THE EXTERNAL MORPHOLOGY OF EXTANT AND FOSSIL VEGETATIVE SHOOTS AS A BASIS FOR PALAEOBOTANICAL STUDIES

[exemplified by a study of silicified Tertiary floras from central South Australia]

by

Christina E. Offler, B.Sc.(Hons.)
Department of Botany, University of Adelaide

Thesis submitted for the Degree of
Doctor of Philosophy, University of Adelaide

December 1969.

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Appendix 1

A LIST OF THE CONIFER SPECIES OCCURRING IN AUSTRALIA AND NEW GUINEA

PODOCARPACEAE

Microstrobos Garden et Johnson

M.fitzgeraldi (F.v.M.) Garden et Johnson
M.niphophilus Garden et Johnson

Microcachrys Hook.f. in Hook.

M.tetragona Hook.f. in Hook.

Dacrydium Soland. ex Forst.f.

group A
D.falciforme (Parl.) Pilger in Engler
group B
D.elatum (Roxb.) Wall. ex Hook.
D.novo-guineense Gibbs
group C
D.franklinii Hook.f. in Hook.

Podocarpus L'Heritier ex Persoon

sect. *Dacrycarpus* Endlicher

P.cinctus Pilger
P.compactus Wasscher
P.imbricatus Blume
P.leptophyllus Wasscher
P.papuanus Ridley

sect. *Nageia* Endlicher

P.blumei Endlicher

sect. *Polypodiopsis* Bertrand

P.vitiensis Seeman

sect. *Sundacarpus* Buchholz et Gray

P.amarus Blume

sect. *Stachycarpus* Endlicher

subsect. B *Idioblastus* Buchholz et Gray
P.ladei Bailey

sect. *Podocarpus*

subsect. B

P.archboldii Gray
P.brassii Pilger
P.dispermus White
P.drouynianus F.v.M.
P.elatus R.Br. ex Mirb.
**P.glaucus* Foxworthy
P.idenburgensis Gray
**P.ledermanii* Pilger
P.neriifolius D.Don ex Lamb.
P.pilgeri Foxworthy
**P.ridleyi* (Wasscher) Gray
P.rumphii Blume
P.spinulosus (Smith) R.Br.ex Mirb.
P.thevetiifolius Zippel

subsect. D

P.alpinus R.Br.ex Mirb.

Phyllocladus L.C.Rich.

P.asplenifolius Hook.f. in Hook.

P.hypophyllus Hook.f.

ARAUCARIACEAE

Araucaria Juss.

sect. *Colymbea*

A.bidwillii Hook.

sect. *Eutacta*

A.cunninghamii Ait. in Sweet

sect. *Intermedia*

A.hunsteinii K.Schum. in K.Schum. et Hollr.

Agathis Salisb.

A.dammara (Lamb.) L.C.Rich.
A.labillardieri warburg
A.microstachya J.F.Bail.et C.T.White
A.palmerstoni F.v.M. ex F.M.Bail.
A.robusta (C.Moore) F.M.Bail.

TAXODIACEAE

Athrotaxis D.Don

A.cuppressoides D.Don
A.laxifolia Hook.f.
A.selaginoides D.Don

CUPRESSACEAE

Actinostrobus Miq.in Lehm.

A.acuminatus Parl.
A.arenarius Gardner
A.pyramidalis Miq.in Lehm.

Callitris Vent.

C.baileyi C.T.White
C.canescens (Parl.) Blake
C.columellaris F.v.M.
C.drummondii (Parl.) F.v.M.
C.endlicheri (Parl.) F.M.Bail.
C.macleayana F.v.M.
C.monticola Garden
C.muelleri (Parl.) F.v.M.
C.oblonga A.et L.C.Rich.
C.preissii Miq.in Lehm.

ssp. *murrayensis* Garden
preissii
verrucosa (A.Cunn.ex Endl.)Garden

C.rhomboidea R.Br. ex A.et L.C.Rich.
C.roei F.v.M.

Diselma Hook.f.

D.archeri Hook.f.

Papuacedrus Li

P.arfakensis (Gibbs) Li
P.papuanus (F.v.M.) Li
P.torricellensis (Schlechter) Li

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* No material available for investigation.

Appendix 2

GROUPS OF *DACRYDIUM*

The following grouping is after Florin (1931, p.248). The general distribution has been inserted after each species to support the observations reported in Chapter III,2, p. 20.

Group A : *D.falciforme* (Borneo, Phillipine Is., New Guinea), *D.taxoides* (New Caledonia).

Group B : *D.araucarioides* (New Caledonia), *D.balansae* (New Caledonia), *D.beccarii* (Borneo), *D.cupressinum* (New Zealand), *D.elatum* (Malay States, Borneo, Phillipine Is., New Guinea, Fiji), *D.gibbsiae* (Mt. Kinabalu, North Borneo), *D.lycopodioides* (New Caledonia), *D.novo-guineense* (New Guinea).

Group C : *D.bidwillii* (New Zealand), *D.biforme* (New Zealand), *D.colensoi* (New Zealand), *D.fonkii* (Chile), *D.franklinii* (Tasmania), *D.intermedium* (New Zealand), *D.kirkii* (New Zealand), *D.laxifolium* (New Zealand).

Appendix 3

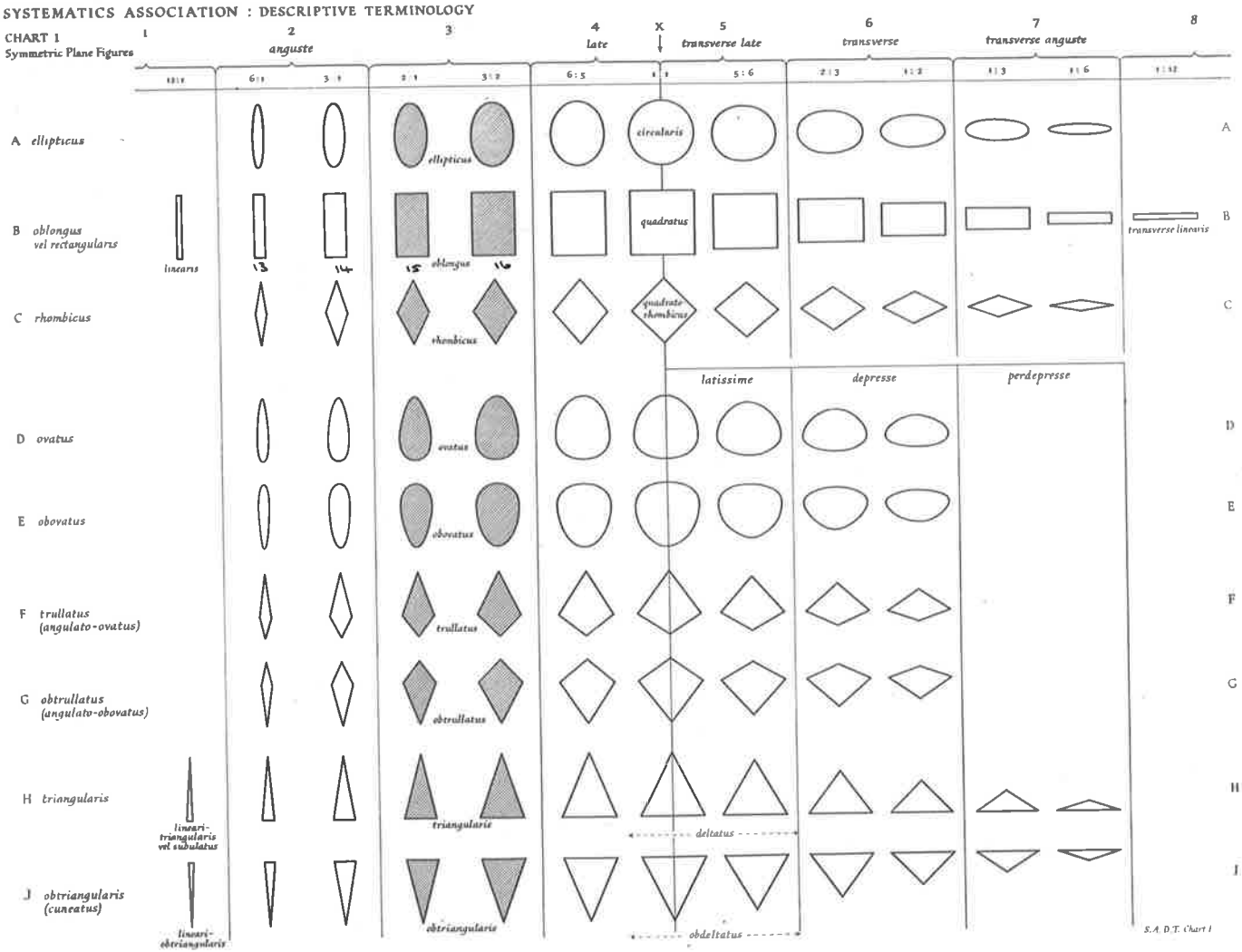
A copy of Chart 1 — Symmetrical Plane Figures — which was published by the Systematics Association Committee for Descriptive Biological Terminology, is presented here.

In October 1962 this committee published an addendum and reissued Chart 1 as Chart 1a (Taxon 11(8) : 245-247). The numbers of reference for each figure were included in Chart 1a and those used in the text of this thesis have been inserted in this copy of Chart 1.

In the text, reference to the numbers on the chart is stated as "SADT nos 15-16". The system of reference suggested by the committee, namely, S.A.15-16, will be adopted in future work.

SYSTEMATICS ASSOCIATION : DESCRIPTIVE TERMINOLOGY

CHART 1
Symmetric Plane Figures



Appendix 4

AN ANALYSIS OF DATA USING GOODALL'S SIMILARITY INDEX BASED ON PROBABILITY.

1. The preparation of data and presentation of results

The data pertaining to the phyllotaxis of shoots and the flattening of the free part of the leaf are used to illustrate the preparation of data for analysis. Only fifteen of the foliage forms are used in the examples.

(1) The characteristics of each foliage form are transferred from the description of the foliage form (Chapter V) to an entities by characteristics table.

EXAMPLE:

CHARACTERISTICS		ENTITIES: *Actinostrobus*	*A. acuminatus* (j)	" (m)	*A. arenarius* (t)	" (m)	*A. pyramidalis* (m)	*Agathis* (im and m)	*Araucaria*	*A. bidwillii* (j)	" (m)	*A. cunninghamii* (j)	" (m)	*A. humsteinii* (j)	" (m)	*Athrotaxis*	*A. cupressoides* (m)	*A. selaginoides* (im)	" (m)
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
	Phyllotaxis																		
1	quadricussate		+	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
2	tricussate		+	+	+	+	+	-	-	-	-	-	-	-	-	-	-		
3	decussate		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
4	spiral		-	-	-	-	-	+	+	+	+	+	+	+	+	+	+		
	Free part																		
5	flattened, not		-	-	-	-	-	+	+	+	+	-	+	+	-	-	-		

+, present; -, absent; (◢, sometimes present — not realized in this example).

(2) The attributes to be used in the analysis are selected from the characteristics. It is not always possible to eliminate all interdependency when selecting attributes. However, if the values for two characteristics are always dependent, only one is used as an attribute. Classification of attributes according to Goodall's programming categories (see Chapter VIII, p.203) is followed by the allocation of code numbers to each value taken by the attribute.

EXAMPLE:

Attribute 1:- Binary attribute, programming category A.
Coded 0,1 - free part flattened or not.

Code number (value)
0. Free portion, blade or cladode flattened
1. " " " " " not flattened

Attribute 2:- Attribute taking more than one value, programming category B.
Codes 0-4 - phyllotaxis decussate, tricussate, quadricussate or spiral.

Code number (value)
Phyllotaxis:-
0. quadricussate or tricussate
1. not quadricussate but tricussate
2. not " " decussate
3. not " " spiral
4. quadricussate but not tricussate (this value has not been realized in the example).

The attributes selected for this analysis and the coding employed is presented in this appendix, 3, p.xiii.

(3) These data are now converted to the coded form.

EXAMPLE:

ENTITIES

ATTRIBUTES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	1	1	1	1	0	0	0	0	1	0	0	1	1	1
2	0	1	1	1	1	3	3	3	3	3	3	3	3	3	3

(4) The coded data is punched on to standard computer cards and fed into the computer together with the programme. The steps involved in the calculation of the similarity index are given in this appendix,2,p.x. An example of the print-out of the results in this case recorded as the combined probabilities for each pair of entities (similarity index = 1 - combined probabilities, see this appendix, 2), is presented in Table 2.

(5) The probability values underlined in Table 2 are used to construct

(a) a dendrogram and

(b) more detailed diagrams of the relationships between the members of the groups shown to exist by the dendrogram presentation.

Table 2

An example of the print-out of results.

h	j	j	Probability[1] j + 1	j + 2	j + 3	j + 4
7	8	.000027094	.270300137	.679262397	.000124949	.045092732
7	13	.806173818	.679262397	.298097586	.456746770	.748256399
7	18	.748256399	.748256399	.748256399	.712686243	.840345254
7	23	.748256399	.456746770	.456746770	.748256399	.613173053
7	28	.867721219	.867721219	.748256399	.556236999	.748256399
7	33	.748256399	.867721219	.748256399	.148458151	.632924786
7	38	.773706474	.806173818	.014058832	.806173818	.941350941
7	43	.941350941	.773706474	.806173818	.059763483	.727838516
7	48	.247235920	.945957820	.945957820	.857581070	.092222175
7	53	.136329381	.092222175	.136329381	.136329381	.030638621
7	58	.001616172	.001616172	.000480165	.000168867	.010967932
7	63	.270300137	.057528572	.900392385	.086058929	.352207390
7	68	.679262397	.002129799	.024272871	.001616172	.002129799
7	73	.001017714	.001616172	.001616172	.002934972	.003931786
7	78	.001616172	.006958654			

h and j represent the pair of entities.

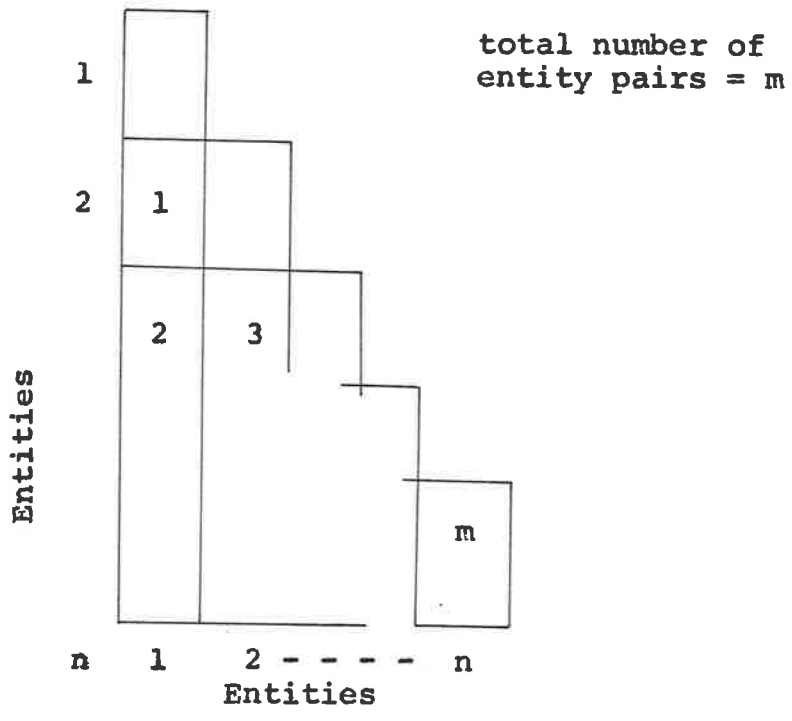
1. This is the combined probability. The programme is also equipped to print-out the similarity index (similarity index = 1 - combined probability).

2. The steps in the calculation of the similarity index

Since attributes always have at least two values (for example, "free part flattened or not") any pair of entities must take one of several possible combinations of attribute value. For example, an attribute coded 0,1 might take one of four values 1,1; 1,0; 0,1 or 0,0.

(1) For each attribute, the frequencies (hence probabilities) with which the possible combinations of values of the attribute are realized by all entity pairs are observed. Thus, each combination of values is given a probability of being observed from a random pair of entities.

- i.e. -



EXAMPLE:

Taking as an example an attribute coded 0,1.

Possible combinations of values	Frequency	Probability
1,1	x_1	$\frac{x_1}{m} \times 100$
0,1	x_2	
1,0	x_3	
0,0	x_4	
	$\Sigma = m$	

In this way, the likelihood is established of any random pair of entities possessing any combination of the values of an attribute.

(2) For each attribute the possible combinations of values are listed in order of decreasing probabilities (they are ordered).

(3) The combination of values realized by the pair of entities in question is then observed. The probability value calculated previously for this combination of values, and the probabilities of the more unlikely combinations of value, are added. This value has been called the cumulative probability by Goodall (1966).

EXAMPLE: (hypothetical example)

For an attribute coded 0,1

	Possible combinations of values	Probabilities	
	1,1	.5	
	0,1	.3	
observed ⟶ combination of values	1,0	.15	Cumulative probability is 0.2
	0,0	.05	
		≤ 1.00	

In this example, the probability is 0.2 which implies that chance would permit such a result one time in five. Of course, this is significant. However, if the probability was very low, for example, 0.000027094, the result would be unlikely to be due to chance. The pair of entities would therefore possess very significant similarity on the basis of the attribute in question.

(4) The calculation presented in the first three steps is applied to each attribute for a pair of entities. The cumulative probabilities of the individual attributes are summed to give a combined probability.

The significance of a probability increases as its numerical value decreases, but by

convention, similarity increases as its numerical value increases. Hence, to convert the probabilistic statement to a similarity index, Goodall (1966) has presented the complement of the combined probability:-

Similarity Index = 1 - combined probability.

3. Attributes and coding

The following is a list of the twenty attributes used in this analysis, together with their classification and the code numbers of the ninety-nine values taken by them.

Attribute Number

1 - 13 — binary attributes, programming category A. Coded 0,1

1. Dominant foliage consisting of true leaves or not.
2. Foliage dimorphic or not.
3. Dominant foliage (usually true leaves) small or not.
4. " " " " " simple or not.
5. " " " " " thick or not.
6. " " " " " appressed or not.
7. Dominant " " " " decurrently inserted or not.
8. Free portion, blade or cladode overlapping the bases of subsequent leaves or not.

9. Leaves differentiated into facial and marginal leaves or not.
10. Axes tetragonal or not.
11. Free portion, blade or cladode flattened or not.
12. " " " " " twisted at insertion or not.
13. Free portion, blade or cladode constricted at insertion or not.

14-20 — attributes taking more than one value, programming category B.

14. Apex incurved or not.

Coded 0-2

Apex:-

0. not incurved
1. incurved or sometimes incurved
2. slightly incurved or sometimes slightly incurved.

15. Phyllotaxis decussate, tricussate, quadricussate or spiral.

Coded 0-4

Phyllotaxis:-

0. quadricussate and tricussate
1. not quadricussate but tricussate
2. " " but decussate
3. " " but spiral
4. quadricussate but not tricussate.

16. Relation between the free part and the axis.

Coded 0-11

Free portion, blade or cladode:-

0. complanate with adnate base
1. spreading and straight
2. " " incurved
3. " " " distally
4. complanate or flattened
5. " " slightly spreading
6. spreading and straight or spreading and incurved distally
7. spreading and incurved or spreading and incurved distally
8. complanate or sometimes flattened
9. " " " slightly spreading
10. sometimes complanate or slightly spreading
11. spreading and straight or sometimes incurved distally.

17. Apex.

Coded 0-19.

Apex:-

0. acute
1. acuminate
2. rostrate
3. cuspidate
4. pungent

5. obtuse
6. narrowly obtuse
7. uncinate
8. acute or obtuse
9. acute or narrowly obtuse
10. acute or rostrate
11. acute or pungent
12. acute or cuspidate
13. acute or mucronate
14. acute or apiculate
15. acuminate or rostrate
16. rostrate or cuspidate
17. rostrate or pungent
18. cuspidate or pungent
19. acute or sometimes acuminately-obtuse.

18. Margins of free portion, blade or cladode.

Coded 0-9.

Margins:-

0. entire
1. entire and thickened
2. entire and revolute
3. " " involute
4. " " fimbriate
5. " " sinuate
6. " " thickened and revolute
7. " " " " toothed

8. entire and revolute and sometimes sinuate

9. not entire.

19. Cross-sectional characteristics of free portion, blade or cladode.

Coded 0-13

Free portion, blade or cladode:-

0. bifacial and keeled on the abaxial surface

1. " " convex in cross-section

2. " " ridged on the abaxial surface (≙ convex in cross-section)

3. bifacial and ridged on the abaxial surface (≙ planar in cross-section)

4. bifacial and striated on the abaxial surface

5. bilateral surfaces planar, not ridged

6. " " " and striated

7. " " ridged on one or both surfaces

8. bifacial and keeled or ridged on the abaxial surface (≙ convex in cross-section)

9. bifacial and keeled or convex in cross-section

10. bifacial and keeled or ridged (≙ planar in cross-section)

11. bilateral surface planar or planar and ridged

12. bifacial surface planar, not ridged

13. bifacial surface planar, not ridged or planar and ridged.

20. Leaf-shape.

Coded 0-14

Leaf-shape:-

0. full leaf rhombic

1. " " trullate

2. " " rhombic or obtrullate

3. " " obtrullate

4. Connate pair of leaves obtriangular or obovate

5. Adnate base of two parts, free portion, blade or cladode deltate or shallowly triangular.

6. Adnate base of two parts, free portion, blade or cladode triangular

7. Adnate base of two parts, free portion, blade or cladode linear to narrowly triangular

8. Adnate base of one part, free portion, blade or cladode broadly to narrowly elliptical

9. Adnate base of one part, free portion, blade or cladode linear to oblong

10. Adnate base of one part, free portion, blade or cladode linear to narrowly triangular
11. Adnate base of one part, free portion, blade or cladode narrowly elliptical or ovate
12. Adnate base of one part, free portion, blade or cladode ovate
13. Full leaf rhombic or trullate
14. Adnate base of one part, free portion, blade or cladode narrowly elliptical or obovate.

FIGURES 1-31

Figure 1

A map showing the distribution of the genera *Actinostrobus*, *Callitris*, *Diselma* and *Papuacedrus* in Australia and New Guinea.

Dashed lines indicate that the position of the boundary is uncertain.

Information about the distribution of *Papuacedrus* is limited and reflects the areas covered by collectors, thus the altitudinal range of the genus recorded by Womersley (unpublished data 1968) has been used in the construction of the boundaries. The boundaries are therefore indicated with dashed lines; full lines have been used only where the presence of *Papuacedrus* has been confirmed by the localities on herbarium specimens studied by the author.

Sources of reference used in the compilation of this map:-

Curtis 1956; Garden 1957; Blake 1959; Forestry and Timber Bureau 1962; Florin 1963 and Womersley unpublished data 1968.

Localities on herbarium specimens lodged in:-

Western Australian Herbarium, Perth, W.A., State Herbarium of South Australia, Adelaide, S.A., Animal Industry Branch, Alice Springs, N.T., Botanic Museum and Herbarium, Brisbane, Qd and Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry, Canberra, A.C.T.

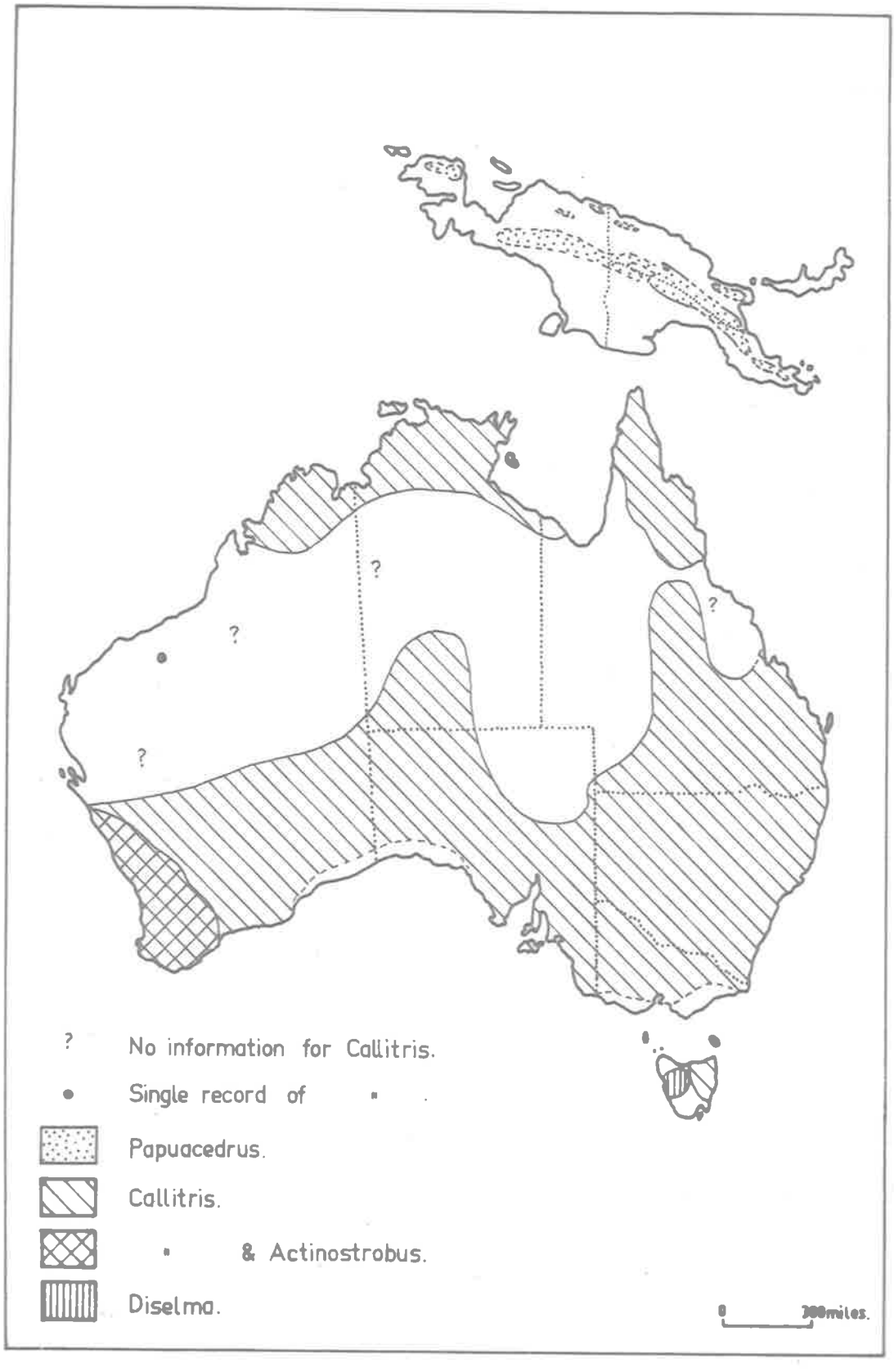

?
No information for Callitris.
Single record of
Papuacedrus.
Callitris.
& Actinostrobus.
Diselma.
0
300miles.

