

Phylogenetic methods

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Lectures

Practicals

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Phenetic approach (multivariate methods; “pattern”; cluster analysis, ordination methods, discriminant analysis)

Cladistic approach (parsimony analysis)

Alternative approaches to the phylogenetic reconstruction (neighbour joining method, maximum likelihood, Bayesian statistical methods)

Phenetic approach

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-Adansonian principles

- (1) The ideal taxonomy is that in which the taxa have the greatest content of information and which is based on as many characters as possible
- (2) A priori, every character is of equal weight in creating natural taxa
- (3) Overall similarity (or affinity) between any two entities is the function of the similarity of the many characters in which they are being compared
- (4) Distinct taxa can be constructed because of diverse character correlations in the groups under study
- (5) Taxonomy is a strictly empirical science
- (6) Affinity is estimated independently of phylogenetic considerations; any phylogenetic deductions are made on the basis of phenetic classification but are not involved in the classificatory process

Phenetic approach

Terms: numerical taxonomy (Sokal & Sneath), statistical systematics (Solbrig), numerical phenetics (Duncan & Baum), multivariate morphometrics (Blackith & Reyment)

Operational taxonomic units (OTU)

Characters, primary data matrix, number of characters, correlations

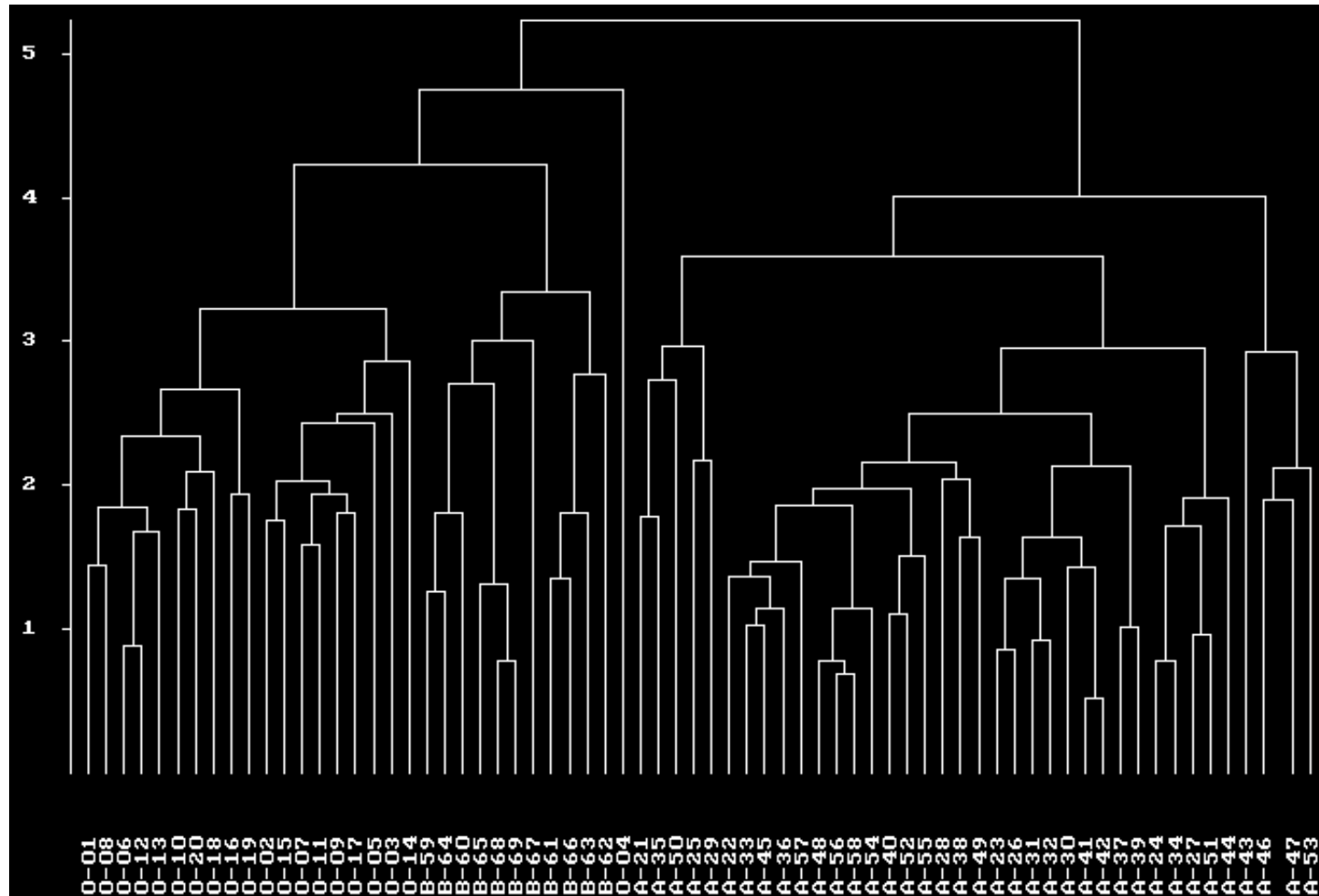
Coefficients expressing relationships among characters or objects -> secondary matrix

