A+B+C
B+C
LAMPREY
SHARK
SALMON
LIZARD
D
A
B
C
x
t 2
time
y
t 1
z
t 0


LAMPREY
SHARK
SALMON
LIZARD
4
3
4
3
? homology ?
13. fin rays
2. jaws
1. paired fins
(a)
LAMPREY
SHARK
SALMON
LIZARD
13
13
4
3
13. fin rays
2. jaws
1. paired fins
(b)


VERTEBRATA
GNATHOSTOMATA
PISCES
OSTEICHTHYES
TETRAPODA
LAMPREY
SHARK
SALMON
LIZARD
D
A
B
C
12. rasping tongue
11. prismatic cartilage
10. adipose fin
9. internal nostril
8. pentadactyl limb
7. stapes
6. renal portal
5. lungs
13. fin rays
x
4. maxilla, dentary
3. large dermal bones
y
2. jaws
1. paired fins
z

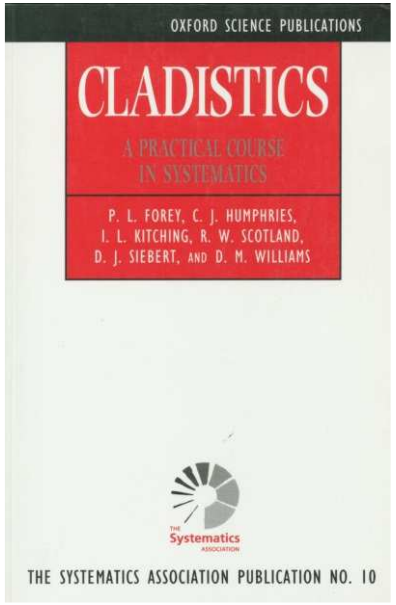
Forey, P.L., Humphries, C.J., Kitching, I.J., Scotland, R.W., Siebert, D.J. & Wiliams, D.M., 1992. *Cladistics. A practical course in systematics.* Clarendon Press, Oxford.

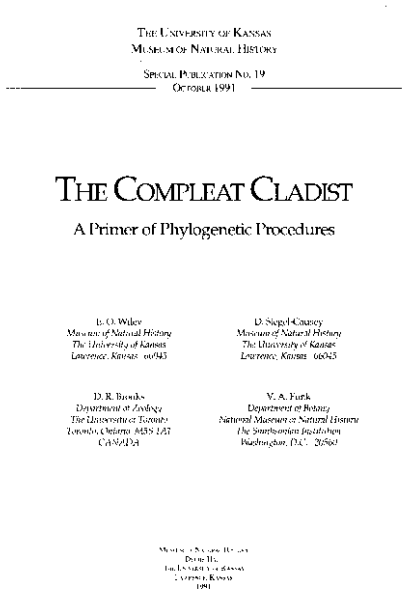
Kitching, I.J., Forey, P.L., Humphries, C.J. & Williams, D.M., 1998. *Cladistics. The theory and practice of parsimony analysis*. Ed. 2. Oxford University Press, Oxford.

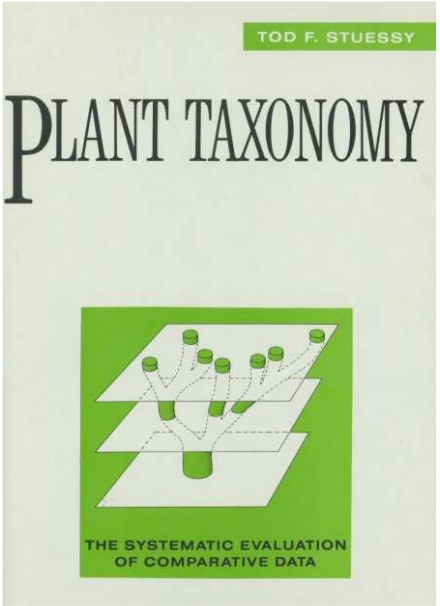
Stuessy, T. F. 1990. *Plant taxonomy: the systematic evaluation of comparative data*. Columbia University Press, New York.

Wiley, E.O., Siegel-Causey, D., Brooks, D.R. & Funk, V.A. 1991. *The compleat cladist, a primer of phylogenetic procedures*. The University of Kansas, Museum of Natural History, Lawrence.