Figure 2

A map showing the distribution of the genera *Agathis*, *Athrotaxis* and *Araucaria* in Australia and New Guinea.

The altitudinal ranges of *Agathis* and *Araucaria* sects *Eutacta* and *Intermedia* recorded by Womersley (unpublished data 1968) have been used in the construction of their distributional boundaries for New Guinea. Dashed lines indicate that the position of the boundary is uncertain. Full lines have been used only where the presence of these taxa has been confirmed by the localities on herbarium specimens studied by the author. The restriction of *Araucaria* sect. *Intermedia* to East New Guinea is after Womersley (unpublished data 1968).

Sources of reference used in the compilation of this map:-

Bailey 1902; Francis 1951; Curtis 1956; Forestry and Timber Bureau 1962 and Womersley unpublished data 1968.

Localities on herbarium specimens lodged in:-

State Herbarium of South Australia, Adelaide, S.A., Botanic Museum and Herbarium, Brisbane Qd and Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry, Canberra, A.C.T.

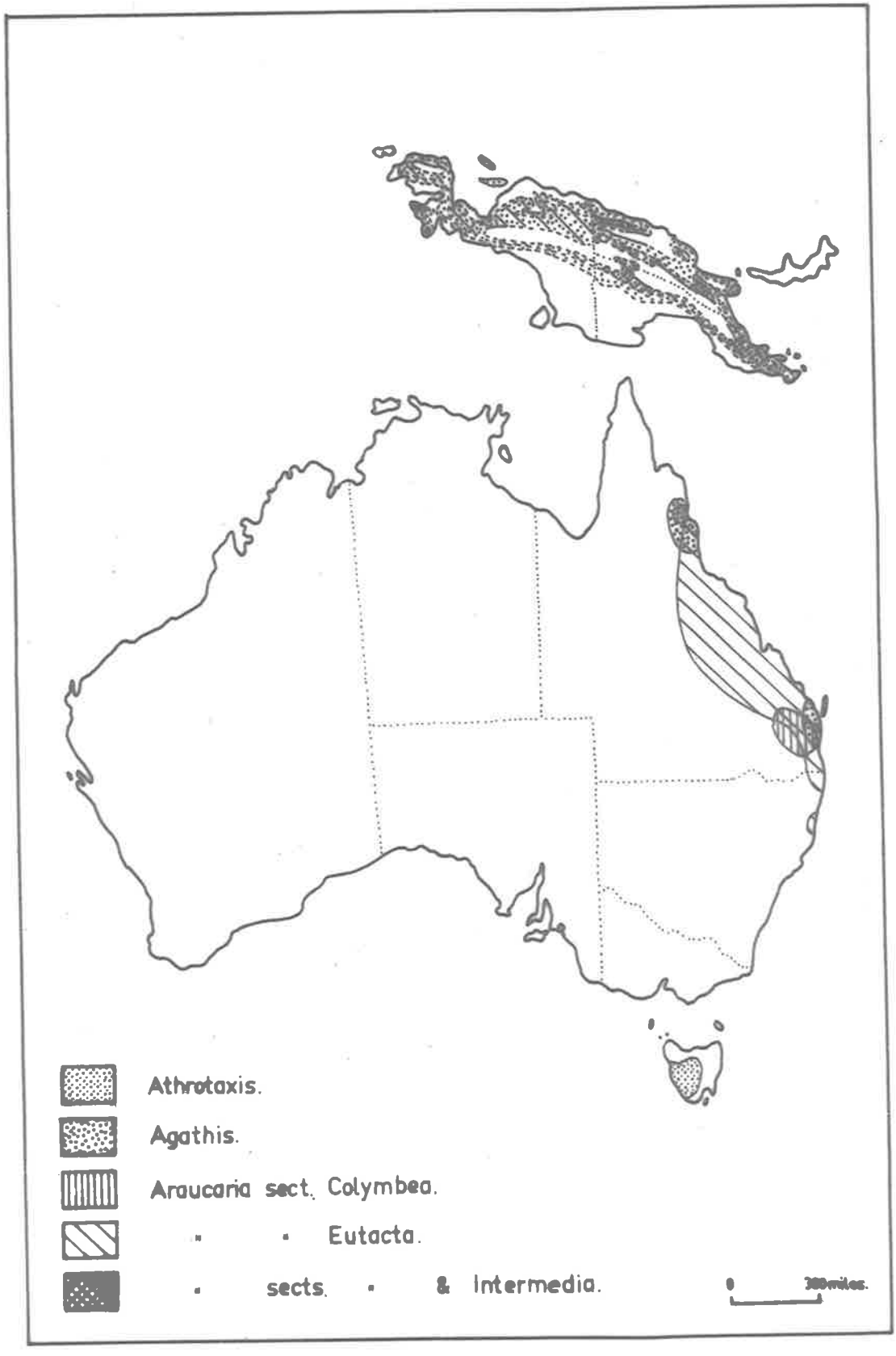

Athrotaxis.
Agathis.
Araucaria sect. Colymbea.
Eutacta.
sects. & Intermedia.
0
300miles.

Figure 3

Maps showing the distribution of the genera *Dacrydium*, *Microcachrys*, *Microstrobos* and *Phyllocladus* in Australia and New Guinea.

The altitudinal ranges of *Dacrydium* and *Phyllocladus* recorded by Womersley (unpublished data 1968) have been used in the construction of their distributional boundaries for New Guinea. Dashed lines indicate that the position of the boundary is uncertain. Full lines have been used only where the presence of the genus has been confirmed by the localities on herbarium specimens studied by the author.

? indicates that no specimens known to the author have been collected from the area.

Sources of reference used in the compilation of these maps:-

Curtis 1956; Forestry and Timber Bureau 1962 and Womersley unpublished data 1968.

Localities on herbarium specimens lodged in:-

State Herbarium of South Australia, Adelaide, S.A. and Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry, Canberra, A.C.T.

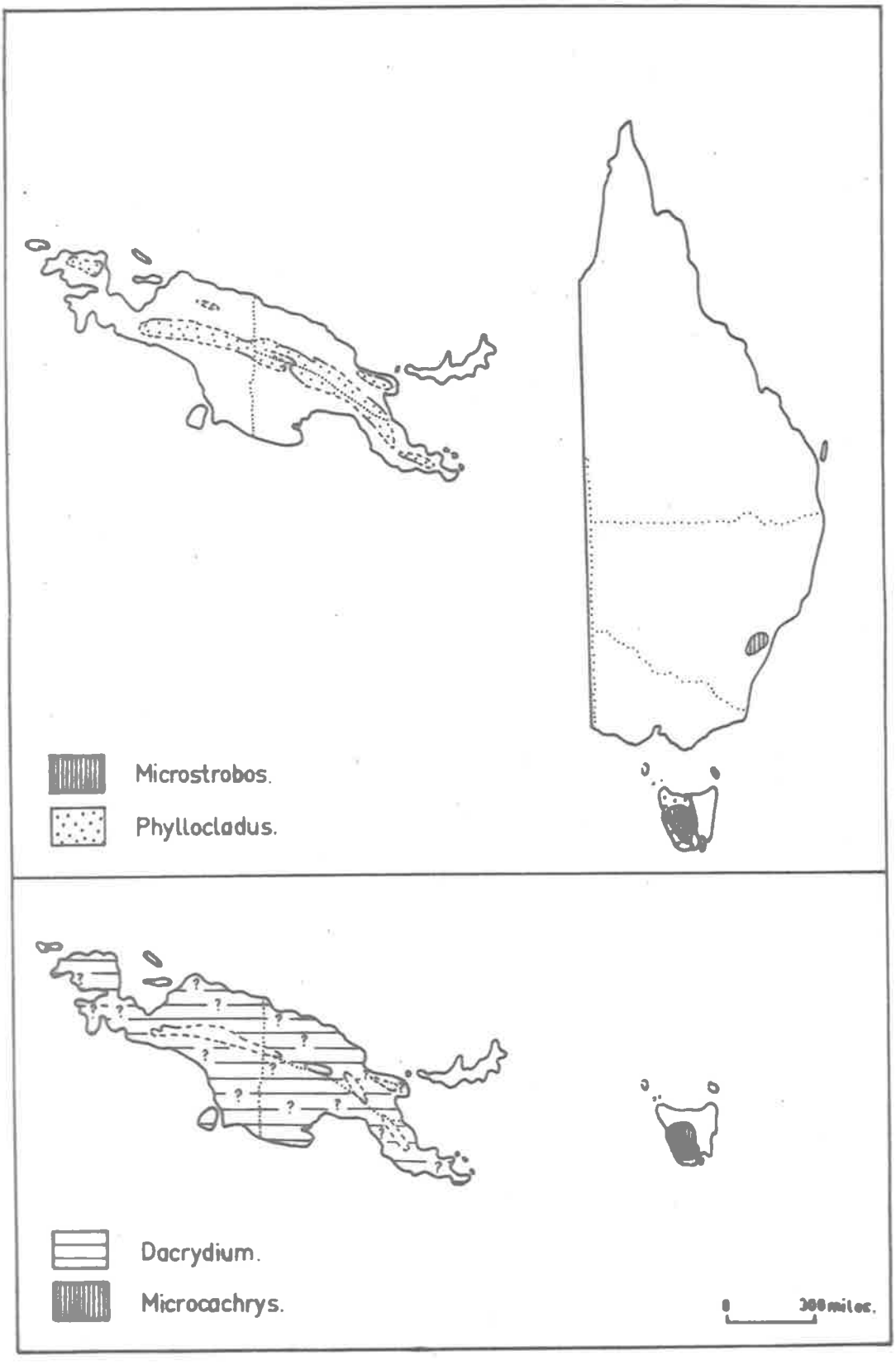

Microstrobos.
Phyllocladus.
Dacrydium.
Microcachrys.
0 300 miles.

Figure 4

A map showing the distribution of *Podocarpus* sect. *Stachycarpus* and *P.* sect. *Podocarpus* subsects B and D in Australia and New Guinea and the Australian distribution of *Podocarpus* sect. *Sundacarpus*.

? indicates that no specimens known to the author have been collected from the area.

Sources of reference used in the compilation of this map:-

Curtis 1956; Willis 1962; Womersley unpublished data 1968.

Localities on herbarium specimens lodged in:-

Western Australian Herbarium, Perth, W.A., State Herbarium of South Australia, Adelaide, S.A., Botanic Museum and Herbarium, Brisbane, Qd and Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry, Canberra, A.C.T.


0 300 miles
Podocarpus sect. Stachycarpus subsect. B Idioblastus.
" " Sundacarpus (For New Guinea distribution see Fig.5)
" " Podocarpus subsect. B
" " D
— specific boundary.
---- general "

Figure 5

Maps showing the distribution of *Podocarpus* sect. *Nageia*, *P.* sect. *Polypodiopsis*, *P.* sect. *Sundacarpus* and *P.* sect. *Dacrycarpus* in New Guinea.

The altitudinal ranges of these sections recorded by Womersley (unpublished data 1968) have been used in the construction of their distributional boundaries. Dashed lines indicate that the position of the boundary is uncertain. Full lines have been used only where the presence of the genus has been confirmed by the localities on herbarium specimens studied by the author.

? indicates that no specimens known to the author have been collected from the area.

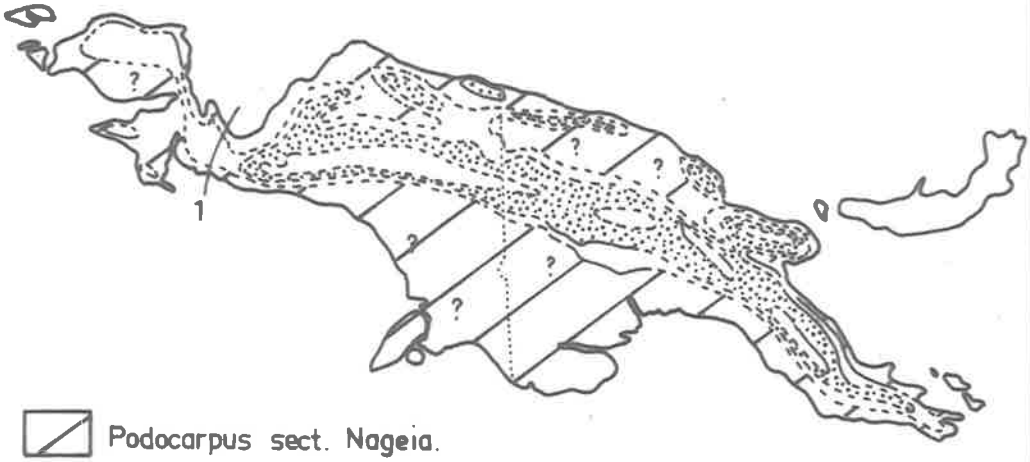
Sources of reference used in the compilation of these maps:-

Wasscher 1941 and Womersley unpublished data 1968.

Localities on herbarium specimens lodged in:-

State Herbarium of South Australia, Adelaide, S.A. and Commonwealth Scientific Industrial Research Organization, Division of Plant Industry, Canberra, A.C.T.

1 Western limit of P. sect. Polypodiopsis (Wasscher 1941).



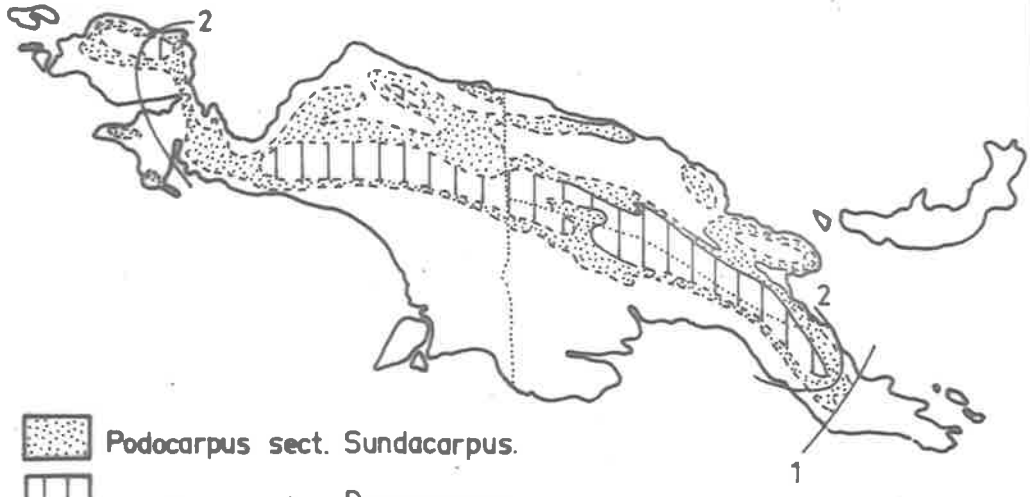
Podocarpus sect. Nageia.

" " Polypodiopsis.

0 300miles

1 Eastern limit of P. sect. Stachycarpus (Wasscher 1941).

2 Western and eastern limits of P. sect. Dacrycarpus (Wasscher 1941)



Podocarpus sect. Sundacarpus.

" " Dacrycarpus.

Figure 6A

Vegetative shoots bearing whorls of two, three and four leaves. Cross-sections of two successive whorls of leaves are superimposed to illustrate the number of orthostichies, namely, four, six and eight, and their position.

or, orthostichy; cr l, cross-section of leaf.

Figure 6B

A diagrammatic representation of the types of whorls found in the conifer shoots studied. Whorls of leaves arising at three successive nodes are represented. The angular displacement between successive whorls is indicated.

The term "quadricussate" has been adopted for leaves arranged in whorls of four (Type D).

——— , whorl 1

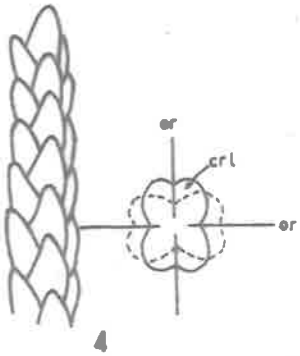
---- , whorl 2 • , axis

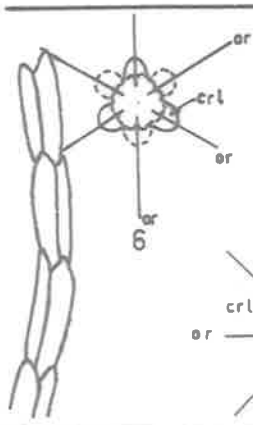
-.-.-, whorl 3

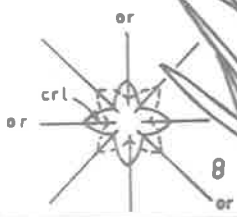
Illustrations of the examples given for each type may be found as follows:-

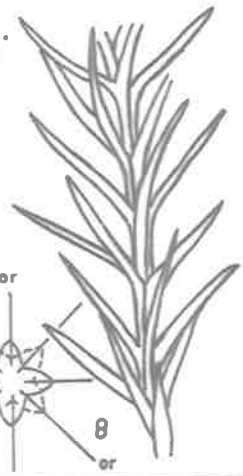
Type A - *Diselma archeri*, Plate 15H,I.
Type B - *Podocarpus vitiensis*, Plate 28E,F.
Type C - *Callitris canescens*, Plate 9F-H.
Type D - *Callitris macleayana*, Plate 11A,B.

WHORLED PHYLLOTAXIS.



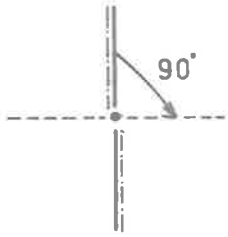






A

Type A



Decussate eg. Diselma archeri

No. of Orthostichies = 4

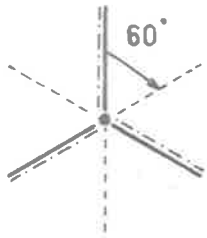
Type B

Decussate-distichous

eg. Podocarpus vitiensis

No. of Orthostichies = 4 (apparently 2)

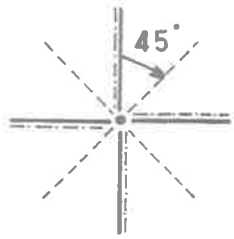
Type C



Tricussate eg. Callitris canescens

No. of Orthosthichies = 6

Type D



Quadricussate

eg. Callitris macleayana (juvenile)

No. of Orthostichies = 8

B

Figure 7

A. A vegetative shoot with two sets of contact parastichies or contact spirals indicated. Note that the margins of the sides of these leaves are in contact. At least two additional sets of spirals exist, but only a small part of the margins of leaves of these spirals are in contact, for example, the apices and bases of leaves. Such spirals have not been used to define the spiral system, that is, the phyllotactic pattern, of shoots.

B. The circumference of a shoot represented in one plane. The spiral system is expressed in terms of $(\underline{n} + \underline{m})$ where n is the number of left-hand spirals and m the number of right-hand ones. The path of a left-hand spiral, spiral one, is indicated. Section 1^2-1^3 is a continuation of 1-1^1 as indicated by the line 1^1-1^2. The number of spirals proceeding around the axis in a left-hand direction can be calculated thus:-
n = 1 + the number of spirals between the two sections 1-1^1 and 1^2-1^3 of the path of spiral one.
In this figure n = 3.
Similarly, if the path of spiral two (a right-hand spiral) is considered, m = 3.
The spiral system of this figure is $(\underline{3} + \underline{3})$; the number of both left-hand and right-hand contact spirals is 3.

C,D. Scaled drawings of spiral systems $(\underline{2} + \underline{3})$ and $(\underline{5} + \underline{3})$ taken from plasticine impressions of the circumference of shoots of *Athrotaxis cupressoides* and *Dacrydium novo-guineense*, respectively.
Scale:- Leaf-length = 1.2 cm.

SPIRAL PHYLLOTAXIS

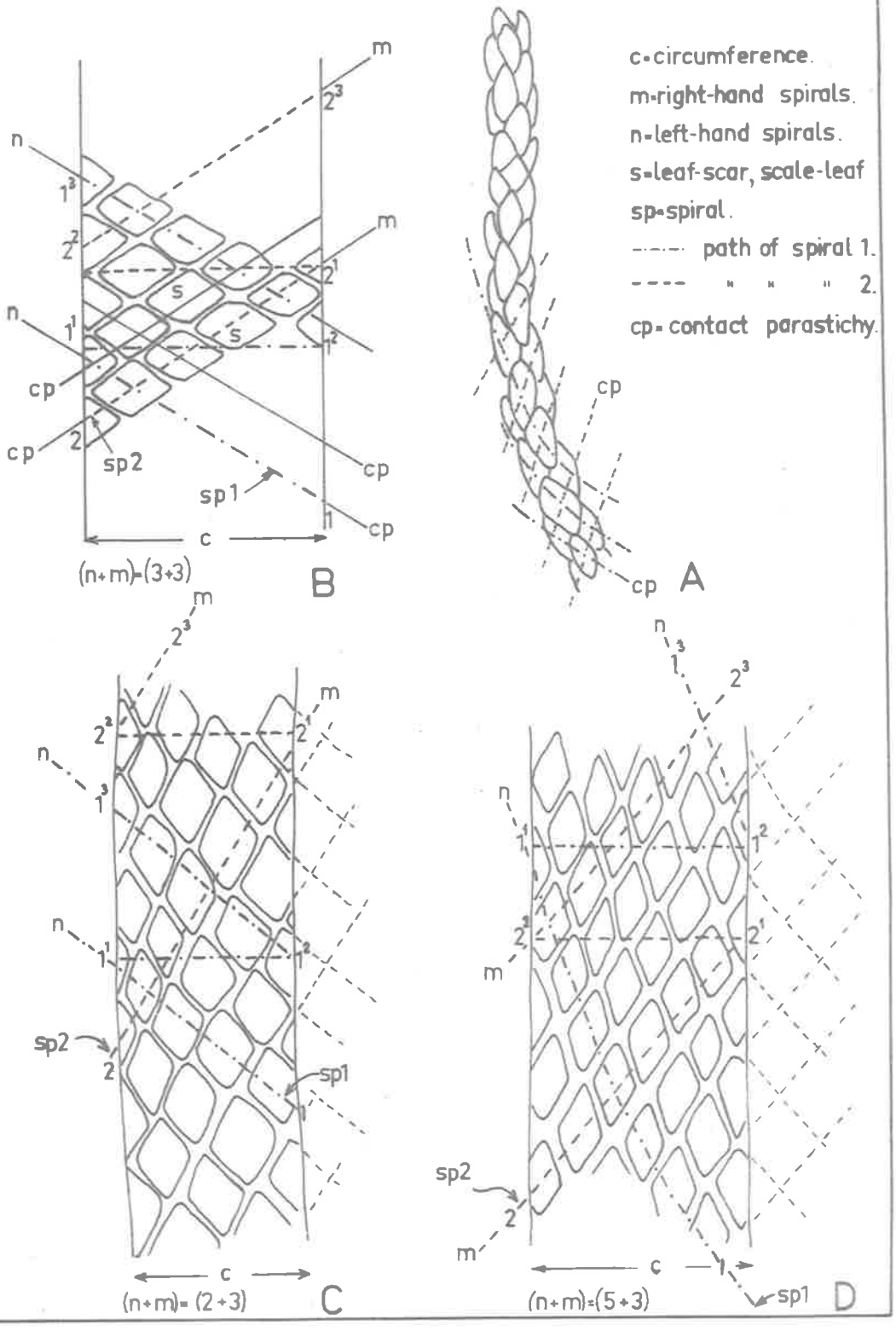


Figure 8

A. A sketch of a shoot to illustrate the effect of variation in internodal length on spiral phyllotaxis. Pseudowhorls of seven closely inserted leaves are separated by three much longer internodes. This pattern of insertion is common for many species of *Podocarpus*, for example, *P.thevetiifolius* (Plate 28C).

p, pseudowhorl; li, long internode.