Multivariate methods (cluster analyses, ordination methods, discriminant analyses)

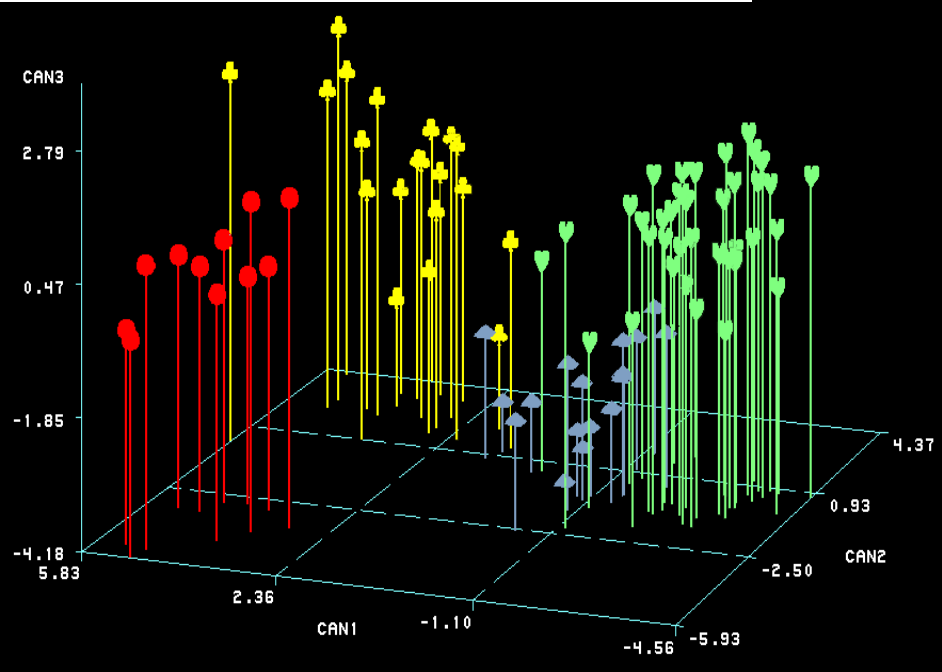
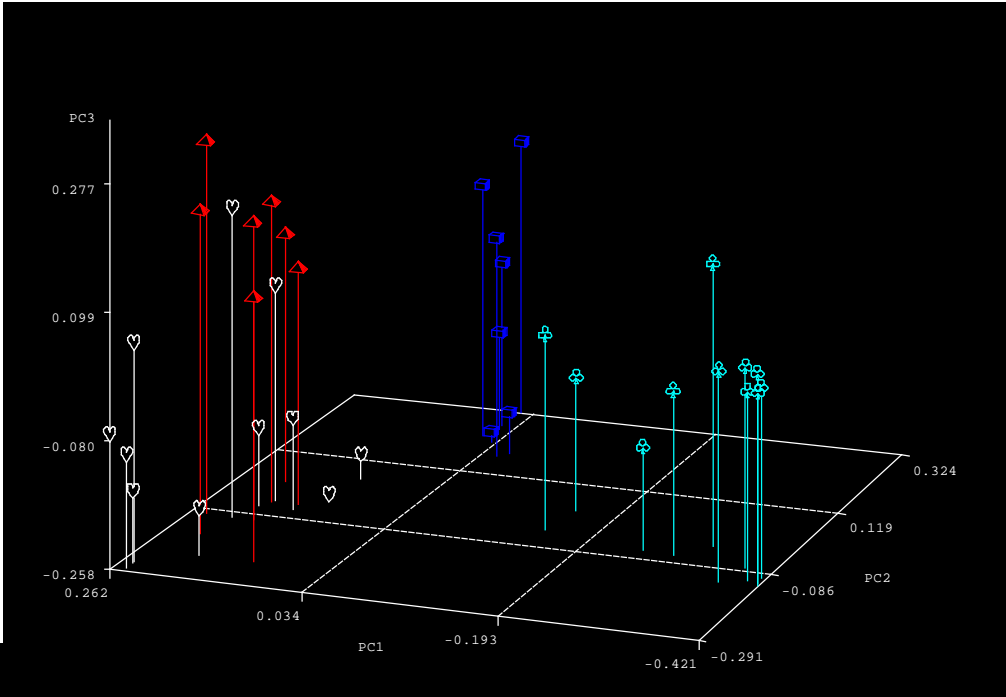
Different methods may bring different results