K dispozícii na www stránke: http://nhm.ku.edu/cc.html

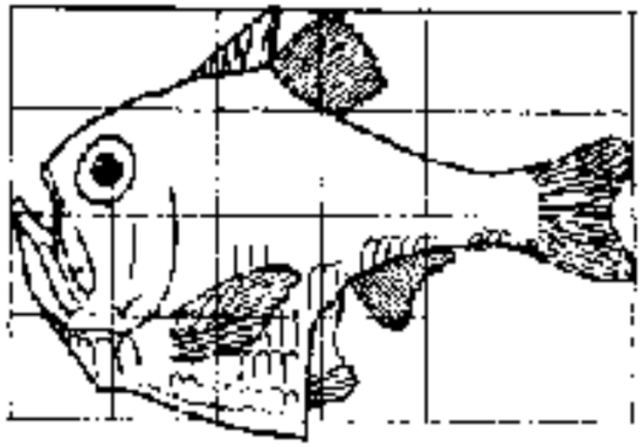




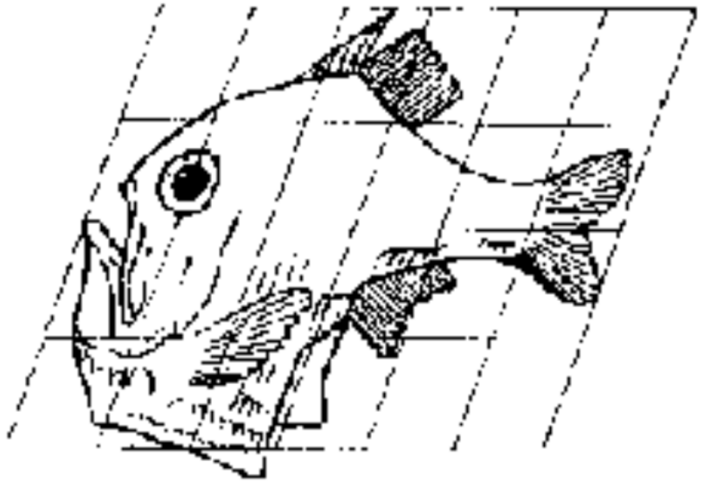


Geometrická morfometrika

Thompson, A. W. 1917. ***On growth and form.*** **Cambridge University Press, Cambridge.**