B. A planar presentation of a whorl of cleared leaves of *Callitris canescens* (mature foliage form) showing the vascular pattern. Only the distal half of the adnate bases of leaves are shown.

Leaf-traces arise approximately mid-way between the "insertion position" and the basal angle. This pattern of vascularization is found in the leaves of other genera, for example, in those of *Athrotaxis* and *Diselma*.

FP, free portion; AB, adnate base;
lf, leaf; cvs, central vascular strand;
lt, leaf-trace; ip, insertion position.

C. A sketch to illustrate how the relationship between the insertion position of the leaf and the plane of distichous flattening affects the amount of twisting of leaf-blades at their insertion.

Leaves three and four are inserted at right-angles to the plane of distichous flattening (parallel to the paper); they are more twisted at their insertion than leaves one and two which are inserted in the plane of distichous flattening.

D. The adaxial surface of leaves with spreading and incurved blades is frequently adnate to the axis near its insertion.

a, axis; ad s, adaxial surface;
ab s, abaxial surface; ip, insertion position.

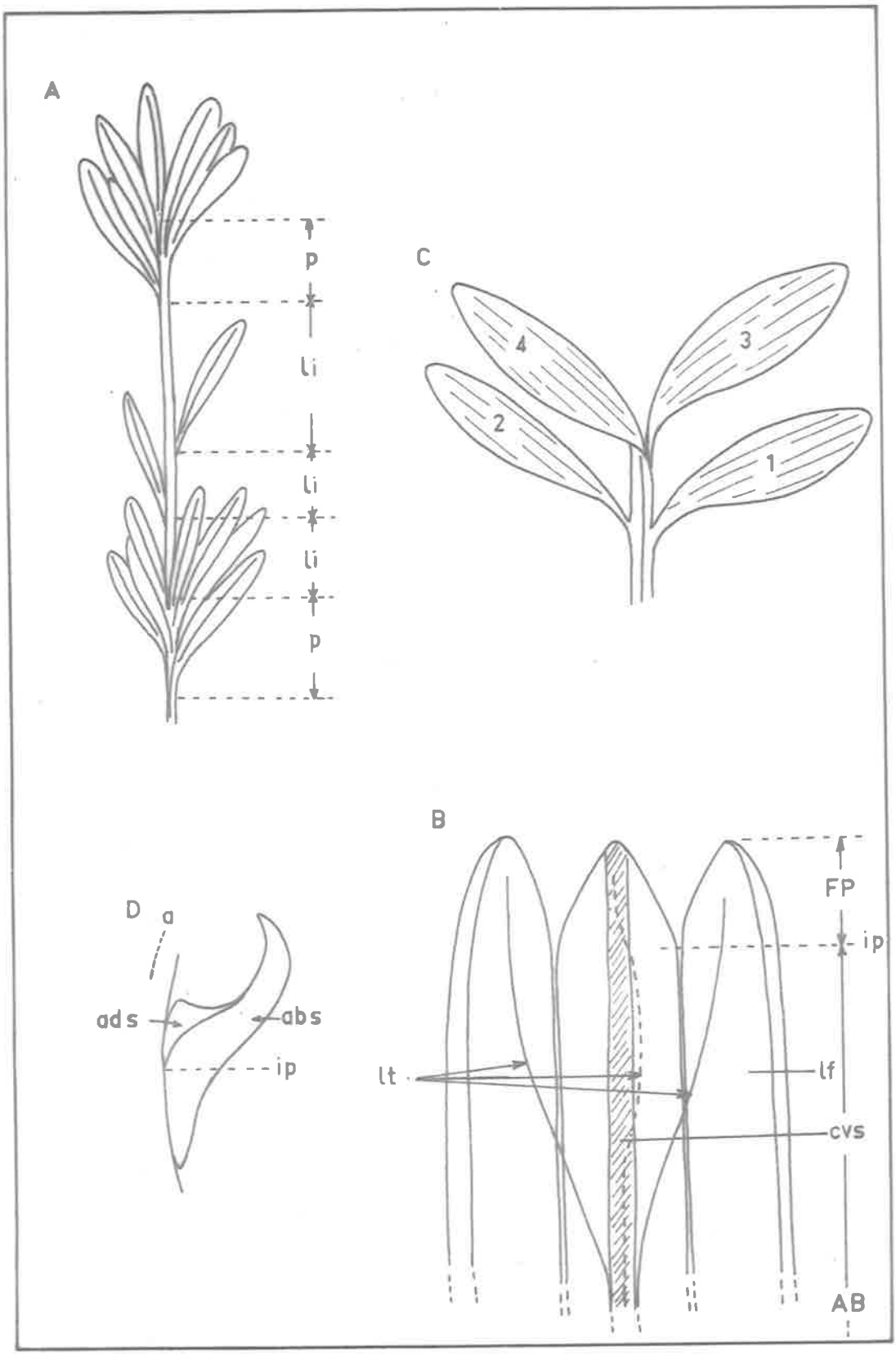
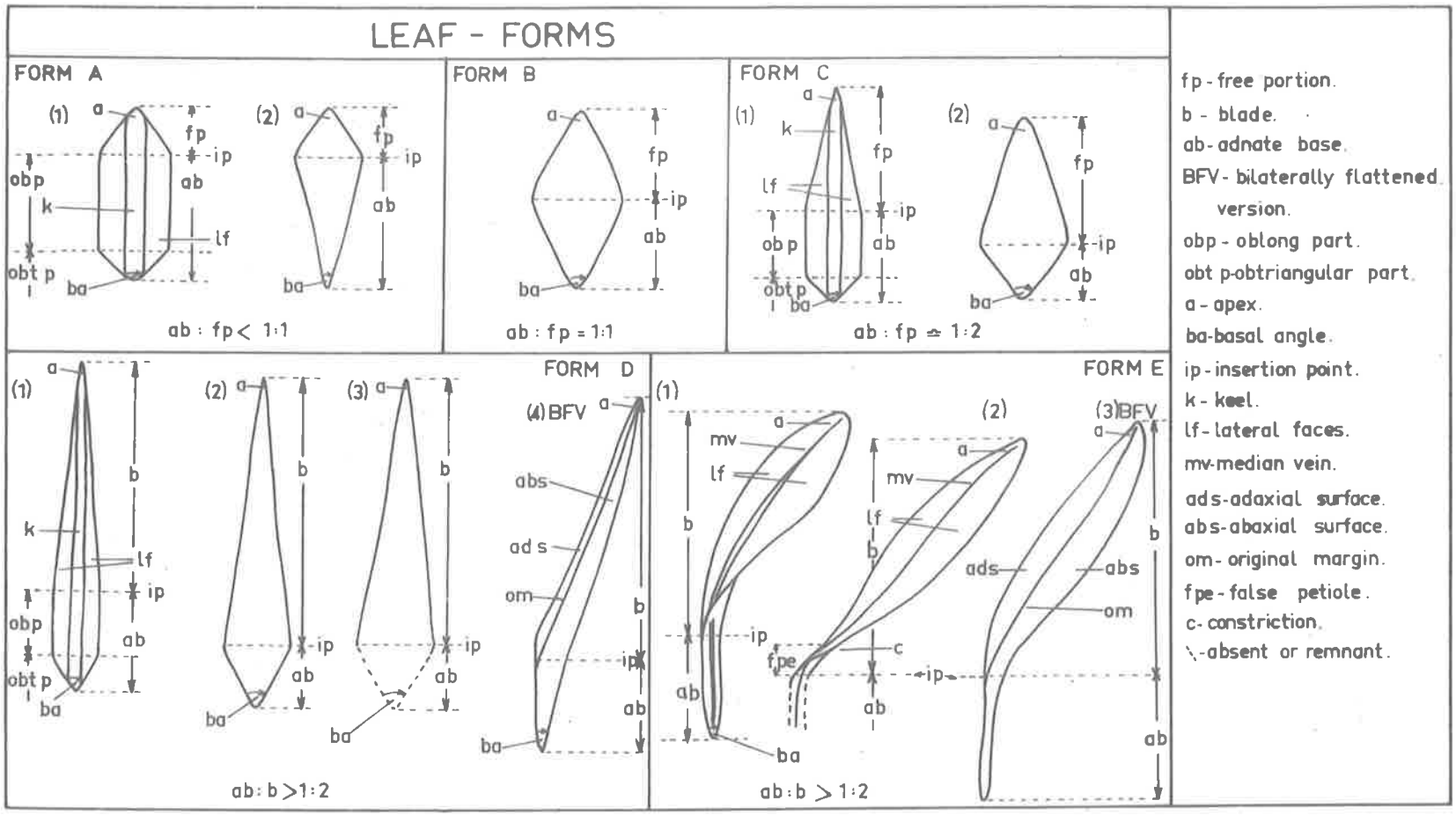

A
p
li
li
li
p
C
4
3
2
1
B
FP
ip
lt
lf
cvs
AB
D
a
ads
abs
ip

Figure 9

Diagrams of the five leaf-forms recognized for the leaves of the Australian and New Guinean conifer species. In forms A, C and D, two adnate base-shapes are common. A(1), C(1) and D(1) are characteristic of foliage forms of species of the genera *Actinostrobus* and *Callitris*; A(2), C(2) and D(2) and (3) are variants of form B and are the result of unequal development of the two parts of the leaf, namely, the adnate base and the free portion or blade. They occur in species of several genera, for example, *Araucaria* and *Dacrydium*. Form D(2) may become bilaterally flattened. This results in D(4) which characterizes the leaves of the juvenile foliage form of *Araucaria cunninghamii* (Plate 6A). In form E the free part becomes dominant and forms a blade. Leaves of this form may be either bifacially (E(1) and (2)) or bilaterally (E(3)) flattened. Towards their insertion bifacially flattened blades may become constricted into a "false" petiole (E(2)).

LEAF - FORMS



fp - free portion.
b - blade.
ab - adnate base.
BFV - bilaterally flattened version.
obp - oblong part.
obt p - obtriangular part.
a - apex.
ba - basal angle.
ip - insertion point.
k - keel.
lf - lateral faces.
mv - median vein.
ads - adaxial surface.
abs - abaxial surface.
om - original margin.
fpe - false petiole.
c - constriction.
\- absent or remnant.

Figure 10A

Diagrams of leaves to illustrate terms and phrases used to describe the relationship between the free portion or blade of the leaf and the axis. The variation in expression of this relationship is classed in three groups, namely, A, B and C. Changes in the form of expression occur within single foliage forms or between the several foliage forms of a species. These changes may be confined within one of the three groups or they may straddle the boundaries between the groups. These changes, or gradations, are indicated and examples to illustrate them are as follows:-

1. *Araucaria cunninghamii* - within the juvenile foliage form, Plate 6A,B, Fig.20.
2. *Dacrydium elatum* and *D.novo-guineense* - between the foliage forms treated in Descriptions 1 and 3, Plates 13E,F; 14B,C, Fig.22.
3. *Callitris macleayana* - between the mature and transitional foliage forms, Plate 28G, Fig.18.
4. *Callitris macleayana* - between the transitional and juvenile foliage forms, Plate 28G, Fig.18.
5. *Araucaria cunninghamii* - between the juvenile and mature foliage forms, Plate 6B,D,E, Fig.20.

Figure 10B

Cross-sections of leaves showing the relationship between the leaf-surfaces and the axis for non-flattened and flattened leaves. Examples:-

Non-flattened:

Bifacial - *Callitris macleayana* - leaf-blades of the juvenile foliage form, Plate 11A,B.

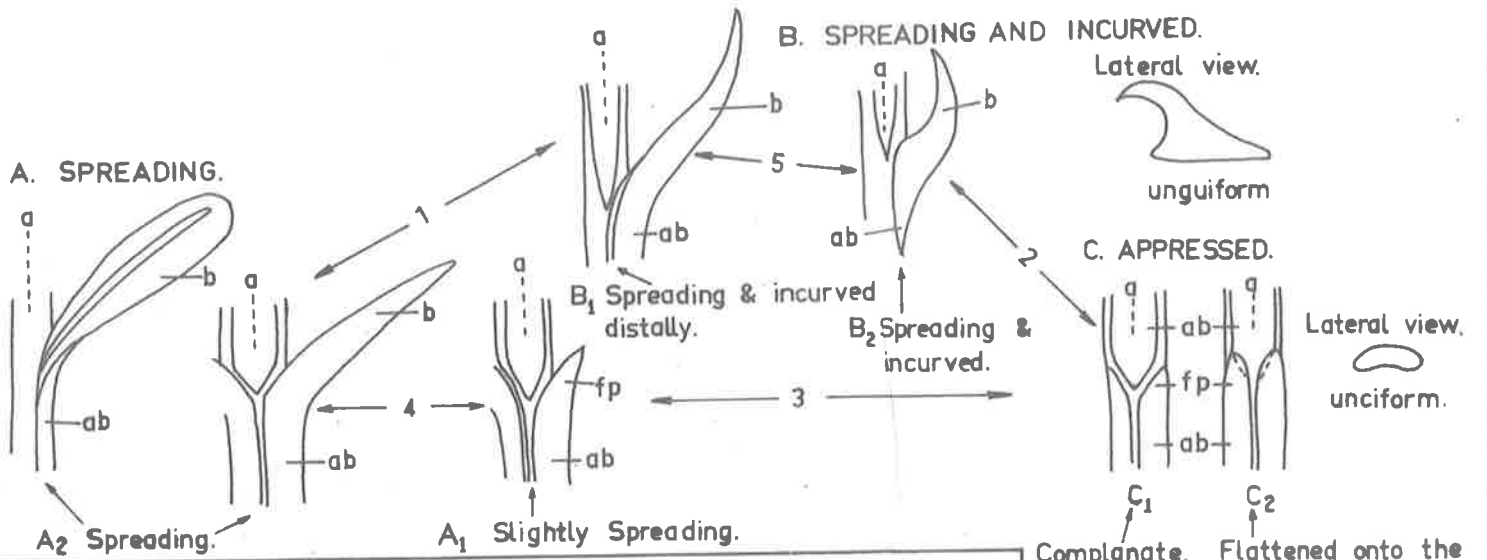
Flattened:

Bifacially flattened - *Podocarpus alpinus* - leaf-blades of the mature foliage form, Plate 21D.

Tetragonal - *Podocarpus* sect. *Dacrycarpus* - leaf-blades of the foliage form treated in Description 5, Plate 25A,B.

Bilaterally flattened - *Araucaria cunninghamii* - leaf-blades of the juvenile foliage form, Plate 6A,B.

THE RELATIONSHIP BETWEEN THE FREE PART OF THE LEAF AND THE AXIS.



a - axis. ⟷ lines along which sequences of gradation occur.
b - blade or free portion.
ab - adnate base. fp - free portion.

A

* axis.
• vascular trace.
u - upper surface.
l - lower " .
adaxial surface.
abaxial " .

FLATTENING

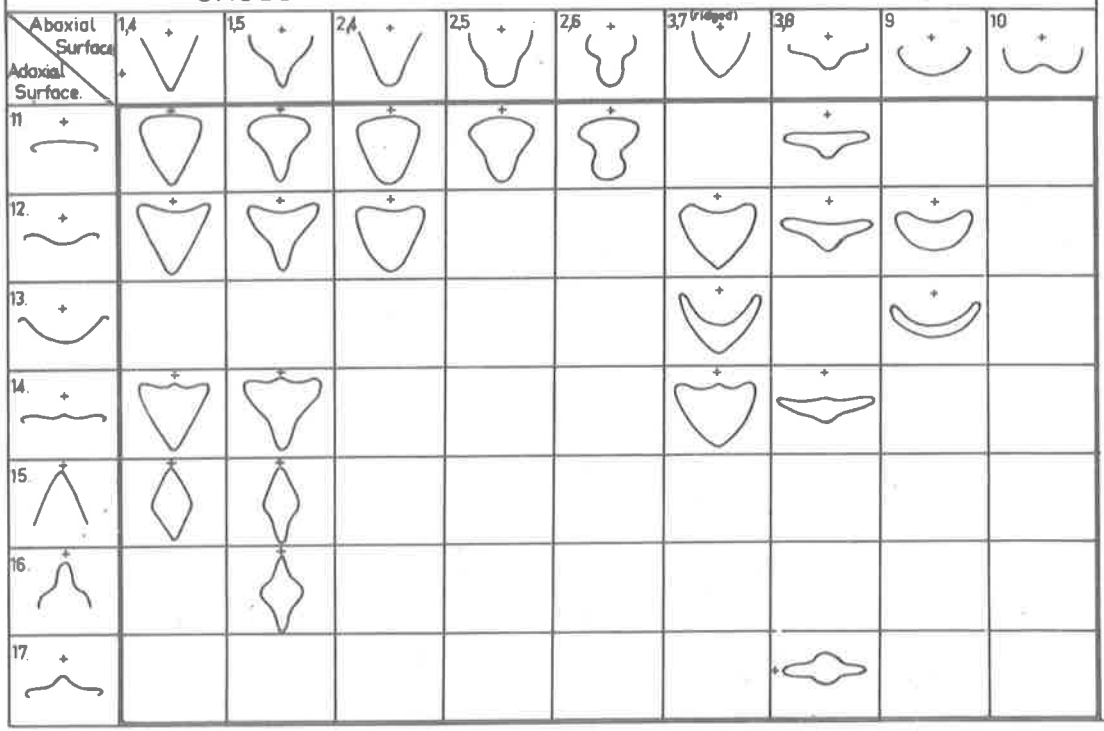
B

Figure 11

Cross-sections of non-flattened leaves observed in the foliage forms of the Australian and New Guinean conifer species.

The cross-sections of the adaxial and abaxial surfaces are given separately in the vertical and horizontal columns; the observed combinations of these surfaces are given in the body of the table. Each surface is described in terms of the keel or median ridge and the lateral faces, except where their combined expression results in a simple shape. Numbers have been assigned to the different types of keels and lateral faces and the observed combinations of them have been recorded. For example, in the horizontal column an abaxial surface with a cross-section of the type 1,4 has an acute keel (1) and lateral faces sloping at a constant gradient (4).
Simple shapes have been assigned a number also. For example, an abaxial surface of type 9 is convex.
The cross-sections of the free part of the leaf are described in terms of the adaxial and abaxial surfaces, for example, a leaf with a cross-section of the type [1,4.12] - 1,4 (abaxial surface-horizontal column) and 12 (adaxial surface-vertical column) - has an acute keel, lateral faces sloping at a constant gradient and a concave adaxial surface.

CROSS-SECTIONS OF NON-FLATTENED LEAVES.



Abaxial Surface

Surface keeled.

1 Keel acute.
2 " rounded.
3 " " & appearing as a ridge.
4 Lateral faces sloping at a constant gradient
5 " " " (but with the gradient reduced towards the margins &/or slightly concave or concave).
6 Lateral faces concave & extending under the keel.
7 " " convex.
8 " " planar or almost planar.

Surface not keeled

9 Surface convex in cross section.
10 " grooved medially.

Adaxial Surface

Surface not keeled.

11 Surface planar or slightly convex.
12 " concave.
13 " deeply concave.
14 " ridged.

Surface keeled,

15 – as for abaxial surface numbers 1,4.
16 – " " " " " 1,5.
17 – " " " " " 3,8.

+ axis.

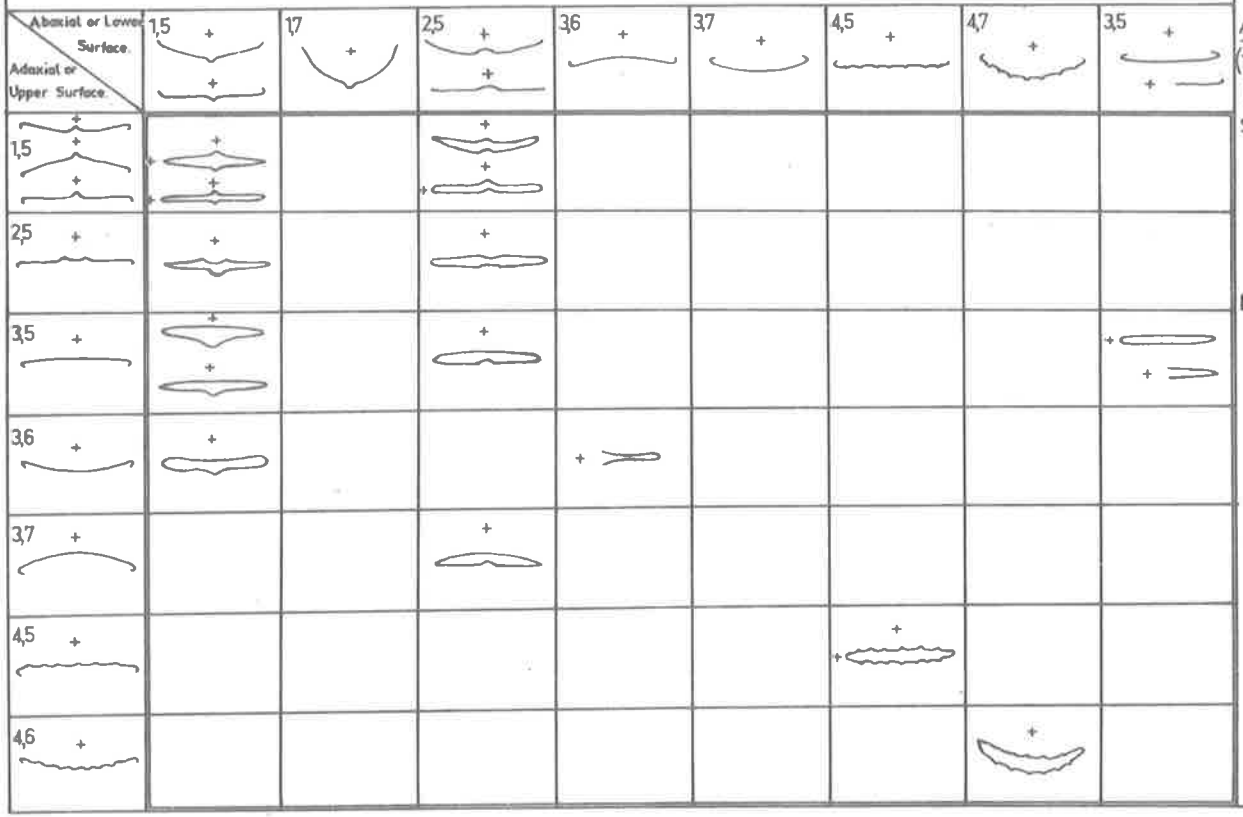
Figure 12

Cross-sections of flattened leaves observed in the foliage forms of the Australian and New Guinean conifer species.

Leaf-surfaces are described in terms of a single vein (or many veins) and lateral faces. For an explanation of the arrangement and use of the table see Figure 11.

Placement of the axis at the side of the cross-section either instead of above it as in 3,6.3,6, or as an additional axis as in 1,5.1,5, indicates that the cross-section is for bilaterally flattened leaves or for both bilaterally and bifacially flattened leaves.

CROSS-SECTIONS OF FLATTENED LEAVES



Abaxial & Adaxial Surfaces.
(Termed Lower & Upper Surfaces if leaves bilaterally flattened.)

Surfaces.
- Single veined.
  - 1. Median vein as a ridge.
  - 2. " " impressed.
  - 3. " " not visible.
- 4. Multi-veined.

Lateral faces of surfaces.
- 5. Planar or sloping.
- 6. Concave.
- 7. Convex.
- + Axis.

Figure 13A

Diagrams of the leaf-shapes studied with the location of length and breadth measurements indicated.

AB, adnate base; FP, free portion; B, blade; AL, apical lobe; Ob Pt, oblong part; Obt Pt, obtriangular part; c, cladode; l, length; b, breadth.