Use of these methods in the past and in the current practice (intraspecific variability, polyploid complexes, study of morphological variation in wide distribution areas, molecular data)

Cluster analysis



Principal component analysis



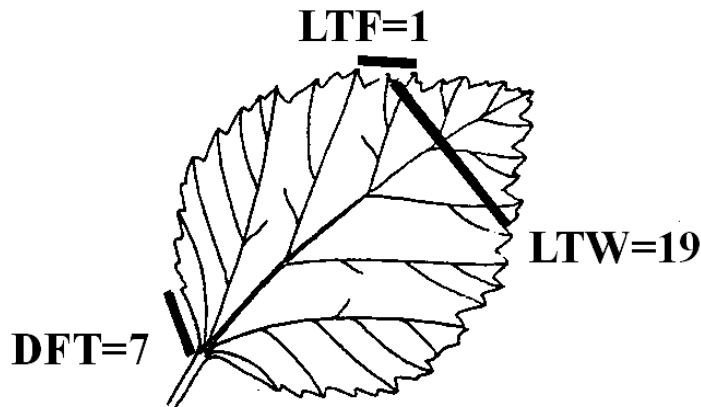
Canonical discriminant analysis

Classificatory discriminant analysis

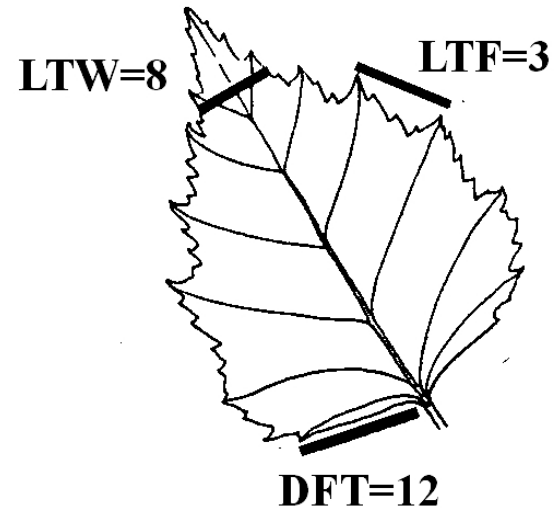
group group membership predicted on the base of developed classificatory criterion (absolute number and percentage of plants classified into particular groups)

	amara	austr.	olot.	opicii	pyren.	Total
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	

B. pubescens = -35



B. pendula = +21



Discriminant function for the determination of *Betula pubescens* and *B. pendula*

$$12\text{LTF} + 2\text{DFT} - 2\text{LTW} - 23$$

positive values *B. pendula*

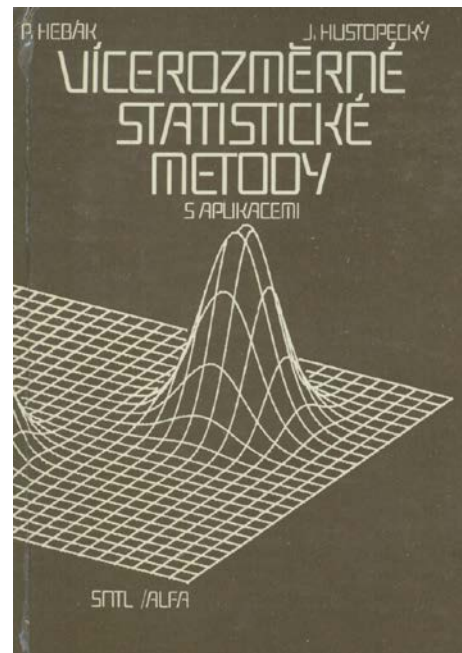
negative values *B. pubescens*

Probability of correct identification 93%

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

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Hebák, P. & Hustopecký, J. 1987: *Vícerozměrné statistické metody s aplikacemi*. SNTL – nakladatelství technické literatury, Alfa, vydavatelství technické a ekonomické literatury, Praha.