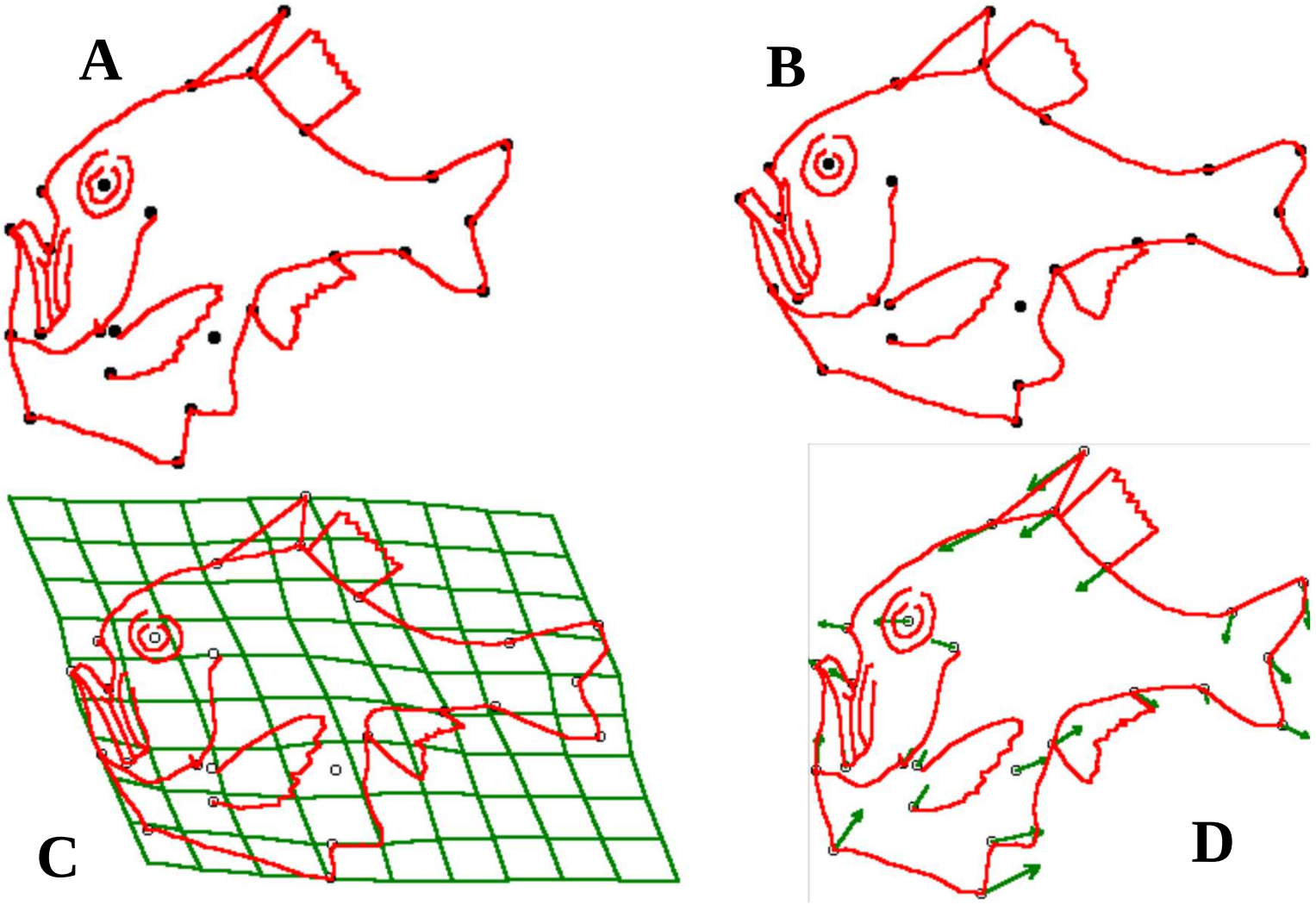


Argyropelecus olfersi.



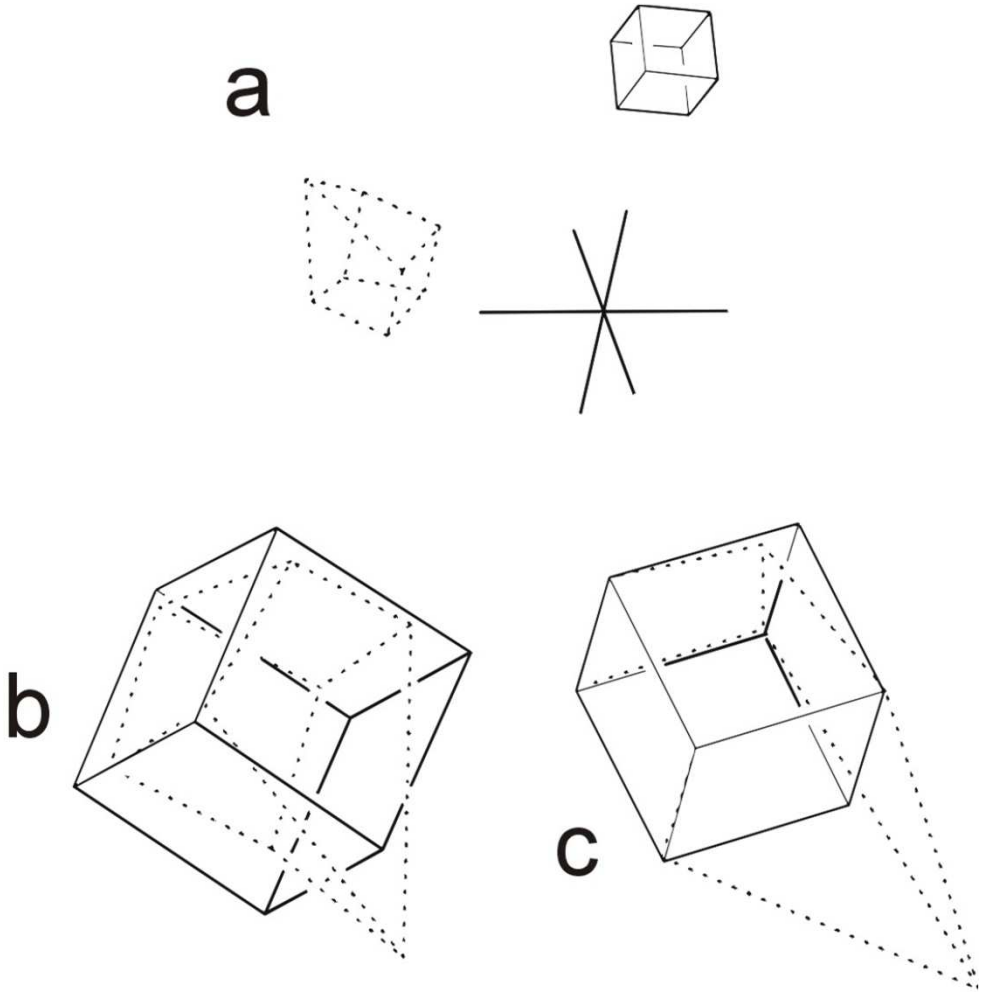
Sternoptyx diaphana.