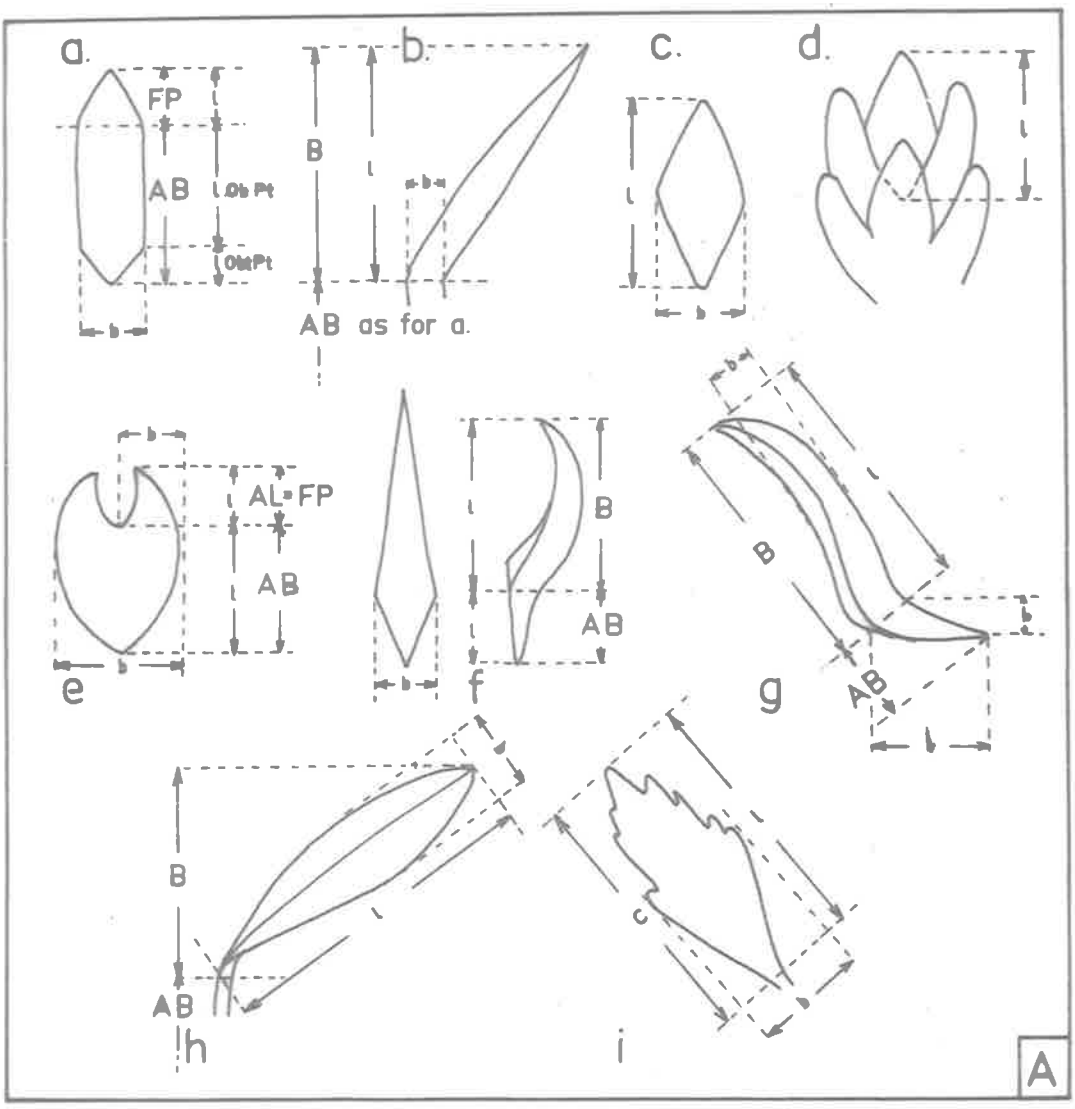
The following examples are of foliage forms characterized by leaves of the specified shape:-

a. *Callitris baileyi* - mature foliage form, Plate 9C.
b. *Callitris baileyi* - juvenile foliage form, Plate 9A.
c,d. *Diselma archeri* - mature foliage form, Plate 15H.
e. *Papuacedrus* - marginal leaves, transitional foliage form, Plate 18B.
f. *Araucaria cunninghamii* - mature foliage form, Plate 6D.
g. *Araucaria cunninghamii* - juvenile foliage form, Plate 6A.
h. *Podocarpus alpinus* - mature foliage form, Plate 21D.
i. *Phyllocladus asplenii folius* - mature foliage form, Plate 20A.

Figure 13B

Sketches to show the method of measuring the apical and spreading angles using a Leitz SM-Pol microscope. The field of view of the microscope is illustrated. The angle prescribed by rotating the cross-hairs from position 1 to position 2 is the apical angle in a and the spreading angle in b. It can be read from the graduated stage.

ad s, adaxial surface; ab s, abaxial surface; ap, apex; lf, leaf; ch, cross-hairs.


a.
FP
AB
Ob Pt
Ob Pt
b
B
l
b
AB as for a.
c.
l
b
d.
l
e
b
AL=FP
AB
b
f
b
B
AB
g
b
B
l
AB
l
h
B
AB
l
i
c
A

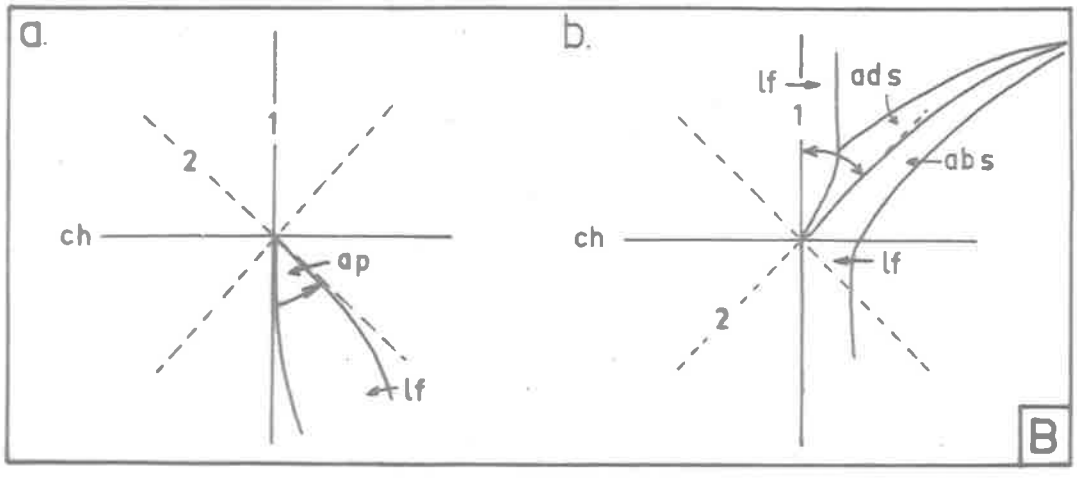

a.
1
2
ch
ap
lf
b.
lf
1
ads
abs
ch
lf
2
B

Figure 14

A dendrogram expressing the relationships between the seventy-seven foliage forms (seventy-nine entities) of the extant Australian and New Guinean conifer species. The method of presentation is after Sneath (1962).

The entity numbers and foliage forms they represent are given below. The age of the foliage form is placed in brackets after the binomial.

1. *Actinostrobus acuminatus* (juvenile)
2. " " (mature)
3. *A.arenarius* (transitional)
4. " " (mature)
5. *A.pyramidalis* (mature)
6. *Agathis* (immature and mature)
7. *Araucaria bidwillii* (juvenile)
8. " " (mature)
9. *A.cunninghamii* (juvenile)
10. " " (mature)
11. *A.hunsteinii* (immature)
12. " " (mature)
13. *Athrotaxis cupressoides* (mature)
14. *A.selaginoides* (immature)
15. " " (mature)
16. *Callitris baileyi* (juvenile)
17. " " (mature)
18. *C.canescens* (mature)
19. *C.columellaris* (mature)
20. *C.drummondii* (mature)
21. *C.endlicheri* (juvenile)
22. " " (transitional)
23. *C.endlicheri* (mature)
24. *C.macleayana* (juvenile)
25. " " (transitional)
26. " " (mature)
27. *C.muelleri* (juvenile)
28. " " (mature)
29. *C.oblonga* (mature)
30. *C.preissii* ssp. *murrayensis* (mature)
31. " " " *preissii* (juvenile)
32. " " " " (mature)
33. " " " *verrucosa* (mature)
34. *C.rhomboidea* (mature)
35. *C.roei* (mature)
36. *Dacrydium elatum-D.novo-guineense* (juvenile)
37. " " " (Description 1)
38. " " *D.novo-guineense* (Description 2)
39. " " *D.novo-guineense* (Description 3)

Figure 14, Cont.

40. *D.falciforme* (mature)
41. *D.franklinii* (mature)
42. *Diselma archeri* (mature)
43. *Microcachrys tetragona* (mature)
44. *Microstrobos fitzgeraldi* (mature)
45. *M.niphophilus* (mature)
46. *Papuacedrus* (juvenile)
47. " (transitional-facial leaves)
48. " (" -marginal leaves)
49. " (dimorphic mature-facial ")
50. " (" " marginal ")
51. " (homomorphic mature)
52. *Phyllocladus asplenifolius* (juvenile)
53. " " (mature)
54. " *hypophyllus* (juvenile)
55. " " (transitional)
56. " " (mature)
57. *Podocarpus alpinus* (mature)
58. *P. amarus* (mature)
59. *P.archboldii* (mature)
60. *P.blumei* (immature)
61. " " (mature)
62. *P.brassii* (mature)
63. *P.* sect. *Dacrycarpus* (Description 1)
64. " " " (Description 2)
65. " " " (Description 3)
66. " " " (Description 4)
67. " " " (Description 5)
68. *P.* sect. *Dacrycarpus* (Description 6)
69. *P.dispermus* (mature)
70. *P.drouynianus* (mature)
71. *P.elatus* (mature)
72. *P.idenburgensis* (mature)
73. *P.ladei* (mature)
74. *P.neriifolius* (mature)
75. *P.pilgeri* (mature)
76. *P.rumphii* (mature)
77. *P.spinulosus* (mature)
78. *P.thevetiifolius* (mature)
79. *P.vitiensis* (mature)

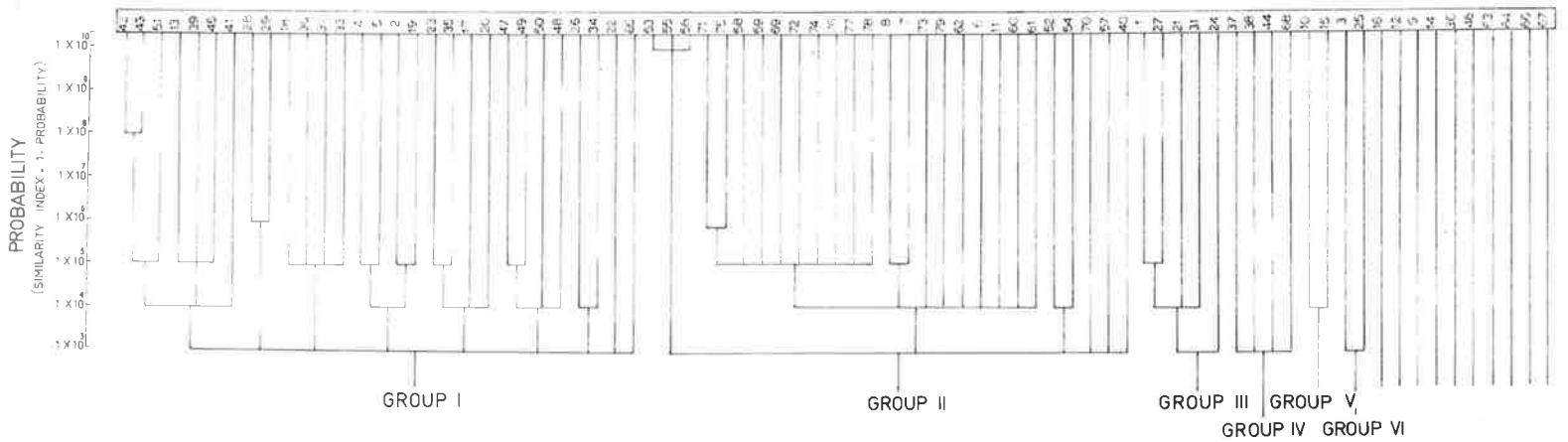

PROBABILITY
(SIMILARITY INDEX - 1 - PROBABILITY)
1 X 10⁻¹⁰
1 X 10⁻⁹
1 X 10⁻⁸
1 X 10⁻⁷
1 X 10⁻⁶
1 X 10⁻⁵
1 X 10⁻⁴
1 X 10⁻³
GROUP I
GROUP II
GROUP III
GROUP IV
GROUP V
GROUP VI

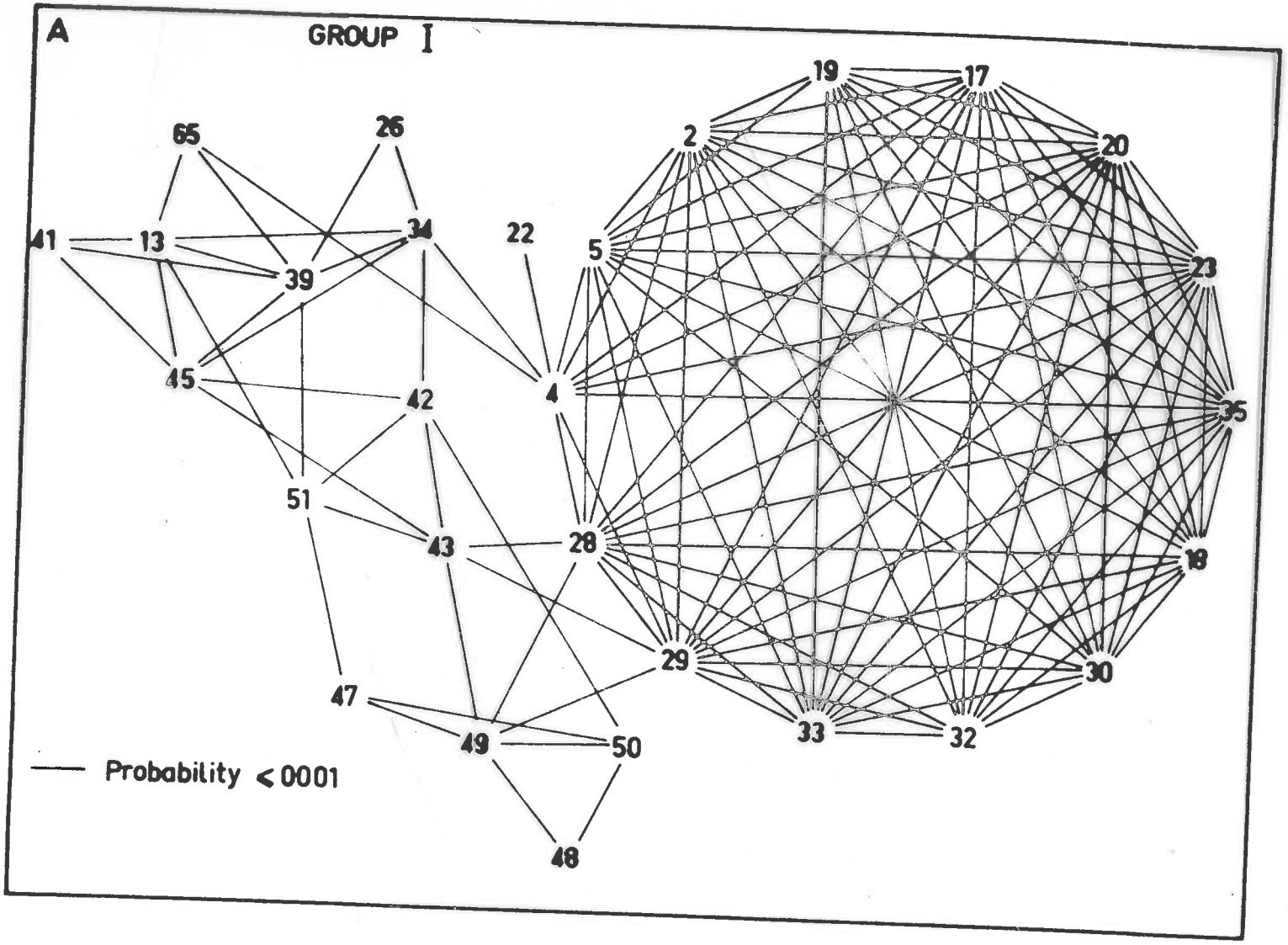
Figure 15A and B

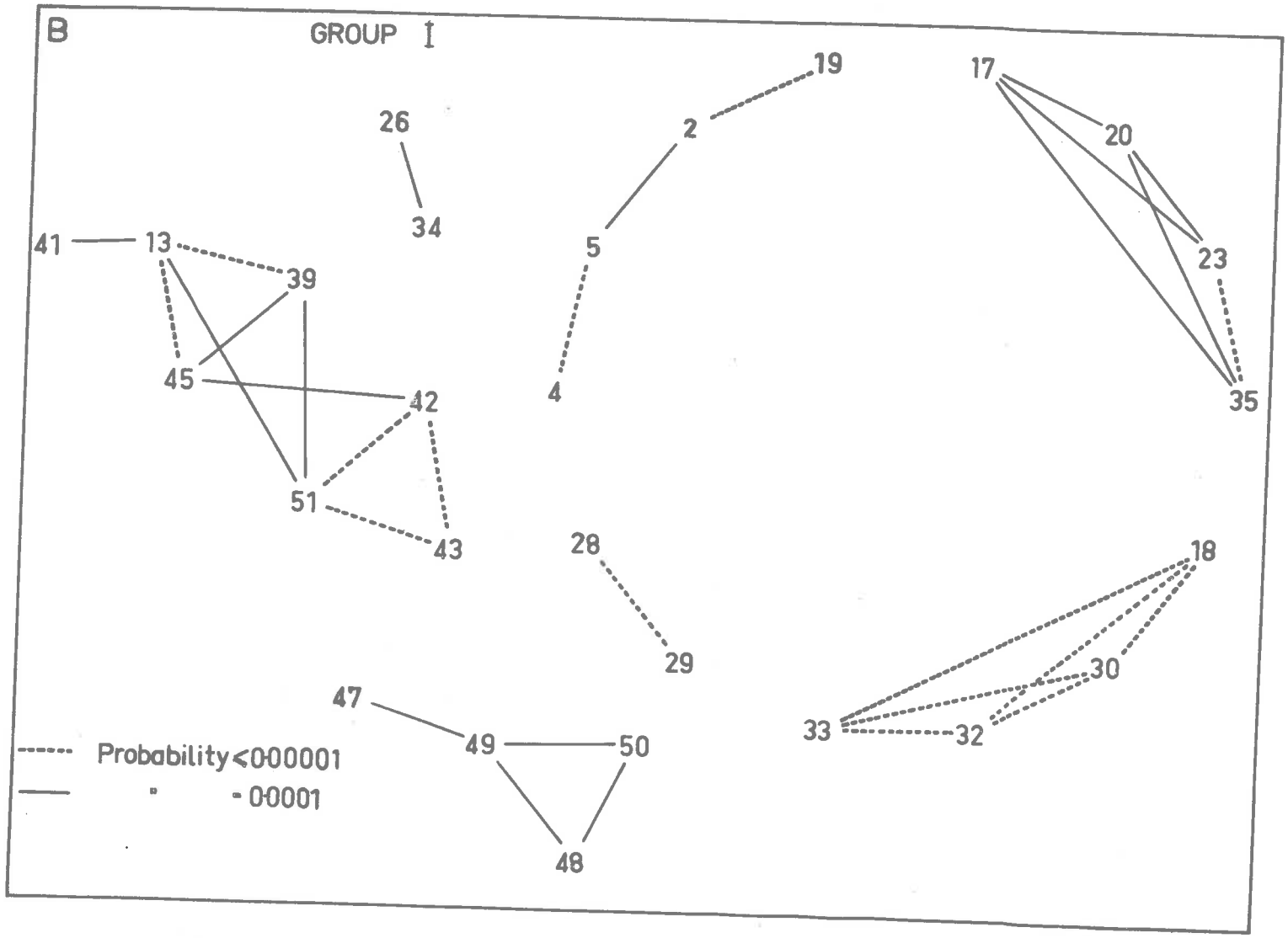
A graphical presentation of the relationships between the members of group I. The method of presentation is after Agnew (1961).

A. Probability values of one in a thousand and less have been used in the compilation of this figure.
B. Probability values of one in ten thousand and one in a hundred thousand are indicated in this figure.

The entity numbers and the foliage forms they represent are given below. The age of the foliage form is placed in brackets after the binomial.

2. *Actinostrobus acuminatus* (mature)
4. *A.arenarius* (mature)
5. *A.pyramidalis* (mature)
13. *Athrotaxis cupressoides* (mature)
17. *Callitris baileyi* (mature)
18. *C.canescens* (mature)
19. *C.columellaris* (mature)
20. *C.drummondii* (mature)
22. *C.endlicheri* (transitional)
23. *C.endlicheri* (mature)
26. *C.macleayana* (mature)
28. *C.muelleri* (mature)
29. *C.oblonga* (mature)
30. *C.preissii* ssp. *murrayensis* (mature)
32. *C.preissii* ssp. *preissii* (mature)
33. *C.preissii* ssp. *verrucosa* (mature)
34. *C.rhomboidea* (mature)
35. *C.roei* (mature)
39. *Dacrydium elatum* and *D.novo-guineense* (Description 3, Chapter V, p.103)
41. *D.franklinii* (mature)
42. *Diselma archeri* (mature)
43. *Microcachrys tetragona* (mature)
45. *Microstrobos niphophilus* (mature)
47. *Papuacedrus* (transitional - facial leaves
48. " (" - marginal leaves Chapter V, p.120)
49. *Papuacedrus* (mature - facial leaves
50. " (" - marginal leaves Chapter V, p.123)
51. *Papuacedrus* (mature - homomorphic foliage, Chapter V, p.124)
65. *Podocarpus* sect. *Dacrycarpus* (Description 3, Chapter V, p.148)


A
GROUP I
19
17
2
20
65
26
41
13
34
22
5
23
39
45
42
4
35
51
43
28
18
29
30
47
49
50
33
32
Probability < 0001
48


B
GROUP I
26
34
41
13
39
45
42
51
43
19
2
5
4
17
20
23
35
28
29
18
30
33
32
47
49
50
48
Probability <000001
- 00001

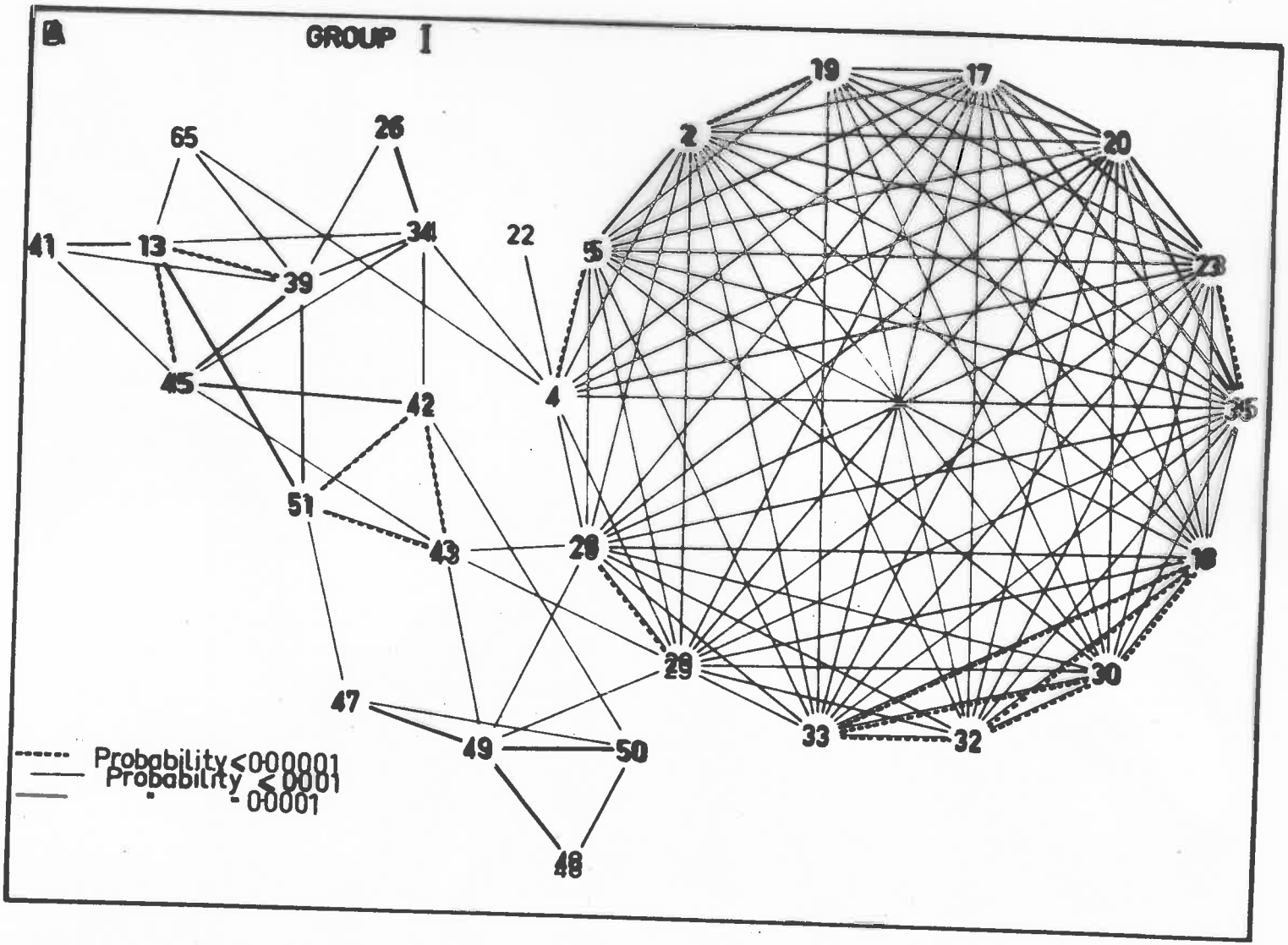

GROUP I
65
26
41
13
34
22
39
5
45
42
4
51
43
28
29
47
49
50
48
19
17
2
20
35
30
33
32
Probability < 000001
Probability < 0001
Probability < 001