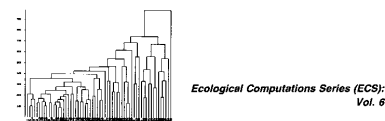
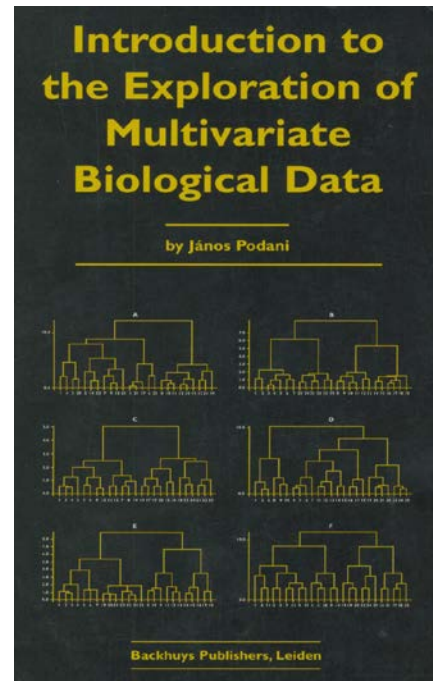
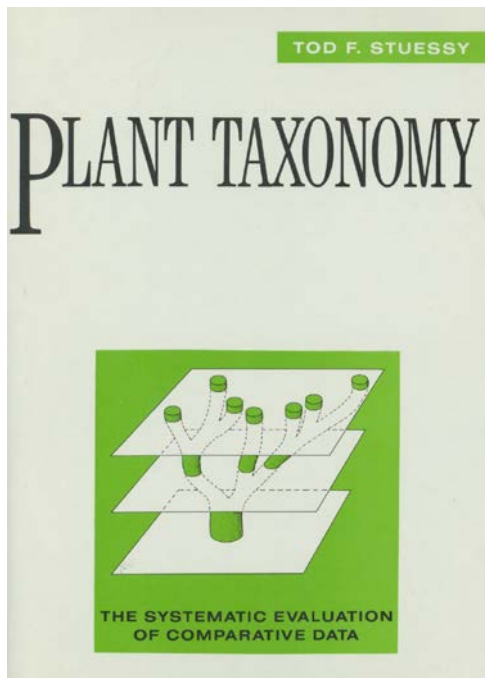


Legendre, P. & Legendre, L. 1998. *Numerical ecology*. Second English edition. Elsevier, Amsterdam.

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

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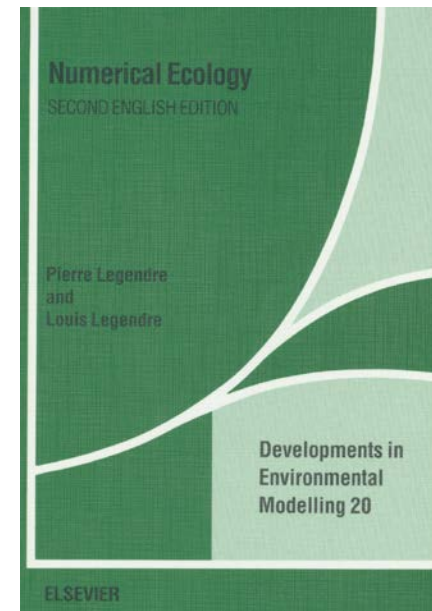
Stuessy, T. F. 1990. *Plant taxonomy: the systematic evaluation of comparative data*. Columbia University Press, New York.



**MULTIVARIATE DATA
ANALYSIS IN ECOLOGY
AND SYSTEMATICS**
- A methodological guide to the SYN-TAX 5.0 package

In memory of my mentor, P. Juhász-Nagy

János Podani
SPB Academic Publishing bv



Cladistic approach

Hennig, W.

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

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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.