Geometrická morfometrika



Vzájomné vzťahy tvarov druhov *Stenoptyx diaphana* (A) a *Argyropelecus olfersi* (B) – vzorové dáta z programu tpsSpline (http://life.bio.sunysb.edu/morph/), C – zobrazenie celkovej transformácie pomocou ohybnej pásky (*thin-plate spline*), D – to isté vyjadrené pomocou vektorov

Geometrická morfometrika



Prokrustova analýza. a – konsenzuálna konfigurácia plnou čiarou, jednotlivý objekt bodkovane; b – superpozícia metódou GLS (rozdíely v pozícii zodpovedajúcich význačných bodov sú porovnateľné); c – superpozícia metódou rezistentného prispôsobenia (objekty sa výrazne líšia v pozícii jediného bodu)

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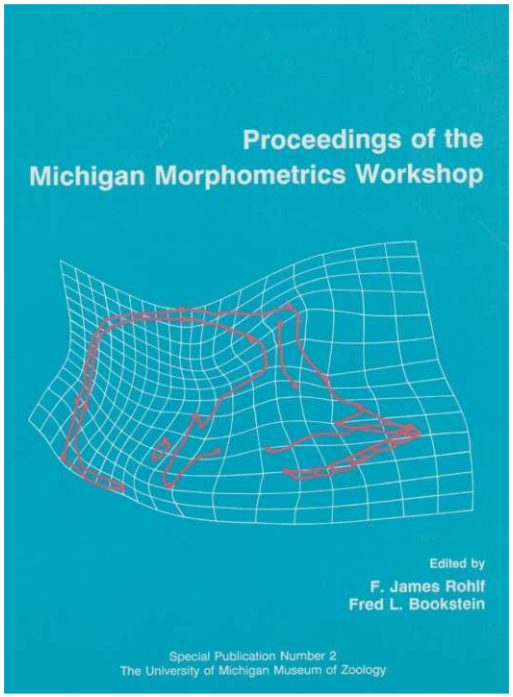

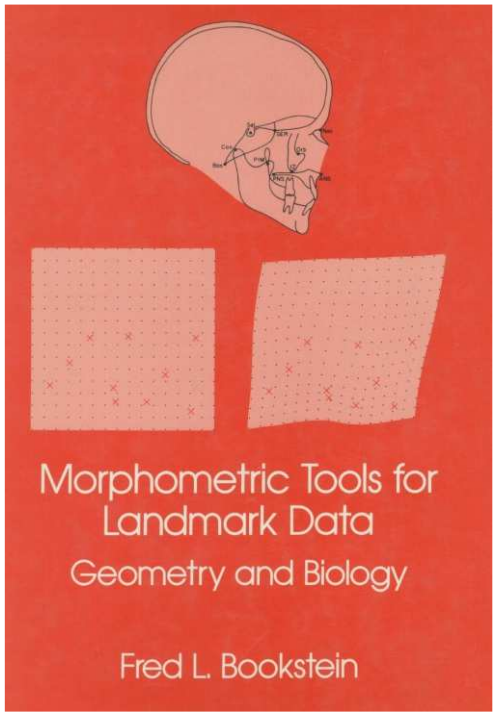

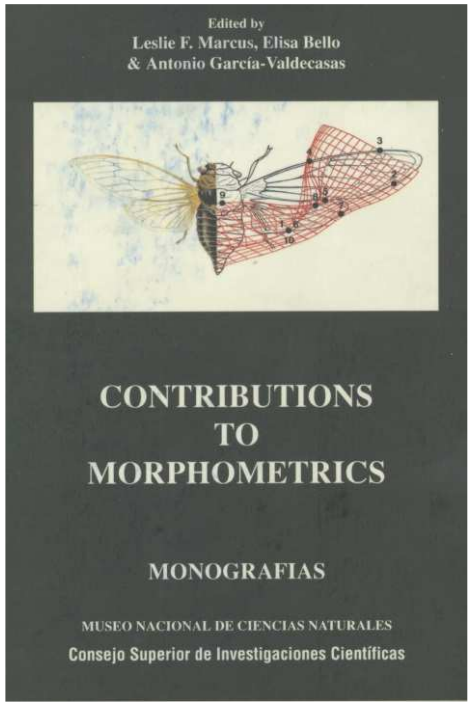

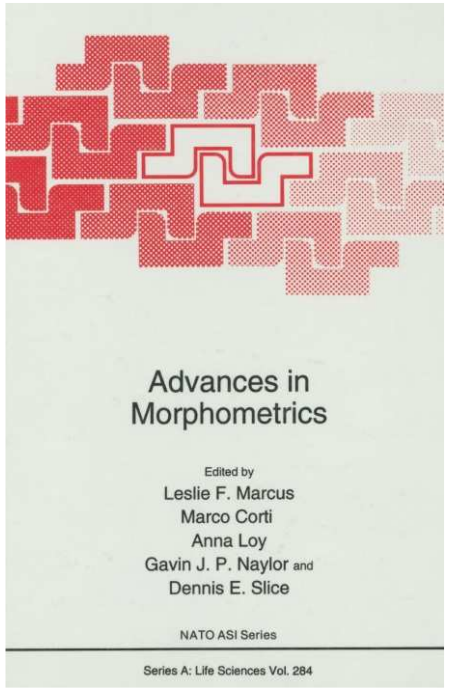

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