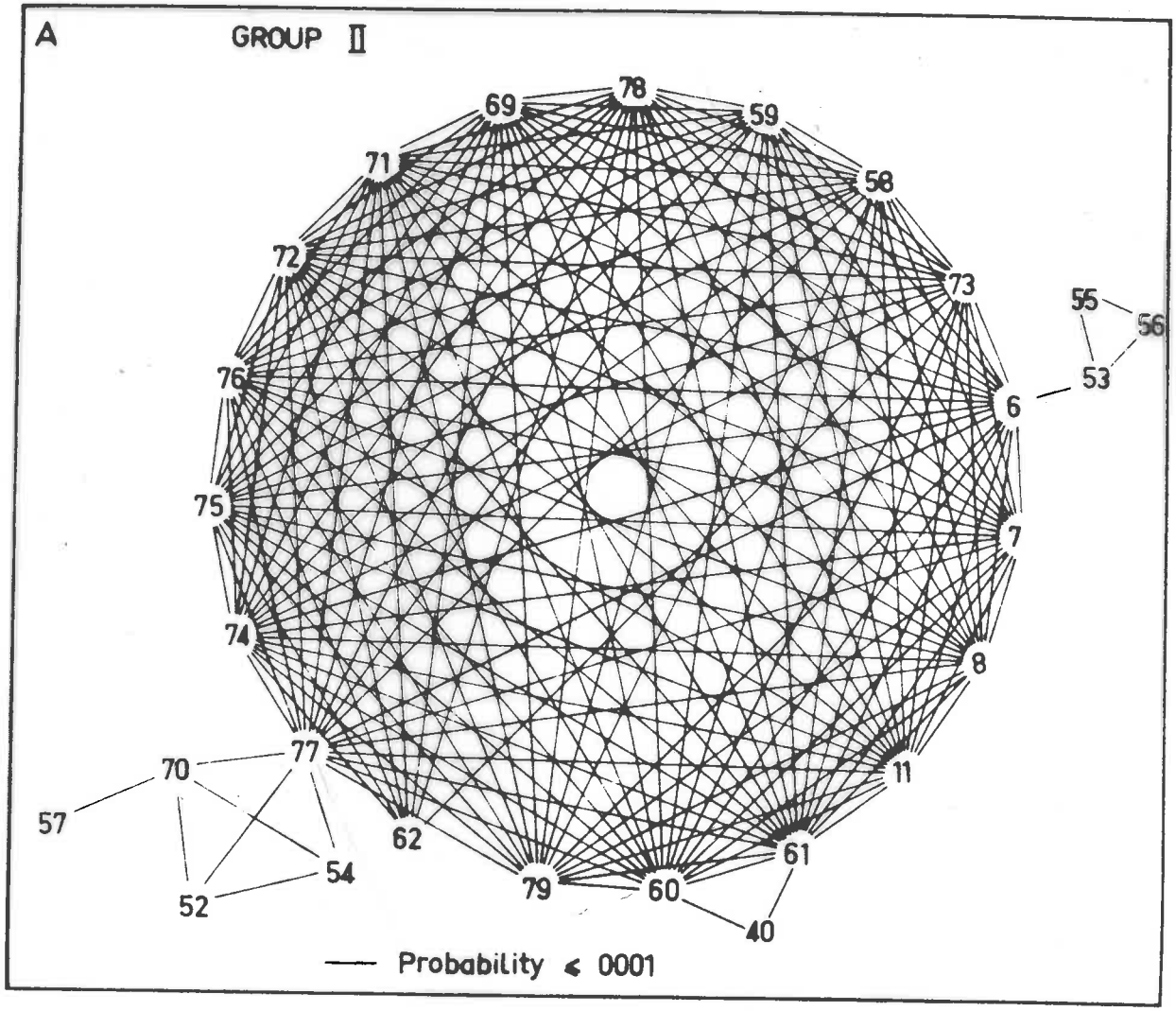
Figure 16A and B

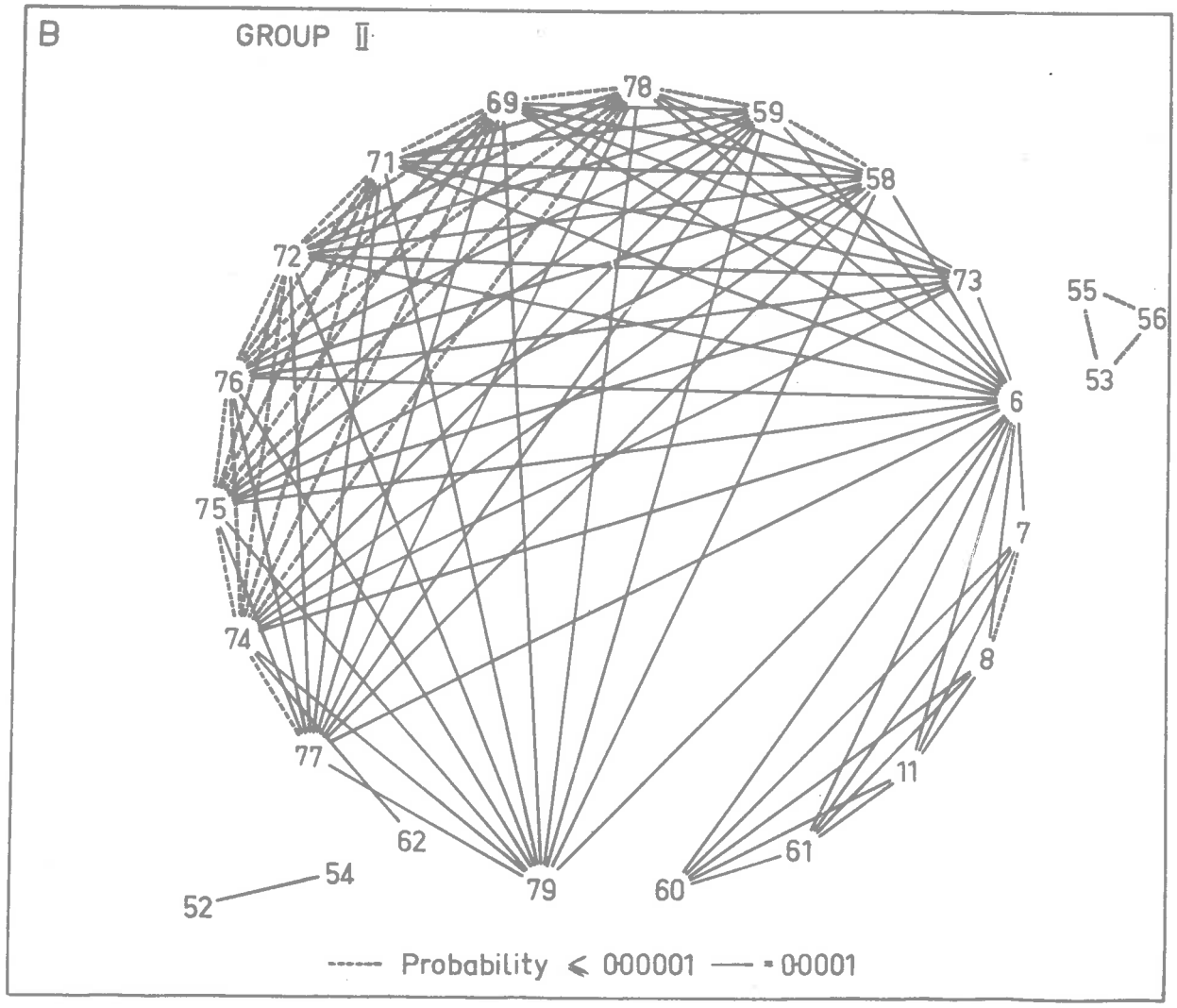
A graphical presentation of the relationships between the members of group II. The method of presentation is after Agnew (1961).

A. Probability values of one in a thousand and less have been used in the compilation of this figure.
B. Probability values of one in ten thousand and one in a hundred thousand are indicated in this figure.

The entity numbers and the foliage forms they represent are given below. The age of the foliage form is placed in brackets after the binomial.

6. *Agathis* (immature and mature)
7. *Araucaria bidwillii* (juvenile)
8. " " (mature)
11. *A.hunsteinii* (juvenile)
40. *Dacrydium falciforme* (mature)
52. *Phyllocladus asplenii folius* (juvenile)
53. " " (mature)
54. *P.hypophyllus* (juvenile)
55. " (transitional)
56. " (mature)
57. *Podocarpus alpinus* (mature)
58. *P.amarus* (mature)
59. *P.archboldii* (mature)
60. *P.blumei* (immature)
61. *P.blumei* (mature)
62. *P.brassii* (mature)
69. *P.dispermus* (mature)
70. *P.drouynianus* (mature)
71. *P.elatus* (mature)
72. *P.idenburgensis* (mature)
73. *P.ladei* (mature)
74. *P.neriifolius* (mature)
75. *P.pilgeri* (mature)
76. *P.rumphii* (mature)
77. *P.spinulosus* (mature)
78. *P.thevetiifolius* (mature)
79. *P.vitiensis* (mature)


A
GROUP II
78
69
59
71
58
72
73
55
56
76
53
6
75
7
74
8
77
70
11
57
62
61
54
79
60
52
40
Probability < 0001


B
GROUP II
78
69
59
71
58
72
73
55
56
53
76
6
75
7
74
8
77
11
62
61
54
52
79
60
------ Probability ≤ 0·00001 —— = 0·0001

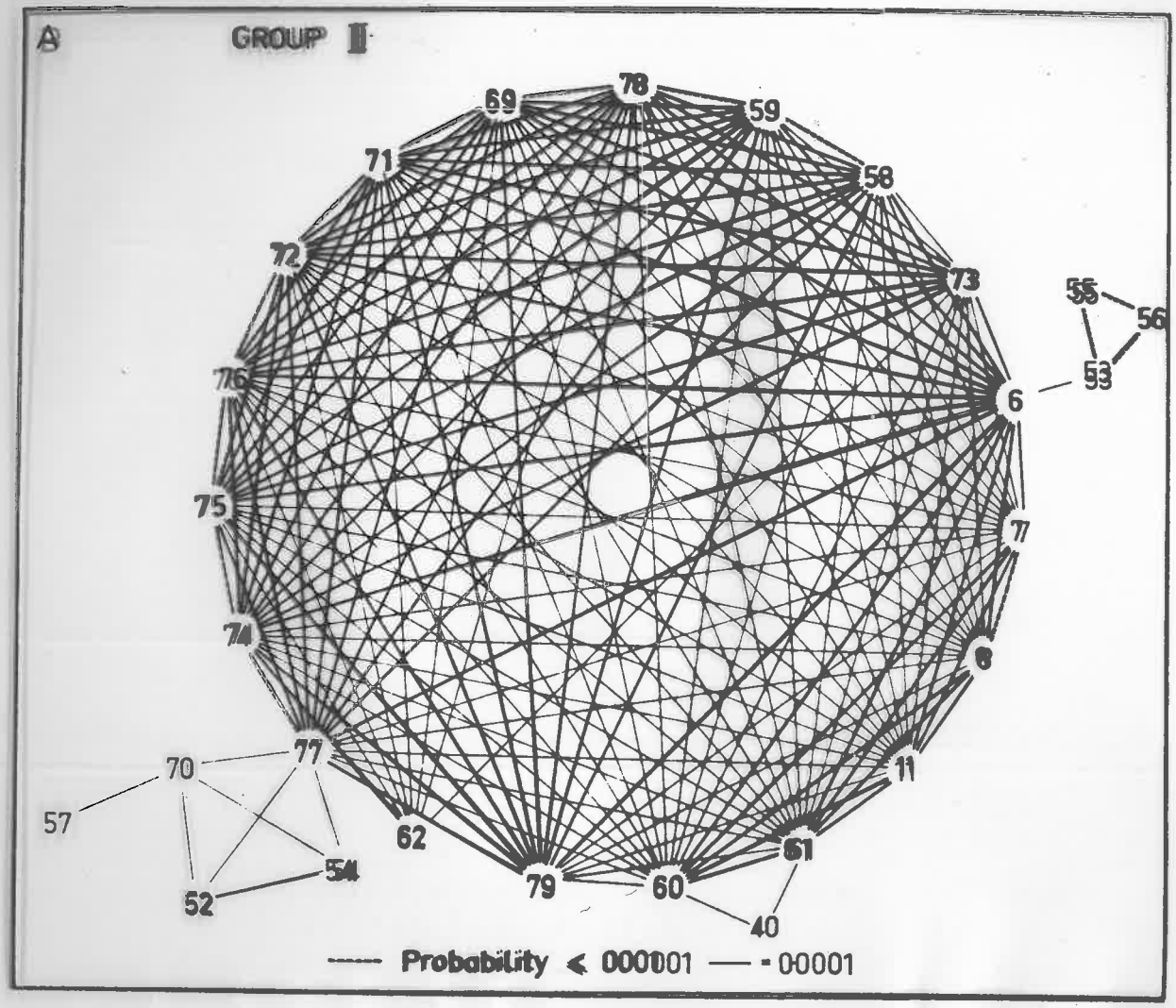

A
GROUP II
69
78
59
71
58
72
73
55
56
53
76
6
75
77
74
8
77
70
11
57
62
61
54
79
60
52
40
----- Probability ≤ 000001 —— - 00001

Figure 17

A graphical presentation of the relationships between the members of groups III to VI. The method of presentation is after Agnew (1961).

Probability values of one in a hundred thousand, one in ten thousand and one in a hundred are indicated.

The entity numbers and the foliage forms they represent are given below. The age of the foliage form is placed in brackets after the binomial.

1. *Actinostrobus acuminatus* (juvenile)
3. *A.arenarius* (transitional)
10. *Araucaria cunninghamii* (mature)
15. *Athrotaxis selaginoides* (mature)
21. *Callitris endlicheri* (juvenile)
24. *C. macleayana* (juvenile)
25. " " (transitional)
27. *C. muelleri* (juvenile)
31. *C.preissii* ssp. *preissii* (juvenile)
37. *Dacrydium elatum* and *D.novo-guineense* (Description 1, Chapter V, p.100)
38. *Dacrydium elatum* and *D.novo-guineense* (Description 2, Chapter V, p.102)
44. *Microstrobos fitzgeraldi* (mature)
68. *Podocarpus* sect. *Dacrycarpus* (Description 6, Chapter V, p.153)

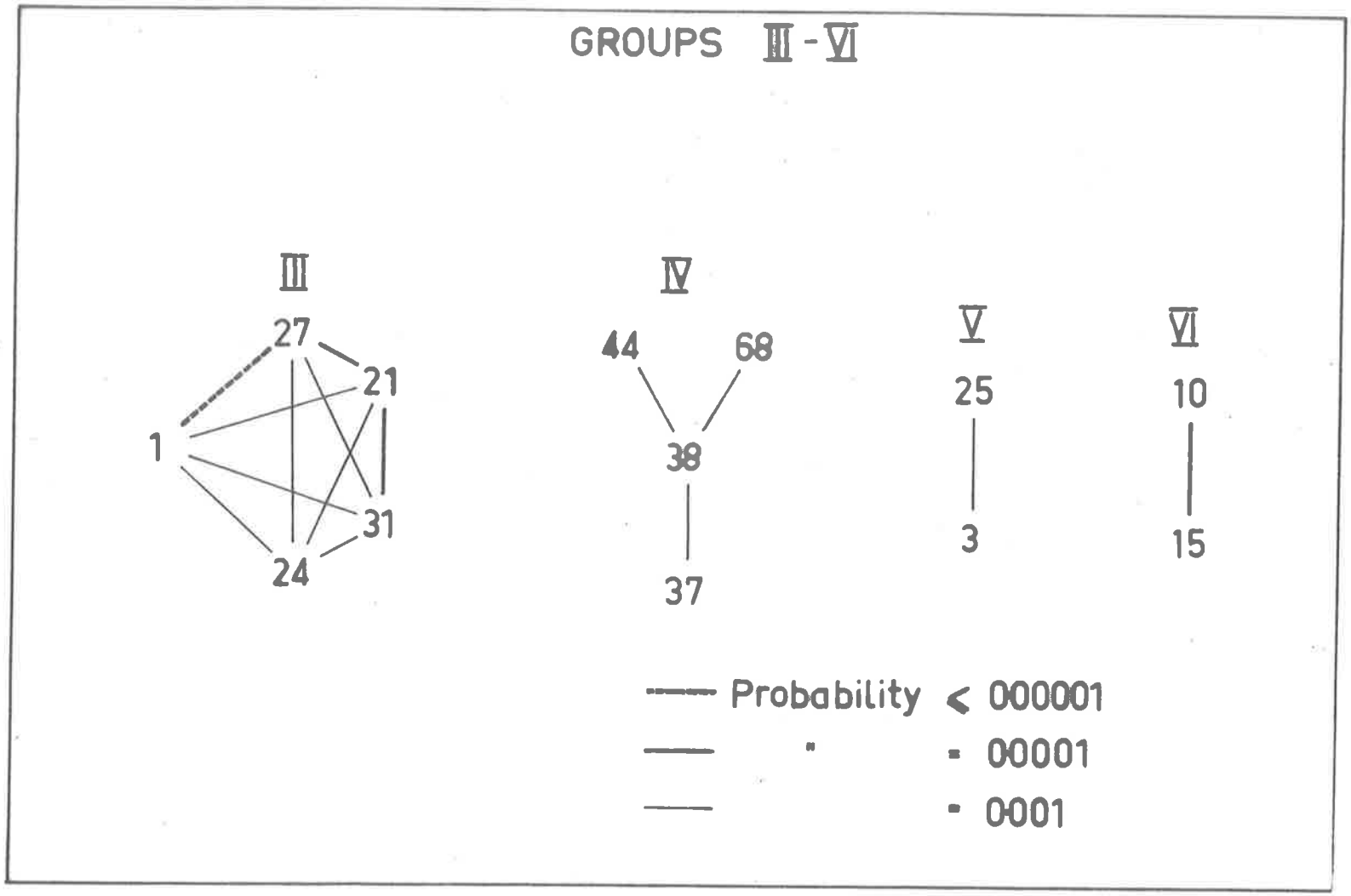
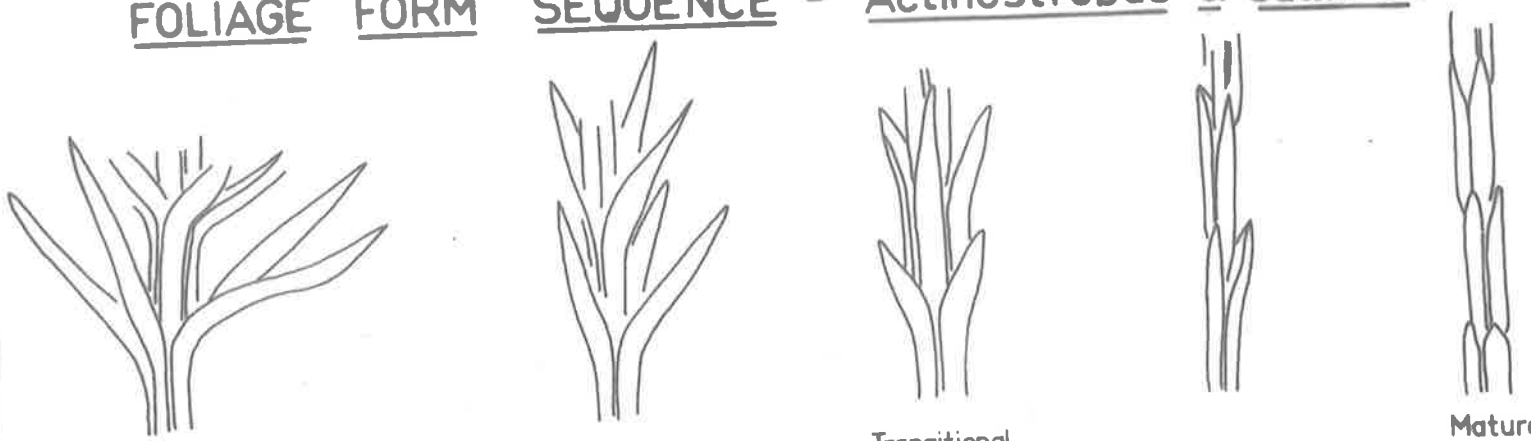

GROUPS III - VI
III
27
21
1
31
24
IV
44
68
38
37
V
25
3
VI
10
15
Probability < 000001
" = 00001
= 0001

Figure 18

A foliage form sequence for the genera *Actinostrobus* and *Callitris*.

The change of foliage form is not always unidirectional and towards the mature form; it differs for different species. Three patterns of change have been observed. In pattern 1 the double line indicates no gradation. In pattern 3 the broken lines indicate a reversal of the specified part of the sequence along the axis.

FOLIAGE FORM SEQUENCE - Actinostrobus & Callitris.



Juvenile

Transitional

Mature

Leaves quadricussate → tricussate →

Blade spreading — decreasing spreading angle → Free portion appressed

Adnate base : blade — " blade-length → Adnate base : free portion

≙ 1 : 3

≙ 3 : 1

Sequence patterns :-

1.

2.

3.

Figure 19

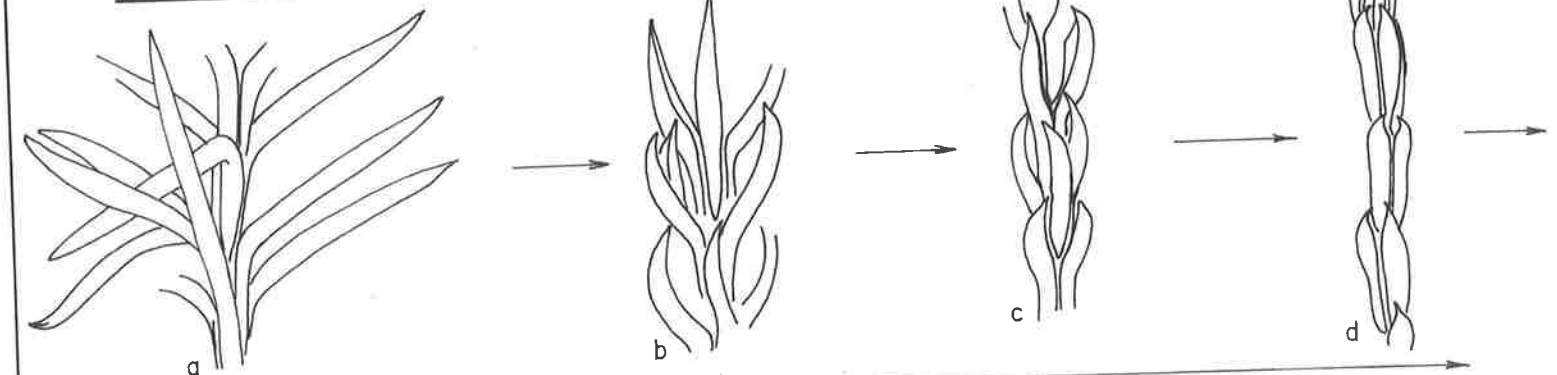
A foliage form sequence for *Callitris endlicheri*.

A. The sequence between the juvenile and transitional foliage forms. This part of the sequence is characterized by incurving of the free part of the leaf.

B. The sequence between the transitional and mature foliage forms. The incurved free portions of leaves of A,d gradually become flattened, that is, incurving of the free part decreases.

$\longrightarrow$, gradation between the forms.

FOLIAGE FORM SEQUENCE - Callitris endlicheri.

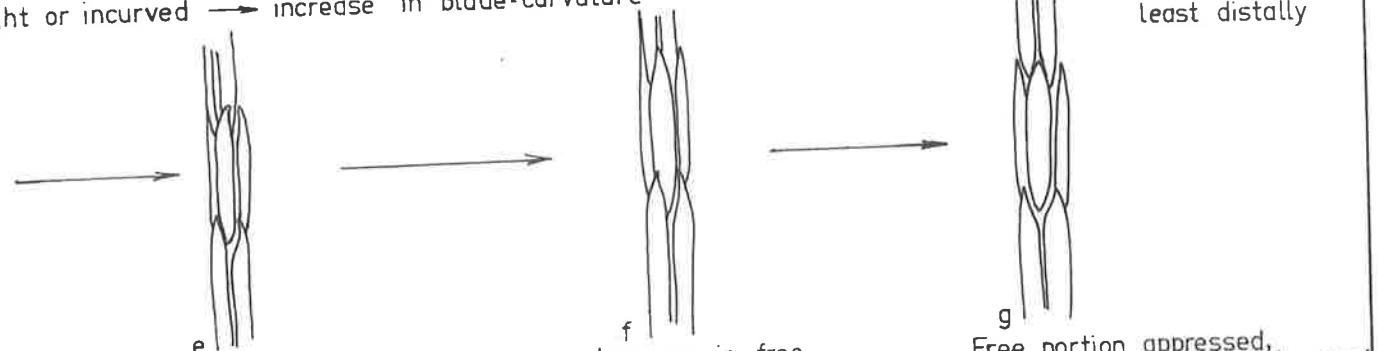


Phyllotaxis quadricussate → tricussate

Blade spreading → decrease in spreading angle → Free portion slightly spreading

→ decrease in blade length

Blade straight or incurved → increase in blade-curvature → Free portion incurved, at least distally



Free portion slightly incurved, complanate → decrease in free portion curvature → Free portion appressed, flattened onto the bases of subsequent leaves

Figure 20

A foliage form sequence for *Araucaria cunninghamii*

⟶ , gradation between the forms.

FOLIAGE FORM SEQUENCE – Araucaria cunninghamii.