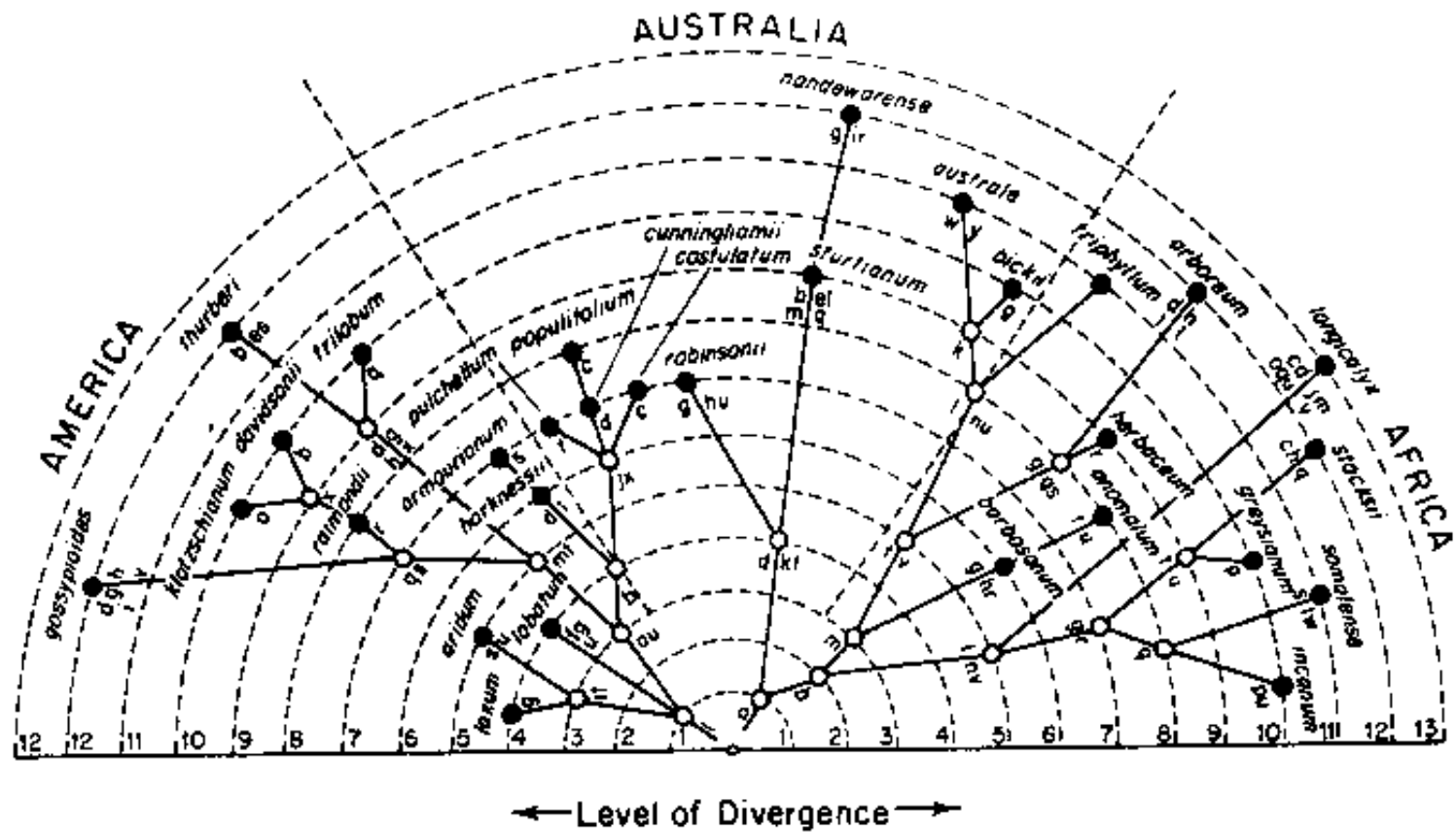


Fig. 2.17 Cladogram (Wagner tree) of 30 species of *Gossypium* (Malvaceae), modified from Frywell¹⁴².