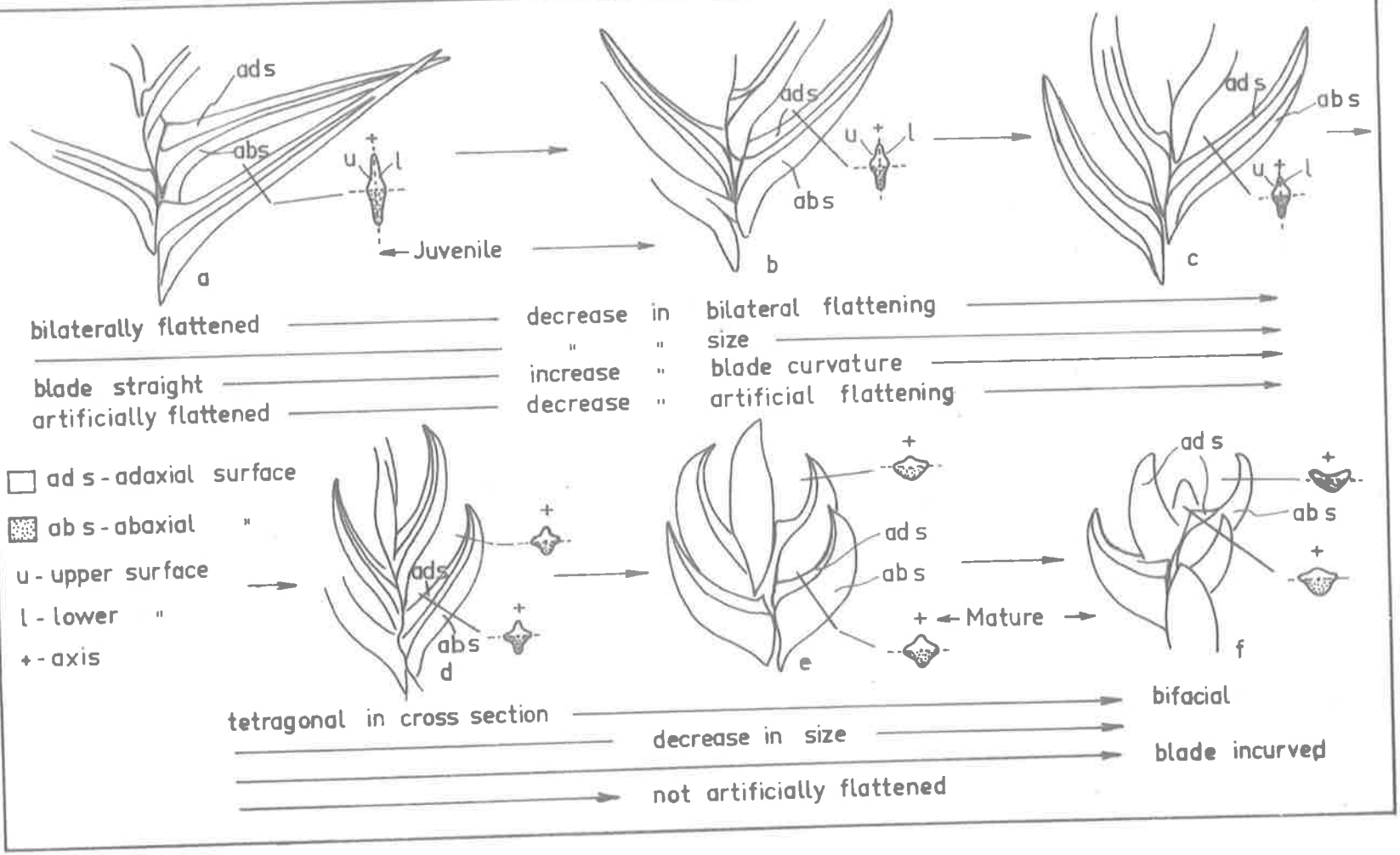
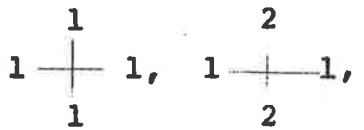


Figure 21

A foliage form sequence for *Papuacedrus* from the juvenile form (a) to the homomorphic mature form (g_1). The homomorphic form is placed in square brackets because it has been observed only on young axes; form g, the dimorphic mature form, is the usual mature form.



represent the amount of flattening of the axis. The length of the lines indicates the relative thickness of two successive whorls of leaves when the axis is viewed from above. 1 and 2 represent the leaves of the two successive whorls. In form a, a whorl of four leaves is represented.

⟶ , gradation between the forms.

FOLIAGE FORM SEQUENCE - Papuacedrus.

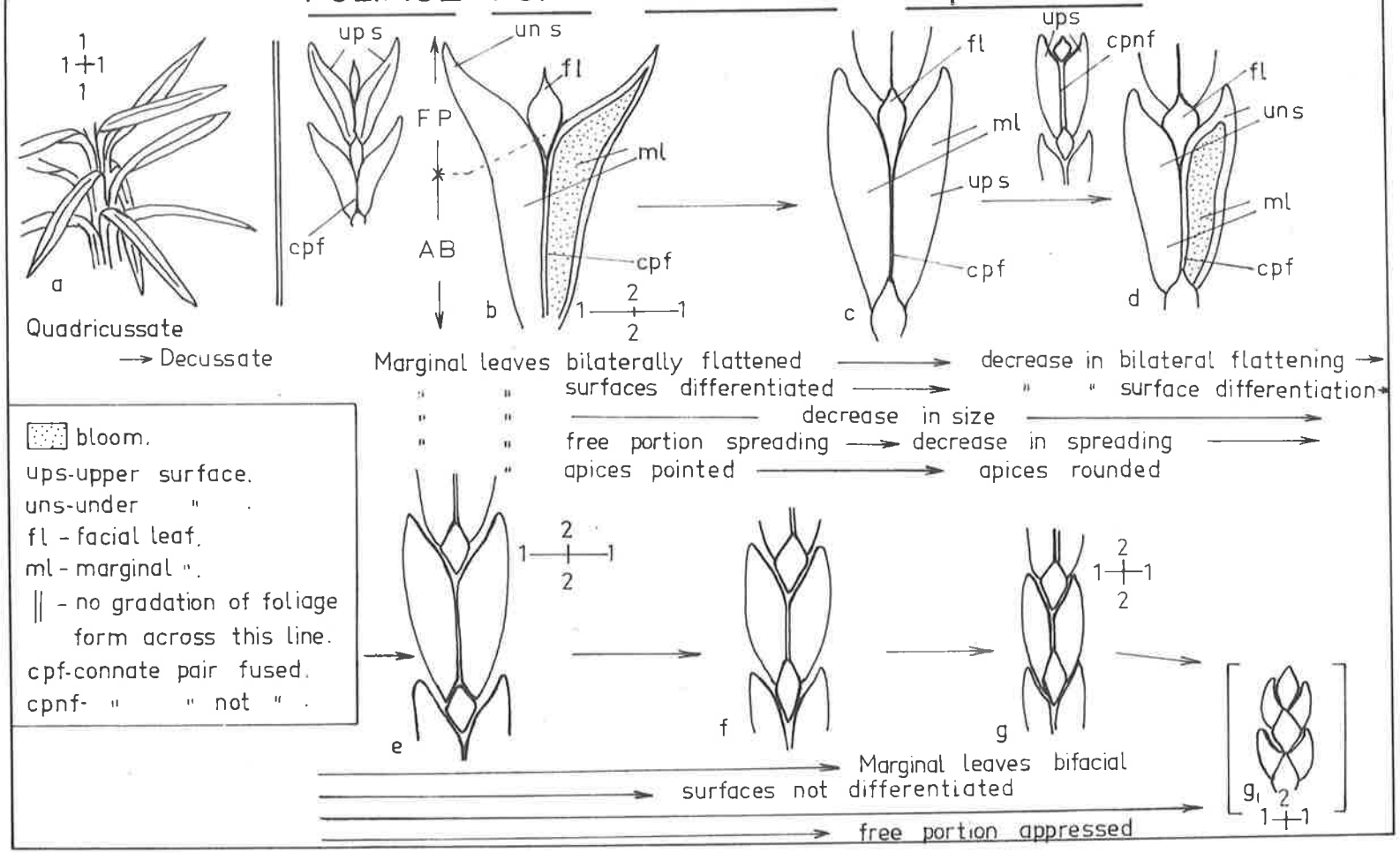


Figure 22

A foliage form sequence for *Dacrydium elatum* and *D.novo-guineense*.

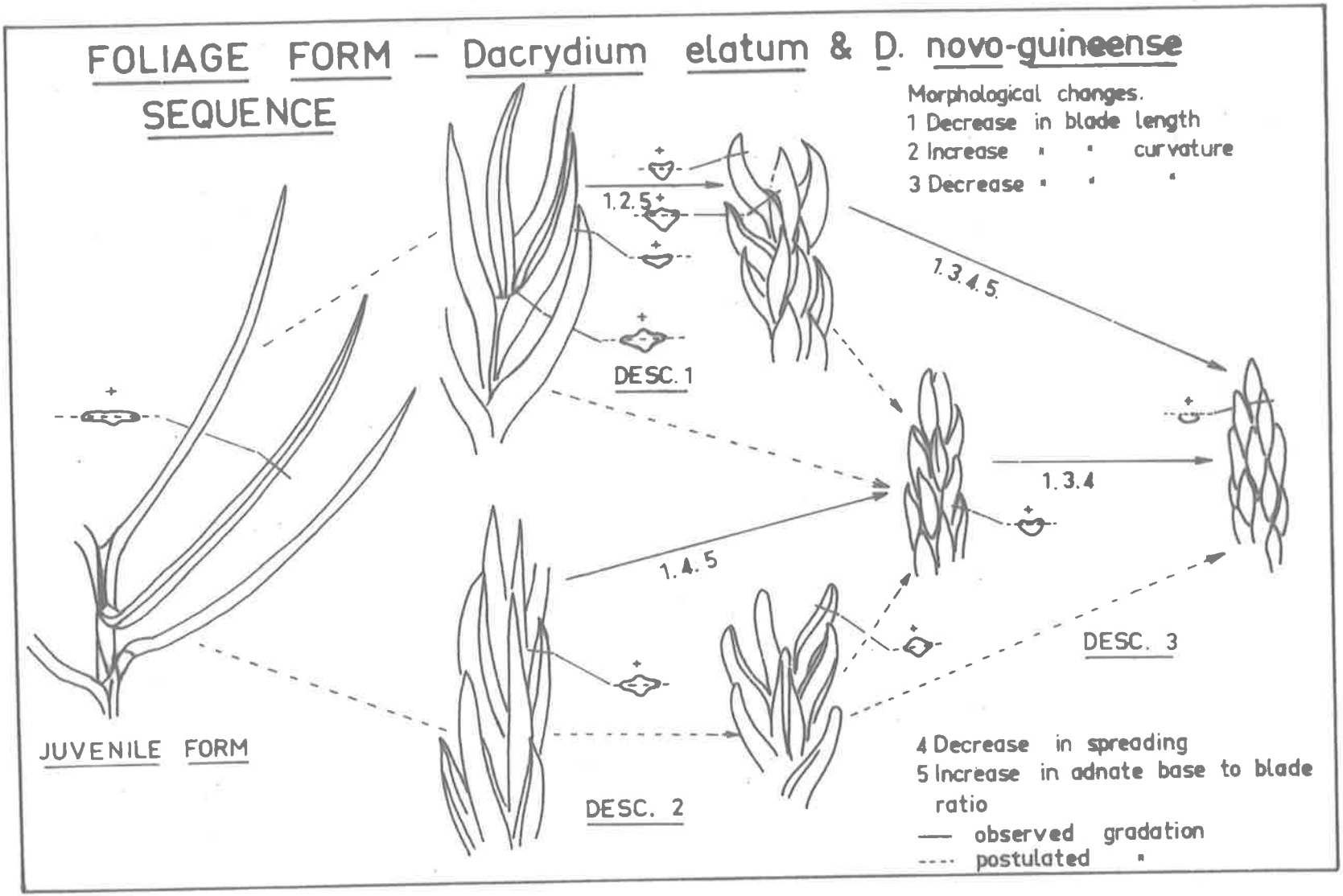

FOLIAGE FORM – Dacrydium elatum & D. novo-guineense
SEQUENCE
Morphological changes.
1 Decrease in blade length
2 Increase " " curvature
3 Decrease " " "
1.2.5
DESC. 1
1.3.4.5
1.3.4
1.4.5
DESC. 3
JUVENILE FORM
DESC. 2
4 Decrease in spreading
5 Increase in adnate base to blade ratio
— observed gradation
---- postulated "

Figure 23

A foliage form sequence for the forms of *Podocarpus* sect. *Dacrycarpus* treated in Descriptions 2 to 5, Chapter V, pp.146-152.

⟶ , gradation between the forms.

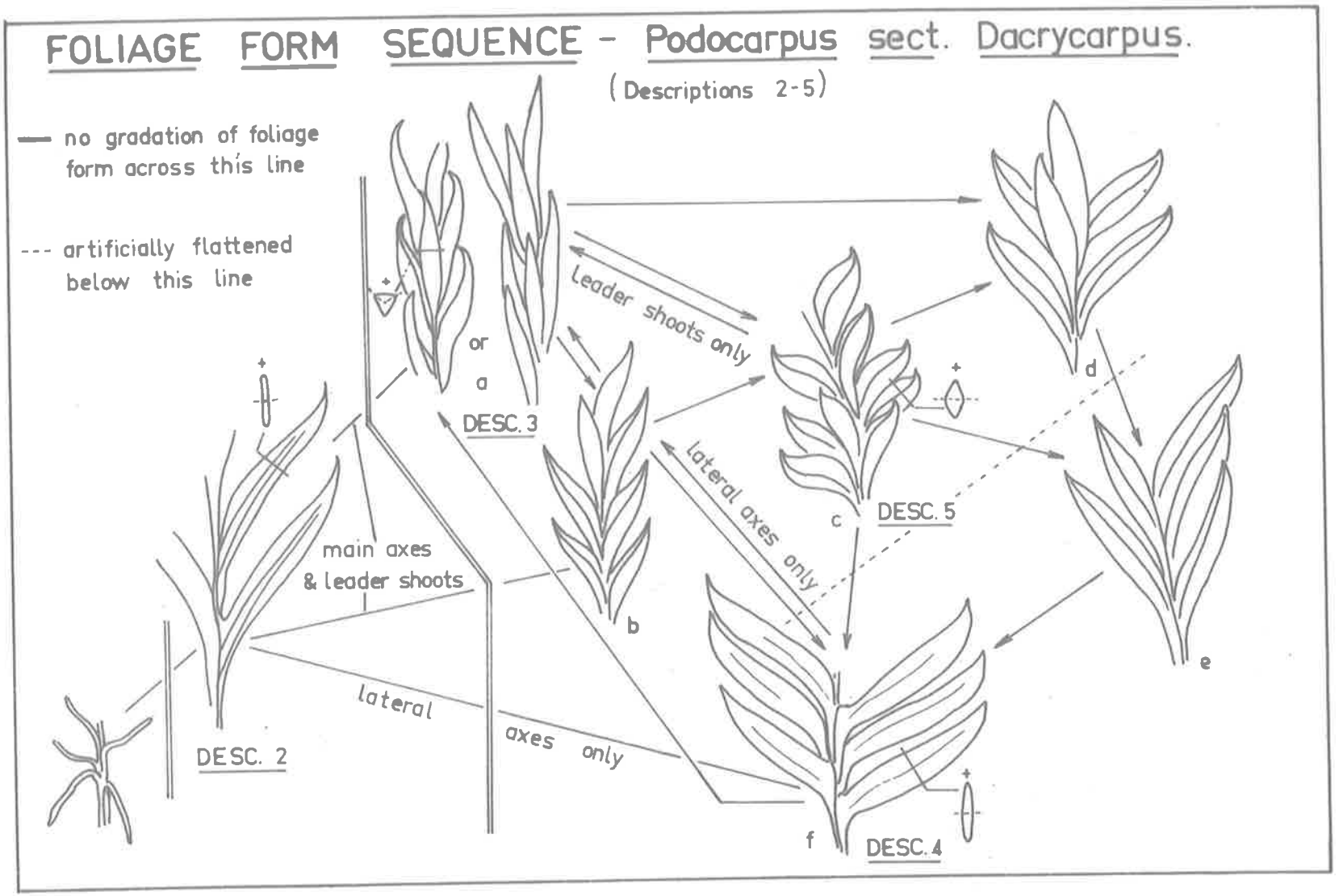

FOLIAGE FORM SEQUENCE - Podocarpus sect. Dacrycarpus.
(Descriptions 2-5)
— no gradation of foliage form across this line
--- artificially flattened below this line
Leader shoots only
or
a
DESC. 3
d
c
DESC. 5
lateral axes only
main axes & leader shoots
b
e
lateral axes only
DESC. 2
f
DESC. 4

Figure 24

A foliage form sequence for the forms of *Podocarpus* sect. *Dacrycarpus* treated in Descriptions 1 and 6, Chapter V, pp.144-146 and 153, 154, respectively.

⟶ , gradation between the forms.

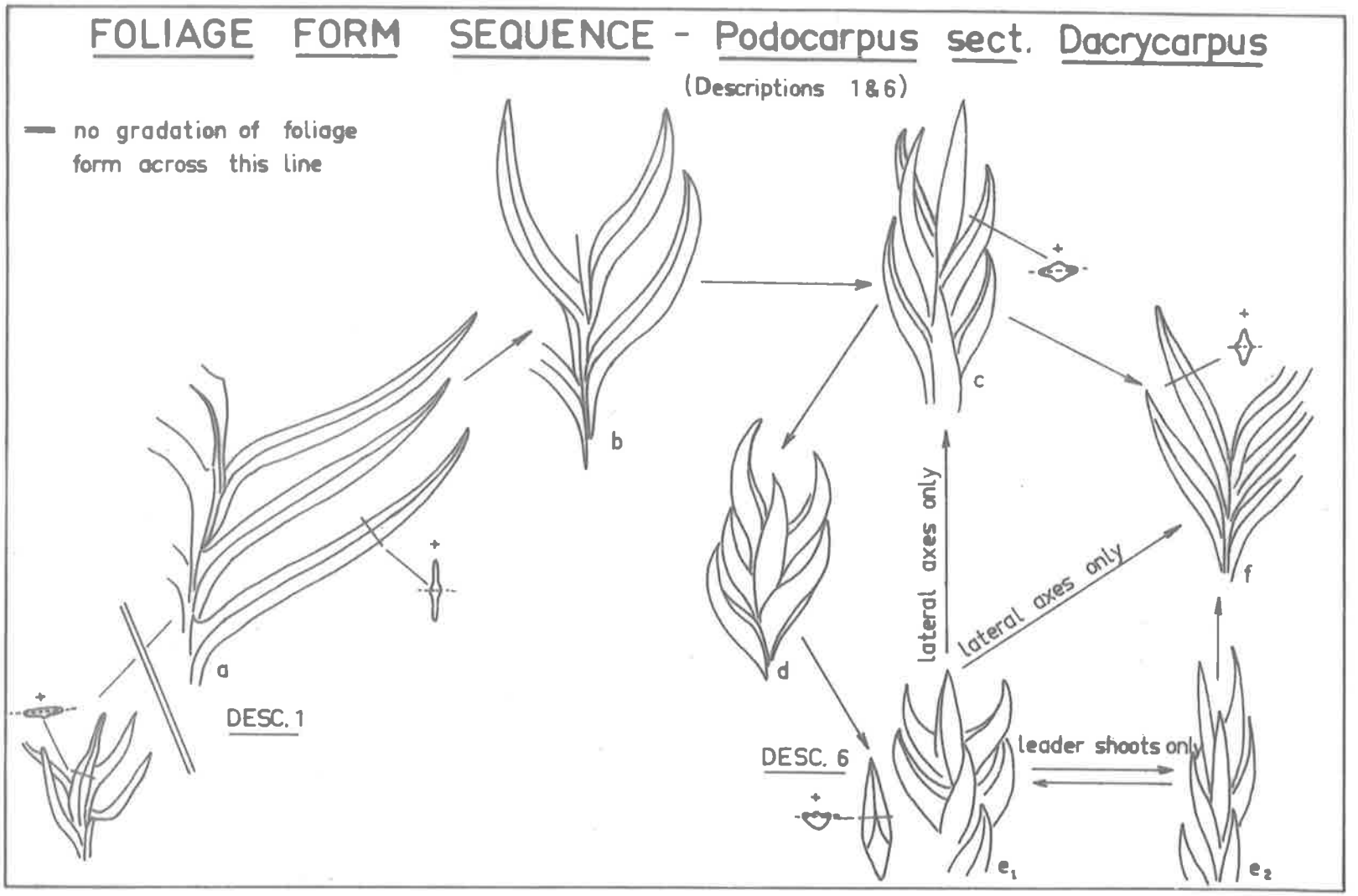

FOLIAGE FORM SEQUENCE - Podocarpus sect. Dacrycarpus
(Descriptions 1 & 6)
no gradation of foliage form across this line
a
b
c
d
e1
e2
f
DESC. 1
DESC. 6
lateral axes only
lateral axes only
leader shoots only

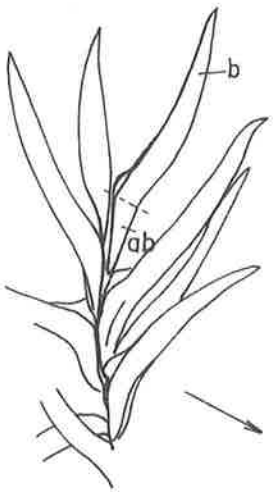
Figure 25

A foliage form sequence for the genus *Athrotaxis*. Note that gradation only occurs between the immature and mature foliage forms of *A.selaginoides*.

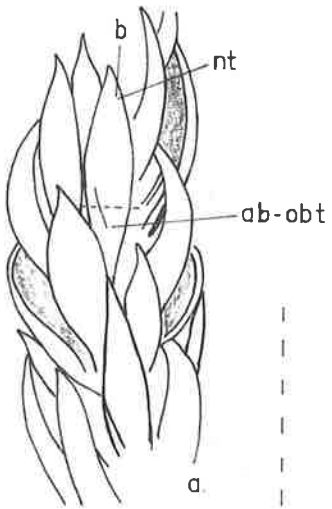
FOLIAGE FORM SEQUENCE — Athrotaxis.

ab - adnate base
fp - free portion
b - blade

nt - narrowly triangular
rh - rhombic
- - species boundary
→ gradation

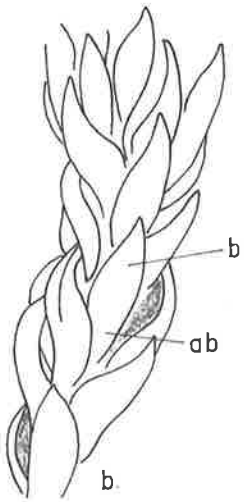


immature

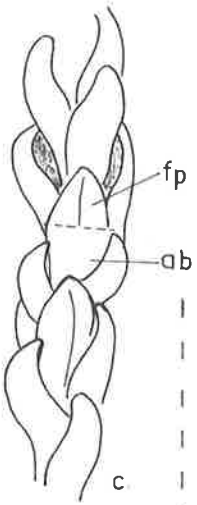


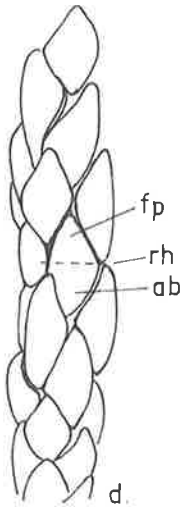
A. selaginoides
mature

Leaf-blade spreading & incurved.
Adnate base : blade 1 : 3·5.
Av. leaf-length = 8·5mm ; breadth = 3·45mm.



A. laxifolia





A. cupressoides
mature

Free portion appressed.
Adnate base : free portion = 1:1.
Av. leaf-length 2·3mm ; breadth 1·6mm.

Figure 26

A. Plans of part of the abaxial surface of a non-keeled (a) and a keeled (b) leaf of the mature foliage form of two species of *Callitris* to show the distribution of their stomates. On the surface of the non-keeled leaf (a) the stomates occur near the margins and, for the length of the adnate base, are sunken in a groove. This groove is formed by incurving of the contiguous margins of pairs of neighbouring leaves. The stomates of the keeled leaf (b) are borne on either side of the keel. When the lateral faces of the leaf are concave, the stomates are slightly protected, but when the lateral faces are sloping, as is the case in the leaves of many species, the stomates are exposed.

B. Leaves of the foliage forms of *Podocarpus* sect. *Dacrycarpus* treated in Descriptions 1 and 2 (Chapter V, pp.144-147). Note the difference in the distribution of stomates of these two leaves.

C. Sketches of a surface of a marginal leaf (a) and young leaves (b) of the transitional foliage form of *Papuacedrus*.
   a. Note that the contribution of the original adaxial surface to the surface of the marginal leaf is smaller than that of the abaxial surface.
   b. Note the concave adaxial surface of the young leaves.

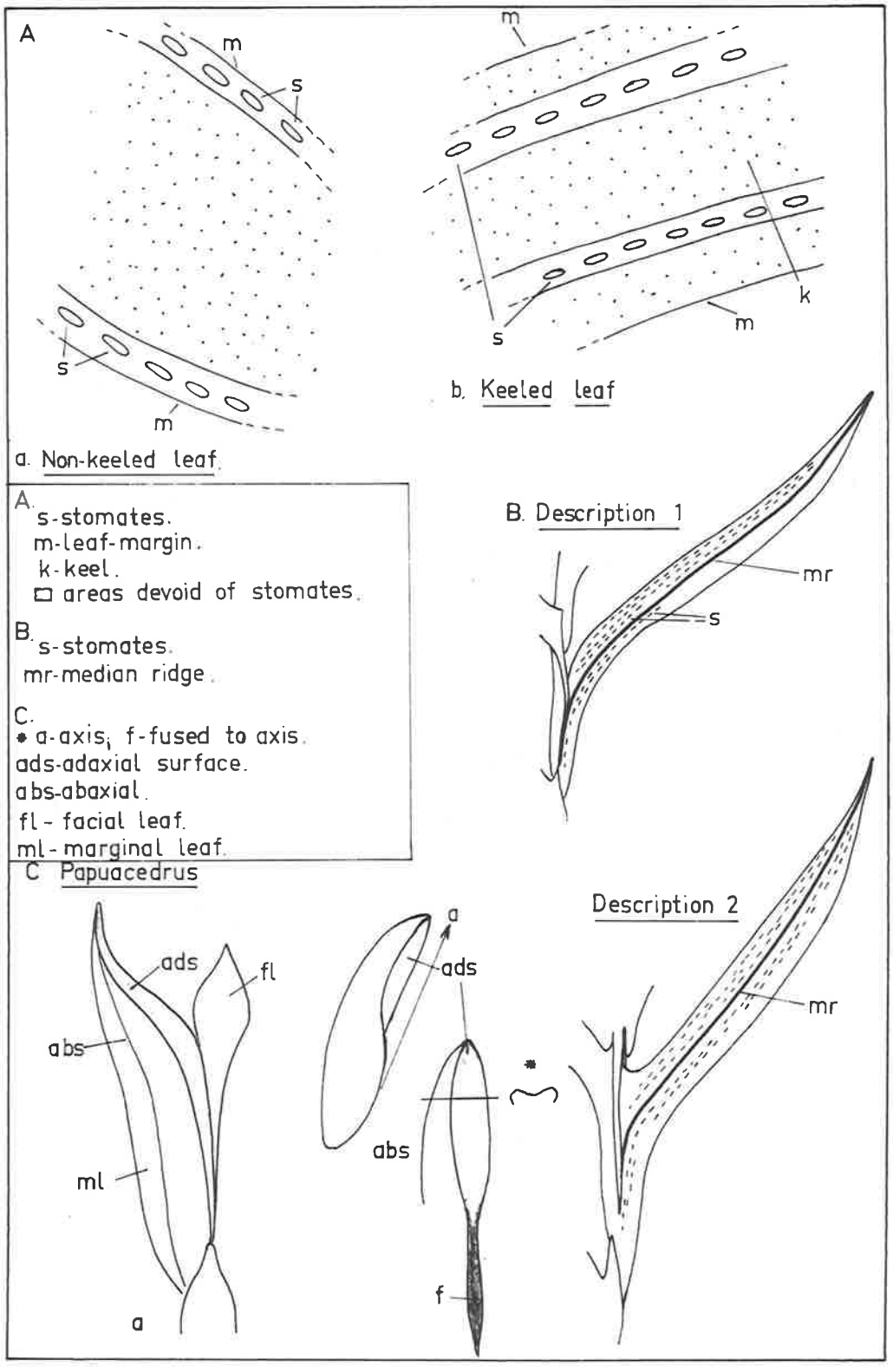

A
m
s
s
m
a. Non-keeled leaf
m
k
s
m
b. Keeled leaf
A.
s-stomates.
m-leaf-margin.
k-keel.
areas devoid of stomates.
B.
s-stomates.
mr-median ridge.
C.
* a-axis, f-fused to axis.
ads-adaxial surface.
abs-abaxial.
fl - facial leaf.
ml - marginal leaf.
B. Description 1
mr
s
C Papuacedrus
ads
fl
abs
ml
a
a
ads
abs
*
f
Description 2
mr

Figure 27

Maps showing the locations of the fossil floras. Note, the location of the Lake Howitt Flora is not known.

The map showing the distribution of erosion surfaces is taken from Jessup (1961, Fig.1).

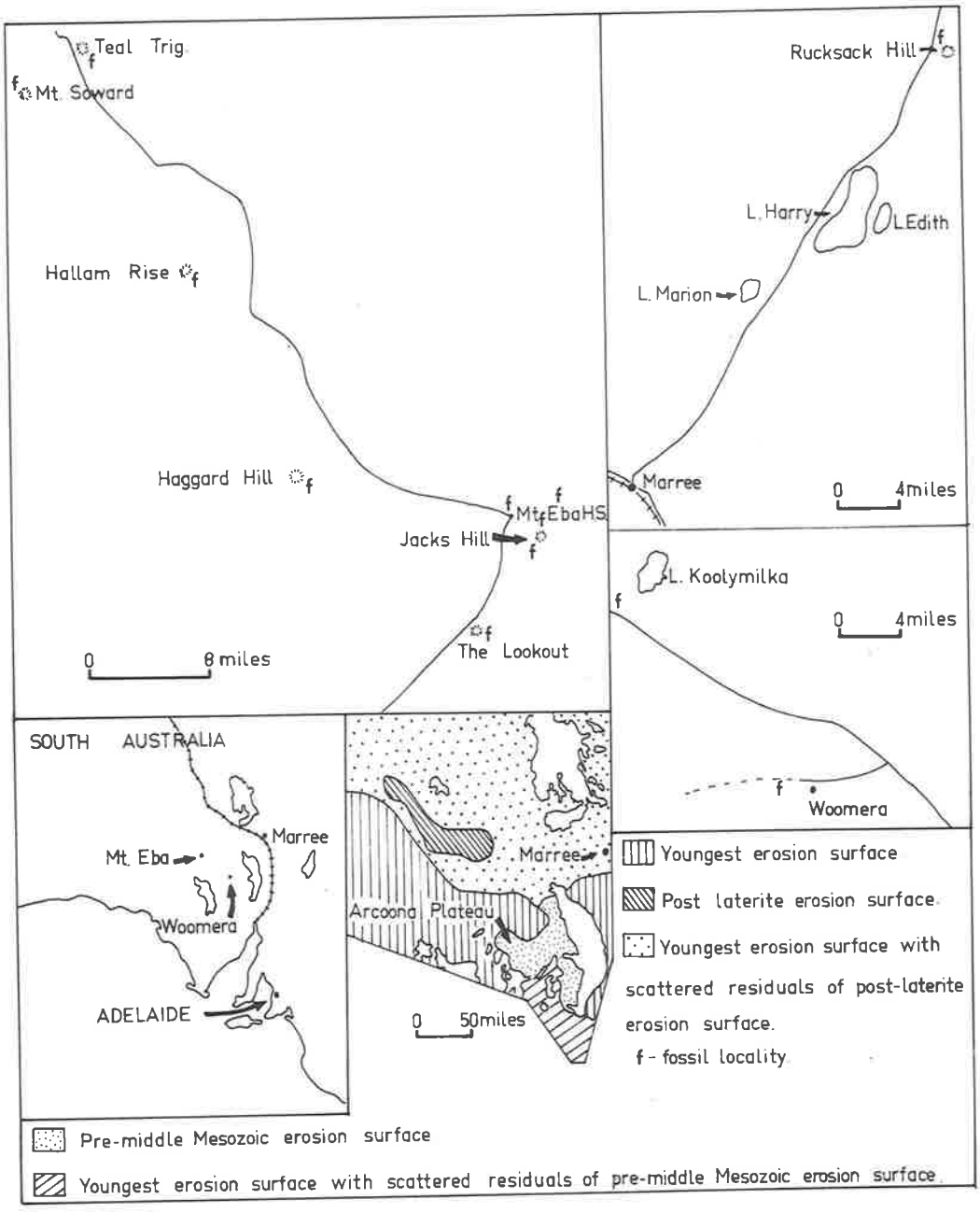

Teal Trig
Mt. Soward
Hallam Rise
Haggard Hill
Mt Eba
Eba HS
Jacks Hill
The Lookout
0 8 miles
Rucksack Hill
L. Harry
L. Edith
L. Marion
Marree
0 4 miles
L. Koolymilka
0 4 miles
Woomera
SOUTH AUSTRALIA
Marree
Mt. Eba
Woomera
ADELAIDE
Marree
Arcoona Plateau
0 50 miles
Youngest erosion surface
Post laterite erosion surface
Youngest erosion surface with scattered residuals of post-laterite erosion surface.
f - fossil locality
Pre-middle Mesozoic erosion surface
Youngest erosion surface with scattered residuals of pre-middle Mesozoic erosion surface

Figure 28

A,B. FORM I. A. *P13596B*. A sketch of part of this specimen. Note the larger obtrullate leaves of the main axis (obt); they often have grooved abaxial surfaces (g). Also note that the free portions of leaves with lateral axes in their axils are often slightly spreading and incurved (ss). A number of small leaves seem to occur on the main axis of this specimen (sl).
B. *P13966A*. This specimen is poorly preserved, but it probably belongs to this form. Note the obtrullate shape of leaves preserved in face view (obt) and the slightly spreading free portions of leaves preserved in lateral view (ss). In addition note the remnant lateral axes (rla).

C,D. FORM II. (fl, facial leaf; ml, marginal leaf). C. *P13637*. A terminal axis bearing dimorphic leaves. The facial leaves overlap the bases of subsequent marginal leaves (om) and sometimes the base of the subsequent facial leaf (of). The marginal leaves are partially bilaterally flattened (pbf); their adaxial surfaces are convex (cv ad s).
D. *P13602*. A branched axis. Note that the leaves of this axis are thinner than those of specimen *P13639*. Also note that the lateral axis arises in the axil of a marginal leaf and commences with a pair of facial leaves.

E. FORM IV. *P13606*. An axis to illustrate the characteristics of this form. The leaves of this form have an obtriangular or obdeltate adnate base (obt) and a narrowly triangular blade (nt). In this specimen the leaf-blades are incurved distally (in d). Note that the adaxial surface of the blade is adnate to the axis for a short distance (ad).

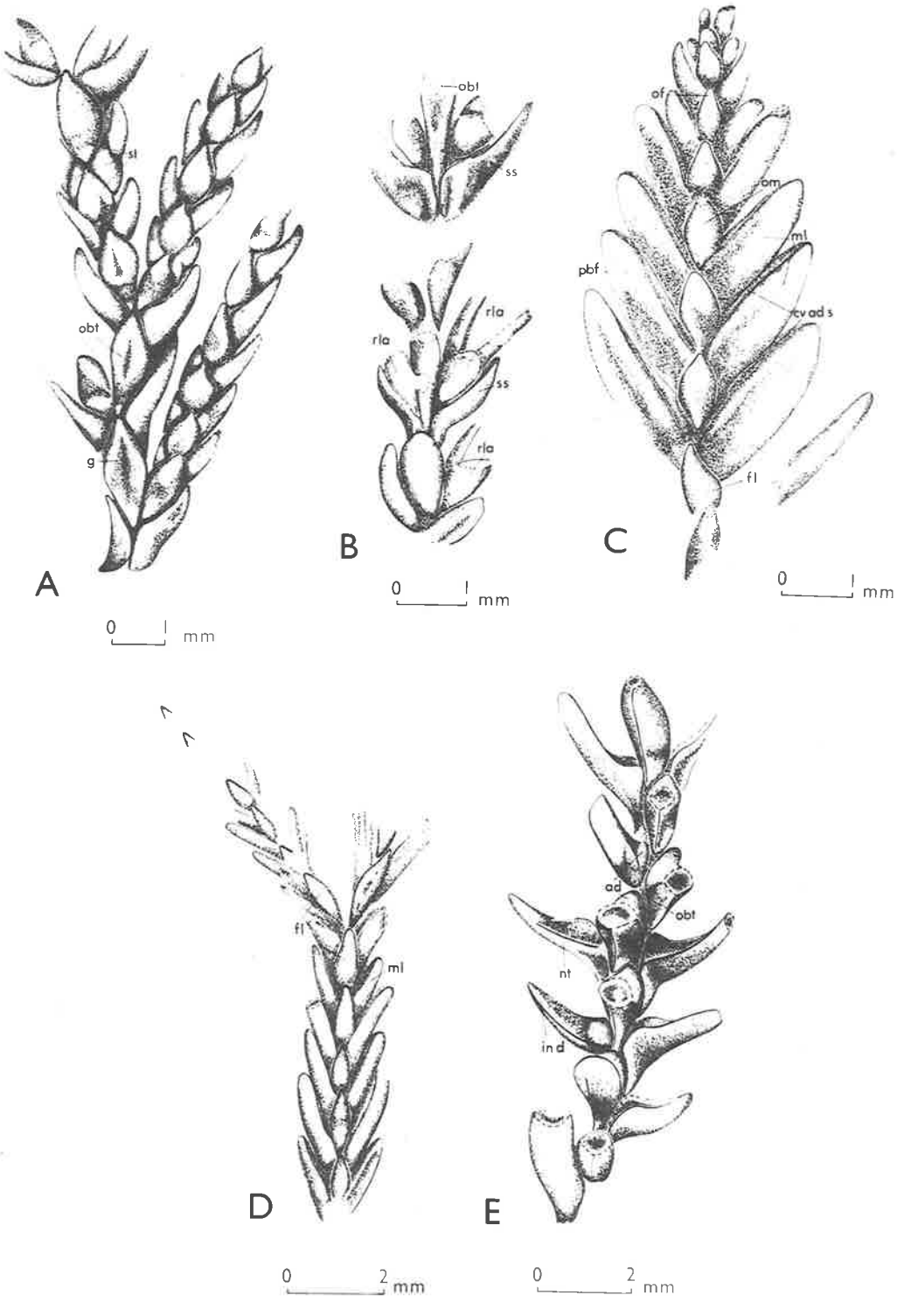

st
obt
g
A
0 1 mm
obt
ss
rla
rla
ss
rla
B
0 1 mm
of
om
ml
pbf
cvads
fl
C
0 1 mm
fl
ml
D
0 2 mm
ad
obt
nt
ind
E
0 2 mm

Figure 29

A. FORM III. *P13637B* (fl, facial leaf; ml, marginal leaf). Part of the specimen to illustrate the dimorphic nature of leaves of this form. Note that the lateral axes arise in the axils of marginal leaves and commence with a pair of facial leaves. Also note that the facial leaves completely overlap the bases of the subsequent pair of marginal leaves. The abaxial surface of the facial leaves is often grooved (g) and the blades of the marginal leaves are partially bilaterally flattened (pbf).

B. FORM V. *P13643*. Note the spirally inserted narrowly rhombic to rhombic leaves which characterize this form. The free portion overlaps the bases of subsequent leaves (o) and is complanate.

C-F. FORM VI. The leaves of this form are spirally inserted and are narrowly rhombic to rhombic; their free portions overlap the bases of subsequent leaves and are complanate or flattened onto the bases of subsequent leaves. Illustrations of four specimens of this form to show the small differences between them.

C. *P13641A*. Note the steeply sloping lateral faces (ss) of the adnate base which taper to a pungent basal angle (pba).

D. *P13596A*. The leaves of this specimen are rhombic and have acute basal angles (ba) and acute, slightly incurved apices (a in a); their free portions overlap to bases of subsequent leaves. Note the variation in leaf-shape and size expressed within this specimen.

E. *P13642A*. Note that the leaves of this specimen only overlap slightly.

F. *P13966A*. The leaves of this specimen are narrowly rhombic and have acute or pungent basal angles (ba) and apices (a).

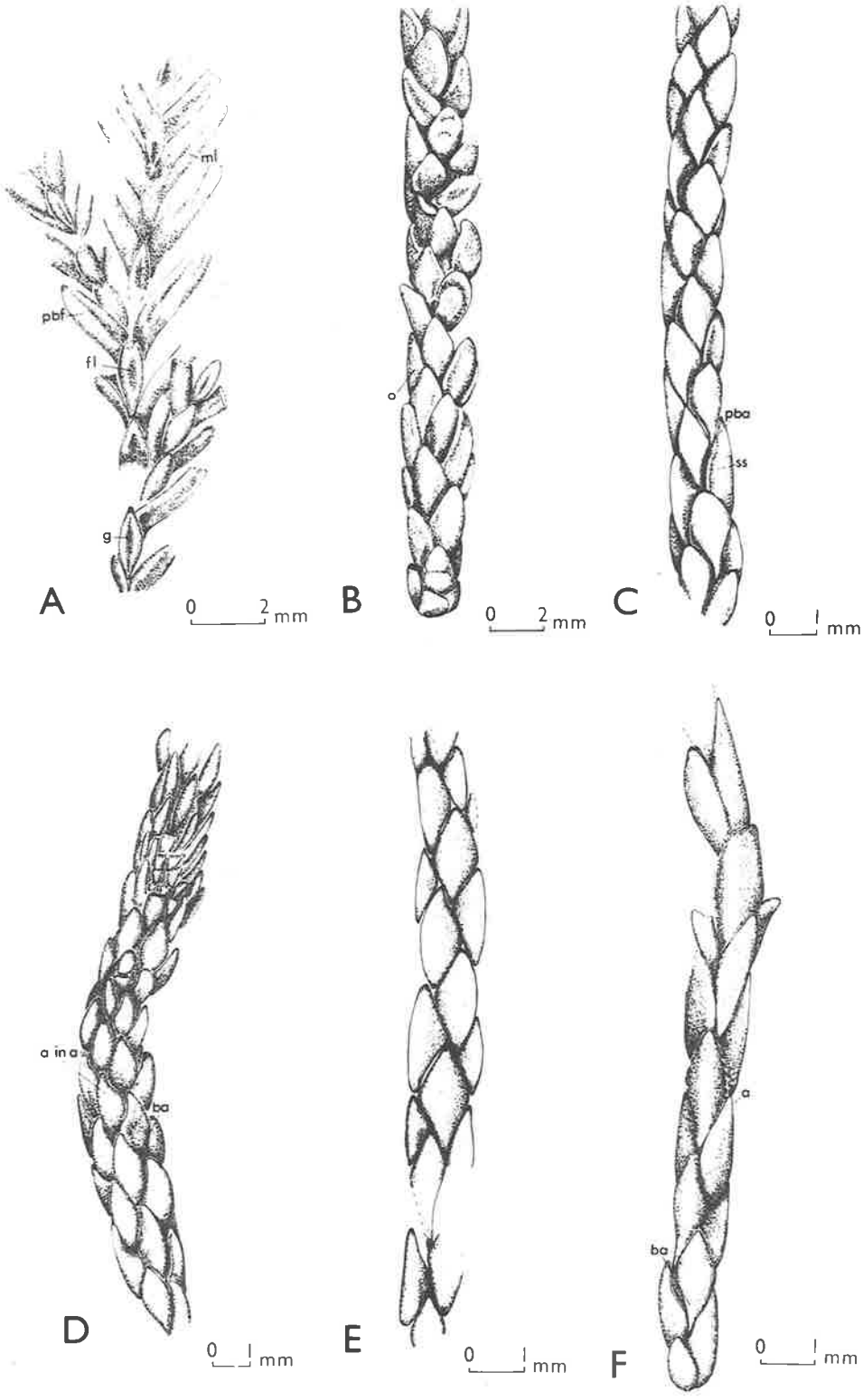

ml
pbf
fl
g
A
0 2 mm
o
B
0 2 mm
pba
ss
C
0 1 mm
a in a
ba
D
0 1 mm
E
0 1 mm
a
ba
F
0 1 mm

Figure 30

A,B. FORM VII. This form is characterized by spirally inserted, obtrullate, scale-like leaves. A. *P13608*. Note the steeply sloping (ss), sometimes concave (cc) lateral faces and the convex adaxial surface (cv ad s). B. *P13612*. This specimen has been compressed during fossilization. Note that the leaves appear partially bilaterally flattened (pbf). Also note the acute keel (ak) and lateral faces with triangular concavities (tc).

C,D. FORM VIII. The size and shape of leaves is very variable in this form. These two specimens illustrate some of this variation. C. *P13632*. The leaves of this specimen are smaller than those of most specimens of this form. They are narrowly rhombic and have complanate free portions. D. *P13962*. Note the slightly spreading leaf-blades. In lateral view the adnate base appears approximately linear (l) and the free portion narrowly oblong (no). Note that some leaves are keeledon their abaxial surfaces.

E,F. FORM IX. This form is characterized by partially bilaterally flattened, spreading blades. The leaves consist of a linear-obtriangular or linear adnate base and a narrowly oblong blade. E. *P13622A*. Note that the blades have been bilaterally flattened and that their surfaces are slightly convex (cv). F. *P13603B*. The leaves of this specimen have shorter adnate bases (ab) and more spreading blades (b) than do those of specimen *P13622A*. Note the tetragonal cross-section of the leaf-blades (txs).

G,H. FORM X. G. *P13625*. This specimen has not been strongly compressed. Note the bifacial adnate bases (b) and narrowly oblong, bilaterally flattened blades (bf). The surfaces of the blades are slightly convex. H. *P13617*. The leaf-blades of this specimen are more strongly bilaterally flattened than those of *P13625*. Note that they are slightly constricted at their insertion (sc) and are ridged medially (rm). The adnate bases are long and bifacial.

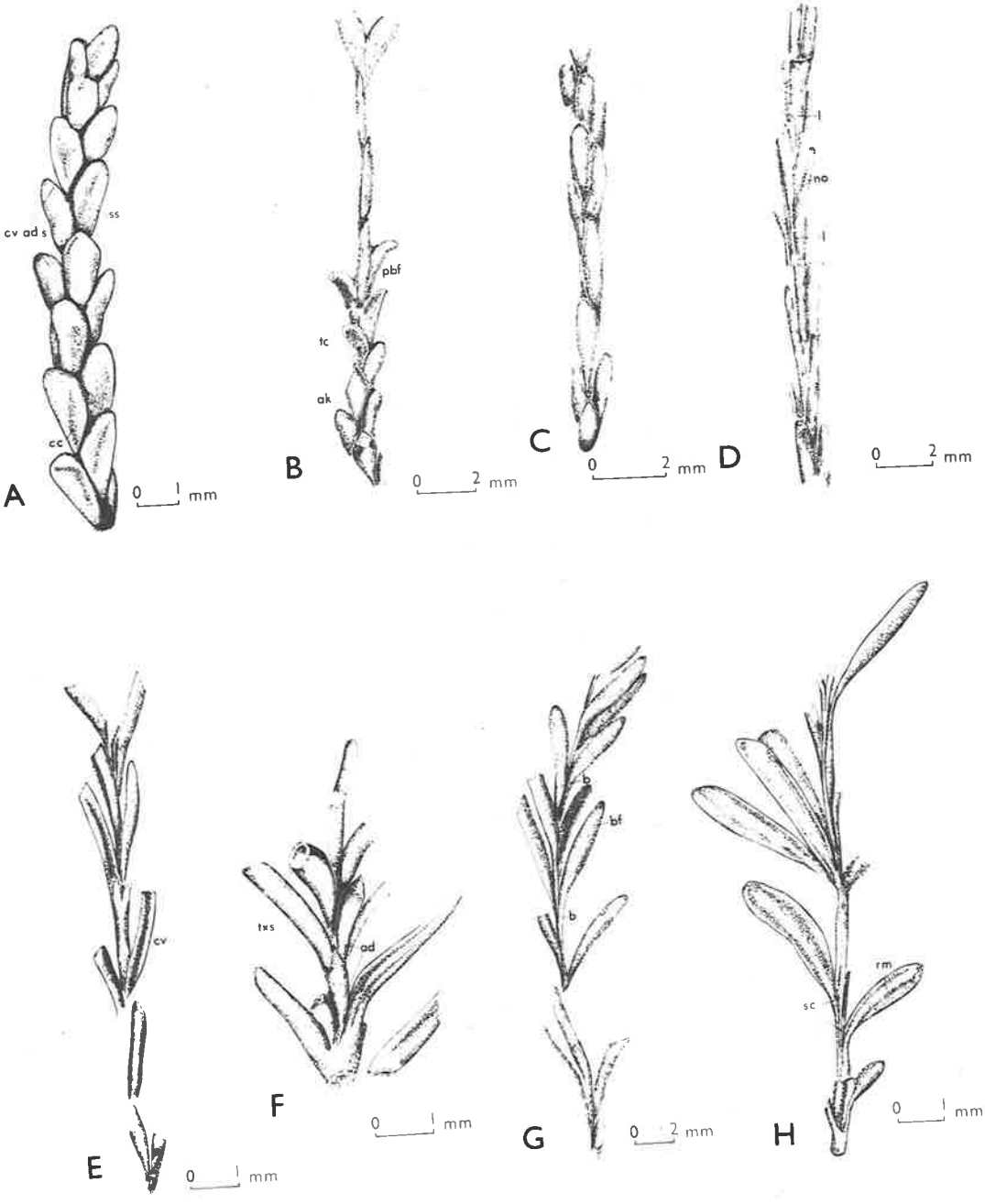

A
cv ad s
ss
cc
0 1 mm
B
pbf
tc
ak
0 2 mm
C
0 2 mm
D
no
0 2 mm
E
cv
0 1 mm
F
tws
ad
0 1 mm
G
b
bf
b
0 2 mm
H
rm
sc
0 1 mm