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

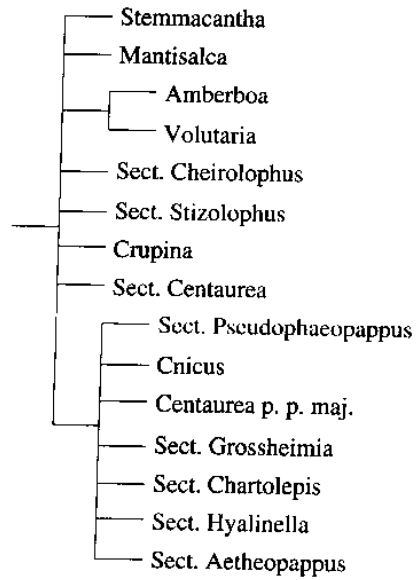


FIGURE 8-4. Strict consensus tree of six equally parsimonious cladograms of *Centaurea* sections and related genera based on cypselas characters from Dittrich (1966, pp. 138-139). The data matrix is given in Table 8-4.

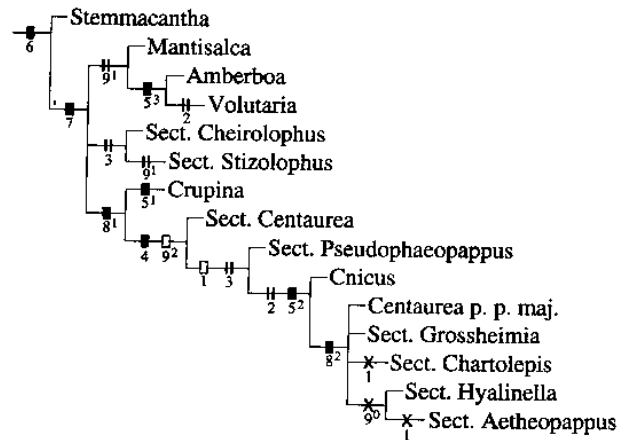


FIGURE 8-5. One of six equally parsimonious cladograms of *Centaurea* sections and related genera based on cypselas characters from Dittrich (1966, pp. 138-139). The characters are given in Table 8-3 and the data matrix in Table 8-4. Solid bars indicate nonhomoplastic synapomorphies; open bars indicate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

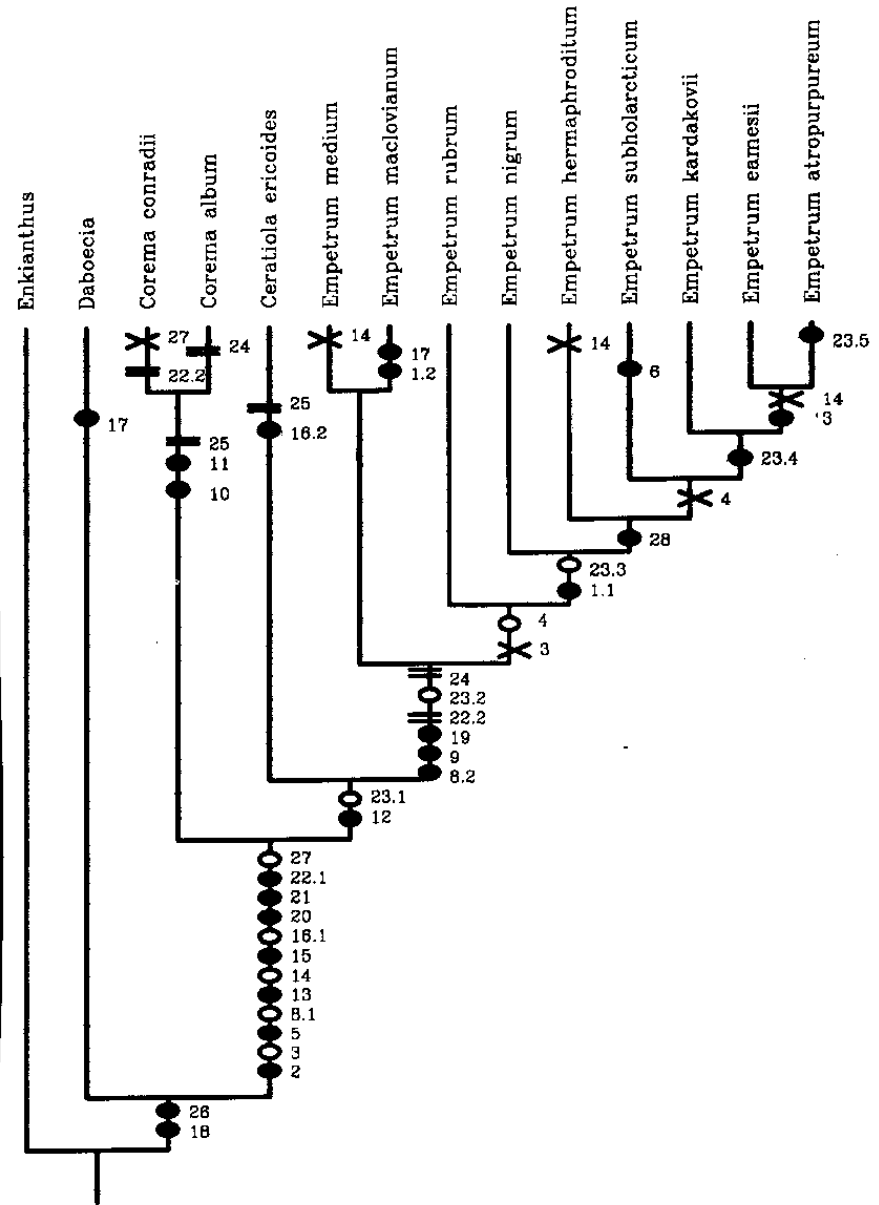


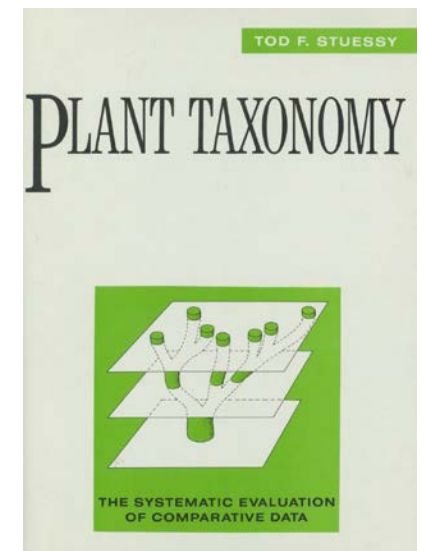
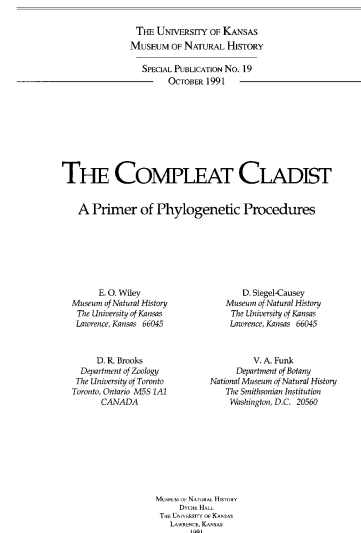
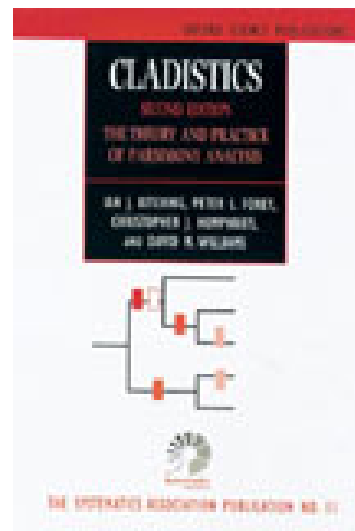
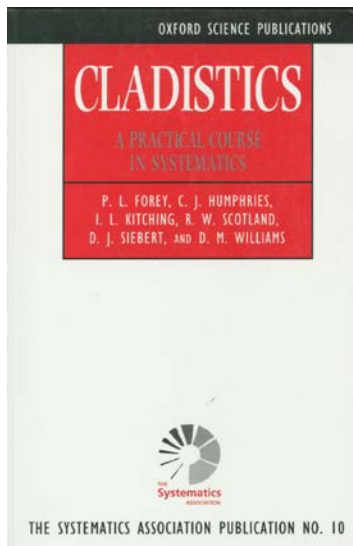
FIG. 2. One of five equally parsimonious cladograms of the Empetraceae. *Enkianthus* and *Daboecia* are outgroup taxa. Characters are numbered in accordance with the text, Appendix 1, and with Table 1. Black dots = synapomorphies (ci = 1), white dots = synapomorphies (ci < 1), parallel lines = parallelisms,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

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

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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.



Alternative approaches to reconstruction of phylogeny

Neighbour joining method