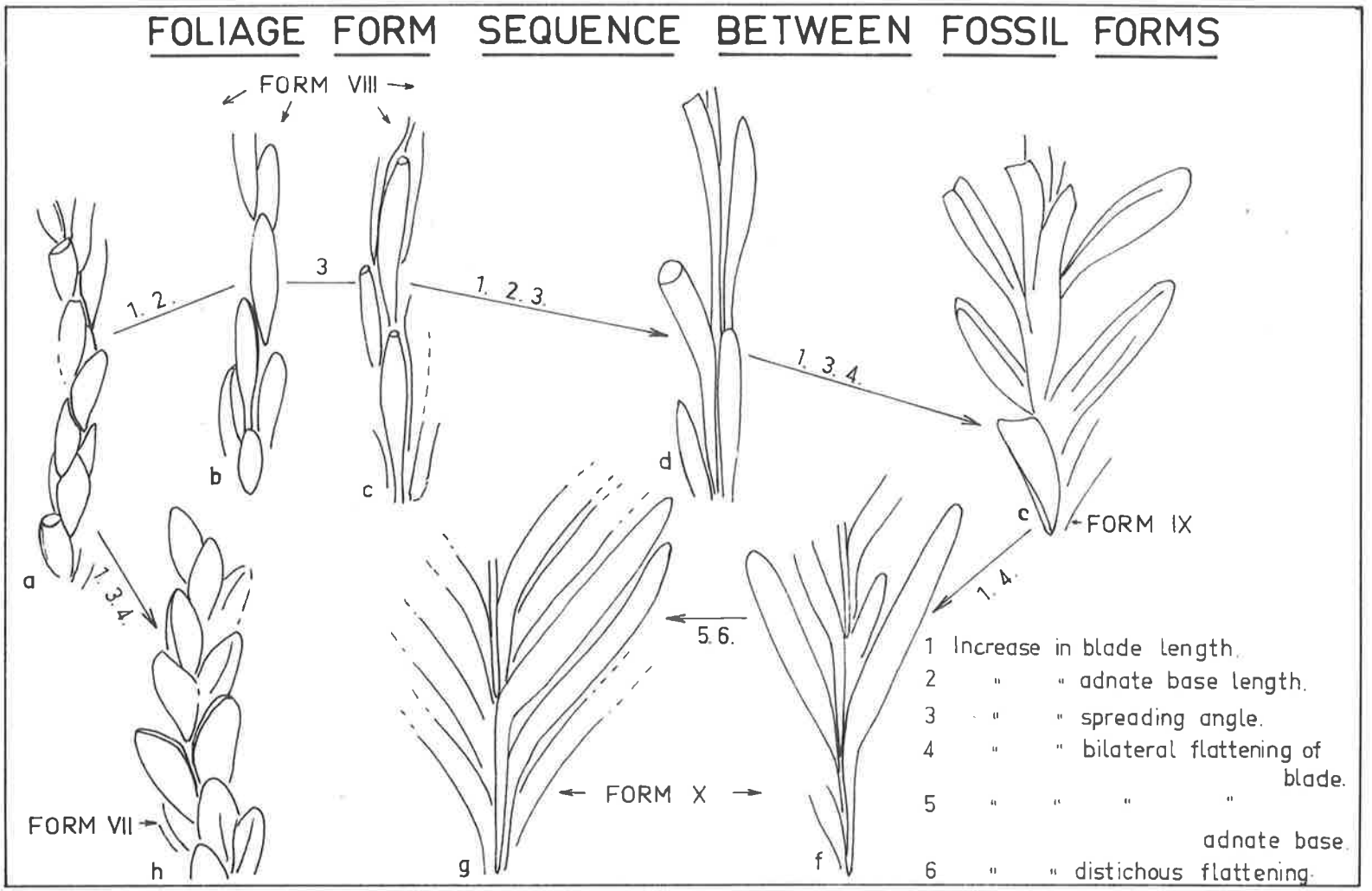
Figure 31

A foliage form sequence which seems to exist between fossil forms VII to X.

The specimens used to illustrate this sequence are:-

a. Specimen *P13641B* (Plate 39D)
b. Specimen *P13632* (Plate 39I)
c. Specimen *P13610* (Plate 39J)
d. Specimen *P13614B* (Plate 40E). Specimen *P13636* (Plate 42A,B) is similar to this specimen; it belongs to Form IX and represents one extreme of the variation expressed by specimens of Form IX.
e. Specimen *P13619* (Plate 40H)
f. Specimen *P13625* (Plate 43E). Specimen *P13616* (Plate 41F) is similar to this specimen; it represents the other extreme of the variation expressed by specimens of Form IX.
g. Specimen *P13967* (Plate 43C,D)
h. Specimen *P13609* (Plate 39A)

FOLIAGE FORM SEQUENCE BETWEEN FOSSIL FORMS



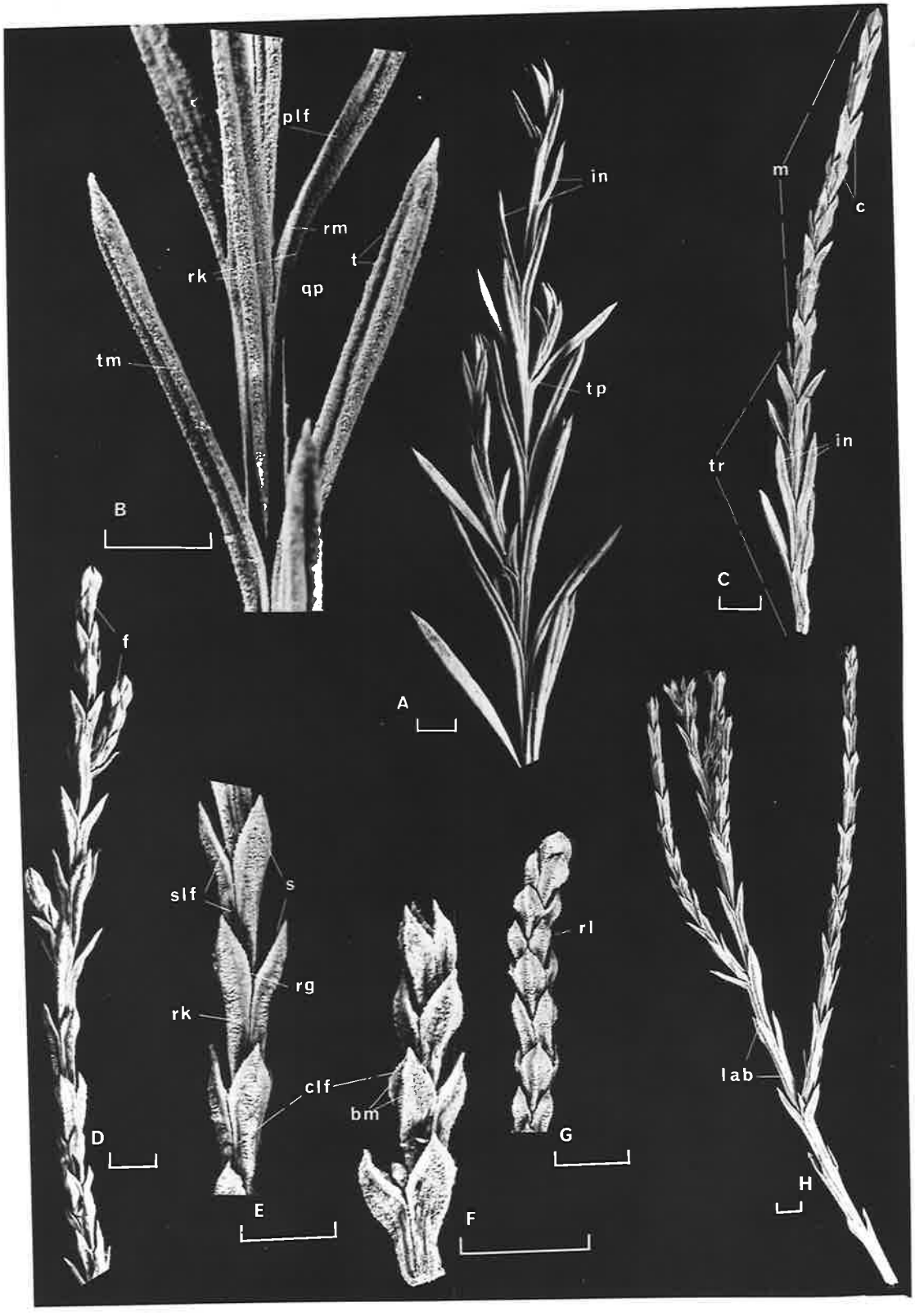
PLATES 1-43

PLATE 1

A-H. *Actinostrobus acuminatus*. A,B. Shoots illustrating the juvenile foliage form. The phyllotaxis is predominately tricussate in this form (A,tp), but shoots may have quadricussately inserted leaves (B,qp). Leaf-blades have a rounded keel (B,rk), almost planar lateral faces (B,plf) and thickened margins (B,tm). Margins may be revolute (B,rm) and have a few fine teeth (B,t). Note the slightly incurved blades of leaves borne towards the distal end of A (in).

C. A shoot bearing both the transitional (tr) and mature (m) foliage forms. The phyllotaxis is tricussate. Note the slightly incurved free portions of leaves of the transitional foliage form (in); those of leaves of the mature foliage form are complanate (c). D-F. Shoots illustrating the mature foliage form. Leaf-size and the amount of spreading are variable (D). Leaves have rounded keels (E,rk). Lateral faces are sloping (E,slf) or sloping but with the gradient reduced towards the margins (E,rg); those of the adnate base may be concave (E,F,clf). Free portions are usually slightly spreading (E,s), but on younger leaves may be flattened onto the bases of subsequent leaves (D,f); their margins sometimes become bowed (F,bm). G. A shoot illustrating the almost rhombic shape of some young leaves of the mature foliage form prior to internodal elongation (rl). H. A branched shoot bearing mature foliage form leaves. Note the unusually long adnate bases of leaves borne on the main axis of this branch complex (lab).

Scale = 2mm


plf
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qp
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C
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rk
clf
bm
E
F
rl
G
lab
H

PLATE 2

A-E. *Actinostrobus arenarius*. A,B. Shoots illustrating the transitional foliage form. The keel of the adnate base is usually rounded (B,rk), but may become acute towards the base of the leaf (B,ak). Sometimes the triangular free portion (B,t) is modified to a narrowly ovate shape by bowing of the margins (B,o); its adaxial surface is usually planar (p ad s).
C. A branched shoot showing transitional foliage form leaves occurring on a rapidly developing axis of a specimen which normally bears leaves of the mature form. The long adnate bases (lab) indicate rapid growth. D,E. Shoots illustrating the mature foliage form. The free portions of leaves are complanate (D,c) or slightly spreading (D,s); sometimes their margins are bowed (E,bm). The adaxial surface is usually convex (E,c ad s); apices are cuspidate (E,ca) or pungent (D,E,pa).

F,G. *Actinostrobus pyramidalis*. Shoots showing the mature foliage form. Free portions are slightly spreading (F,s) or sometimes complanate (F,c); only those of young leaves are flattened onto the bases of subsequent leaves (F,f). Slightly spreading free portions with planar adaxial surfaces (F, p ad s) are most common, but sometimes they are complanate with convex adaxial surfaces (G,c ad s); these usually have bowed margins (G,bm).

Scale = 2mm

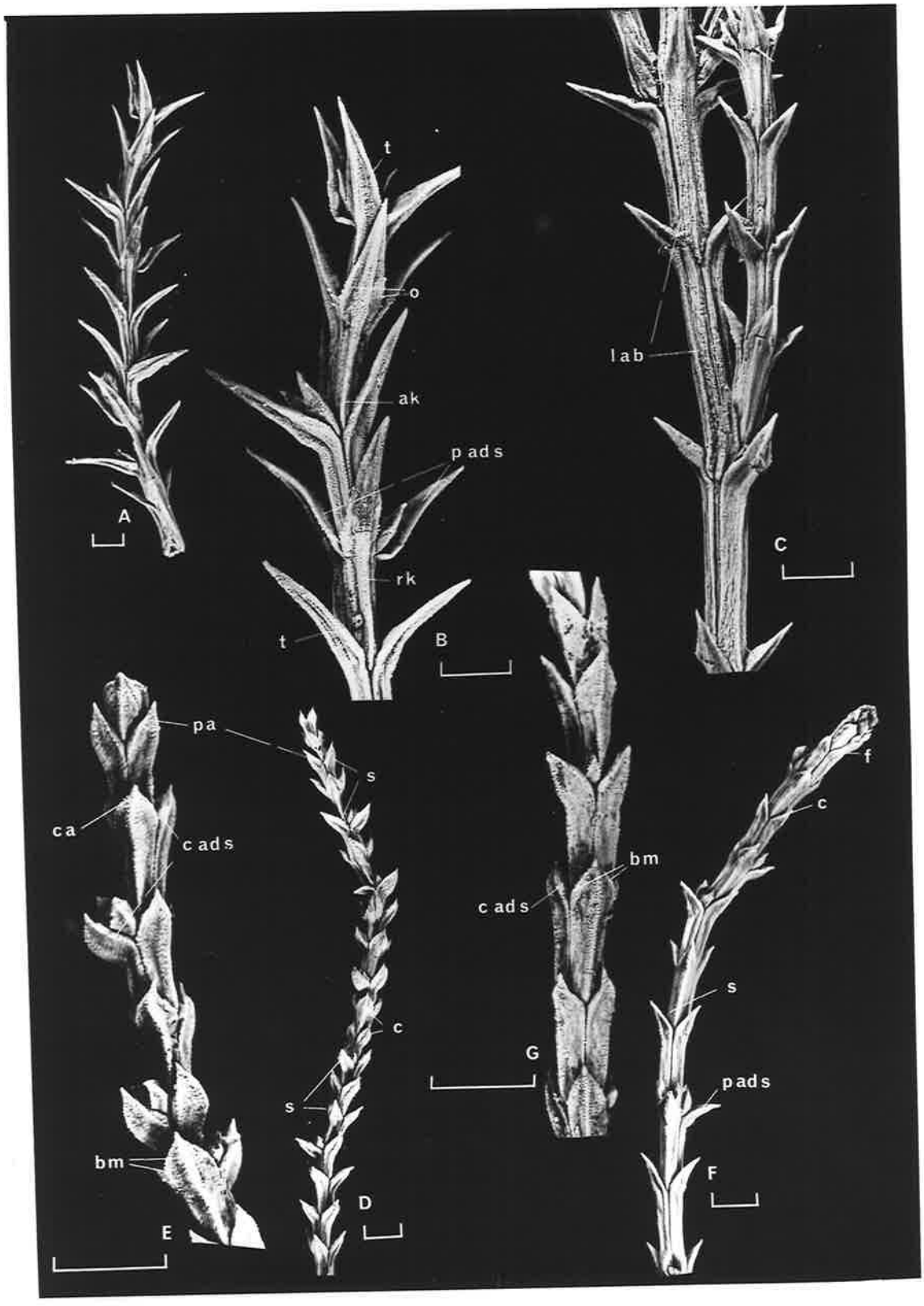
t
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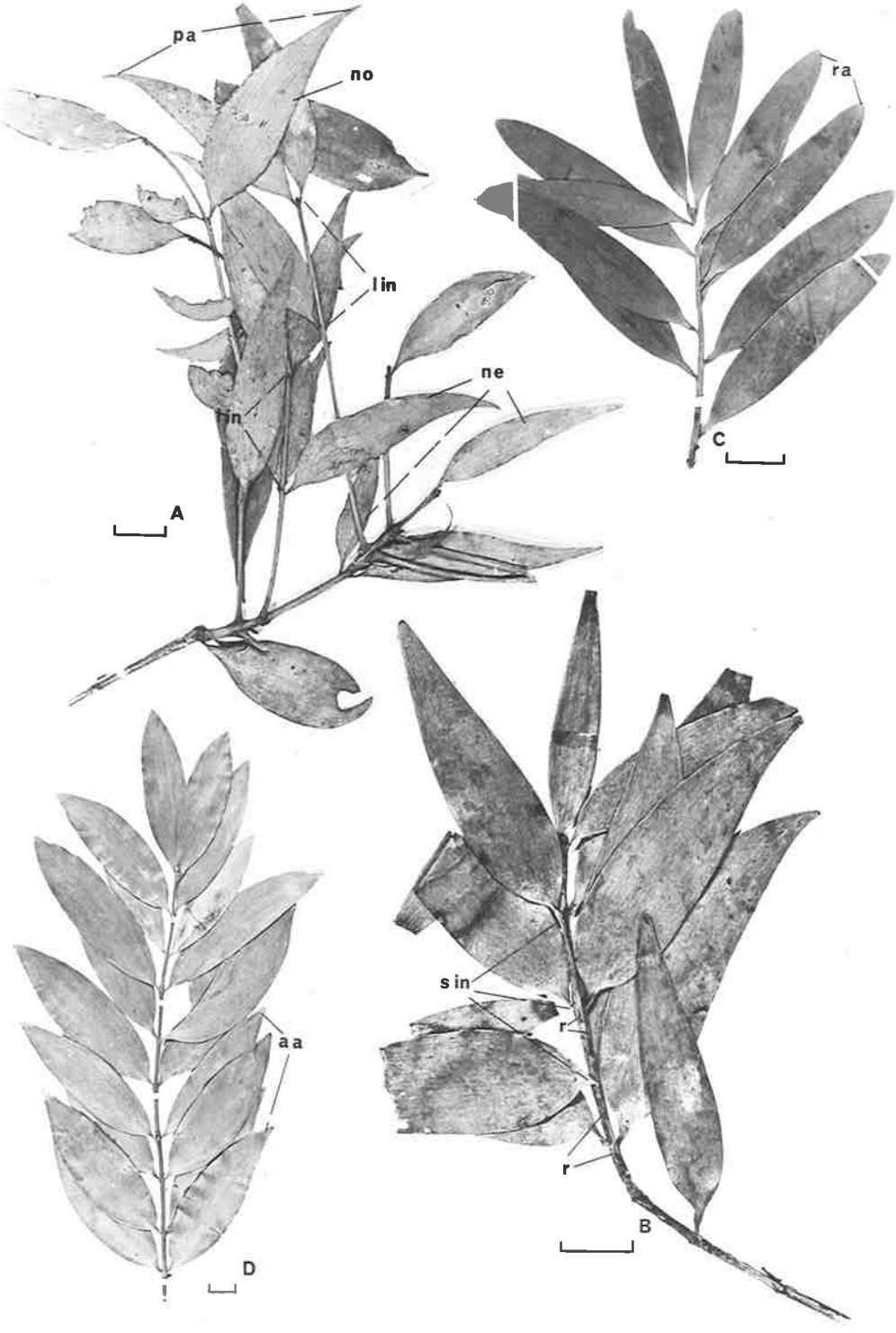
PLATE 3

A,B. *Agathis labillardieri.* A. Part of a herbarium sheet *(Womersley NGF 3679)* of the immature foliage. The leaves are inserted decussate-distichously and are separated by very long internodes (l in). The blades are narrowly elliptical (ne) or narrowly ovate (no); they are distinctly striated and usually have pungent apices (pa). B. A shoot illustrating the mature foliage form. The decussate-distichous insertion is retained, but the internodes are shorter (s in). The position of adnate bases, now fused to the axis, is depicted by ridges (r).

C,D. *Agathis robusta.* Shoots illustrating variation within the mature foliage form. Note the decussate-distichous phyllotaxis and acute apices (aa) of the leaves of D and the approximately alternate phyllotaxis and more rounded apices (ra) of the leaves of C.

Scale = 2cm


pa
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B

PLATE 4

A-C. *Agathis microstachya.* A. Part of a herbarium sheet *(Schodde 3268* - sheet 1) of the immature foliage. Note the decussate-distichous insertion and long internodes (1 in). B,C. Specimens illustrating the mature foliage form. Note the distichous flattening near the apices of axes (B,df) but the lack of an overall distichous appearance (B). Leaf-blades are constricted and twisted at their insertion (C,c,t); the amount of twisting varies (compare C,t_1, t_2), see Chapter IV, Fig. 8C. The adnate bases are twisted around the axis (C,t ab); those of young leaves are distinct (B,C,d ab), but they become fused to the axis with age (B, f ab).

D. *Agathis dammara.* A shoot apex of the mature foliage form showing decussately inserted leaves unaffected by distichous flattening (nd).

Scale = 2cm


A
lin
B
df
d ab
f ab
C
t1
t ab
c
t2
c
d ab
D
nd

PLATE 5

A-F. *Araucaria bidwillii*. A-C. Immature foliage form. A. A shoot showing the variation in leaf-size and blade-shape which is characteristic of this foliage form. Blades vary from ovate (o) to narrowly elliptical (e). The phyllotaxis is spiral, but the elliptical blades are twisted near their insertion (t), thus appear distichous. B. An enlargement of part of A showing the twisting (t) and irregular shape (iab) of the adnate base, the lack of constriction of the blade at its insertion (nc) and the adnation of the adaxial surface of the blade to the axis (a ad s). C. An enlargement of the distal part of the adaxial surface of a leaf-blade showing the short median ridge (mr). D-F. Mature foliage form. D. Part of a herbarium sheet illustrating distichous flattening of leaves of this form and the acrotonous variation in leaf-size which is paralleled by changes in blade-shape from ovate (o) to narrowly elliptical (e). E. An enlargement of an axis bearing leaves with partially distichously flattened, narrowly elliptical blades. F. An enlargement of part of E showing irregularly shaped adnate bases (iab) which are twisted at their insertion (t) and the adaxial surface of the blade which is adnate to the axis (a ad s).

Scale = 2mm for A-C,E,F

Scale = 1cm for D

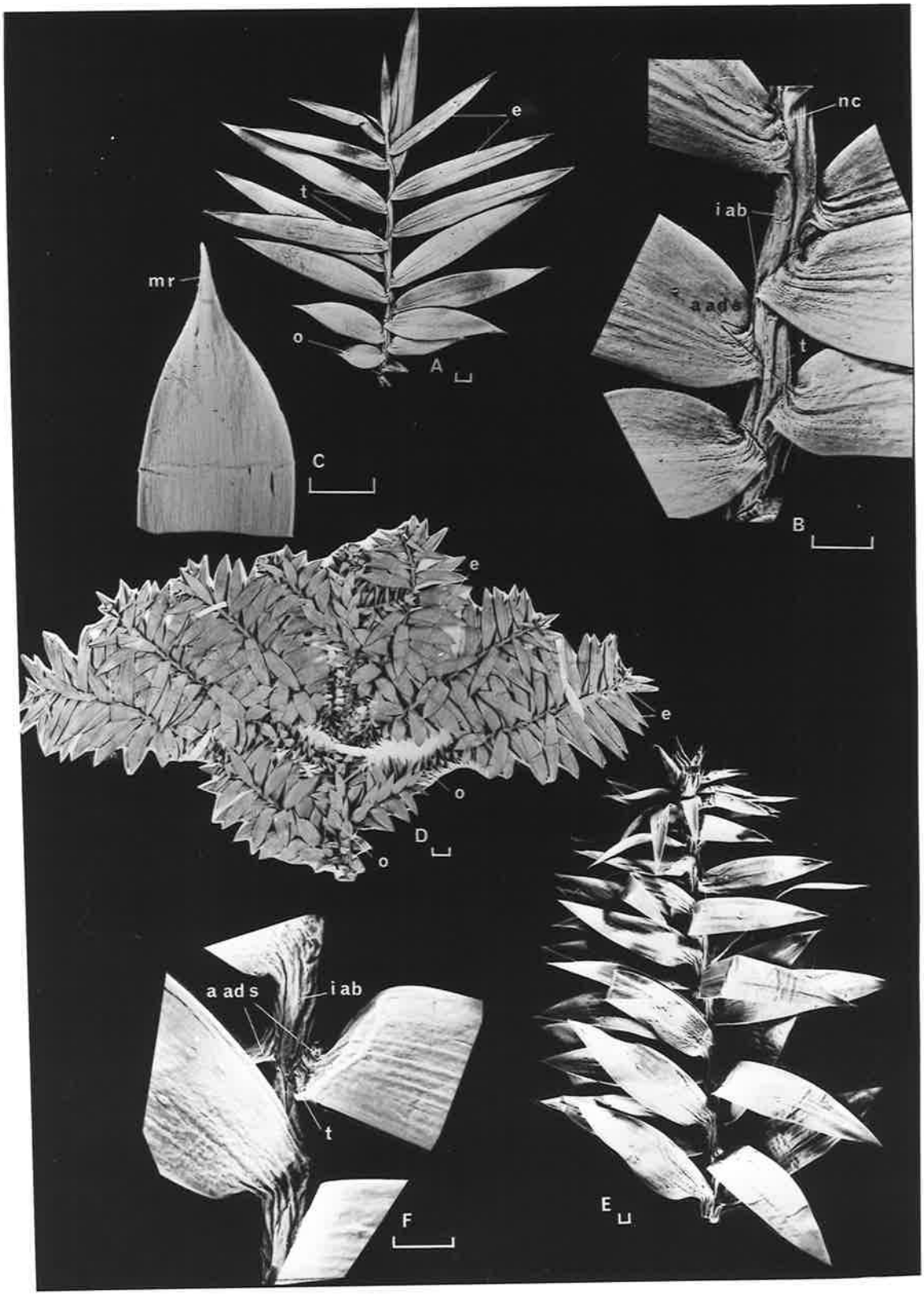
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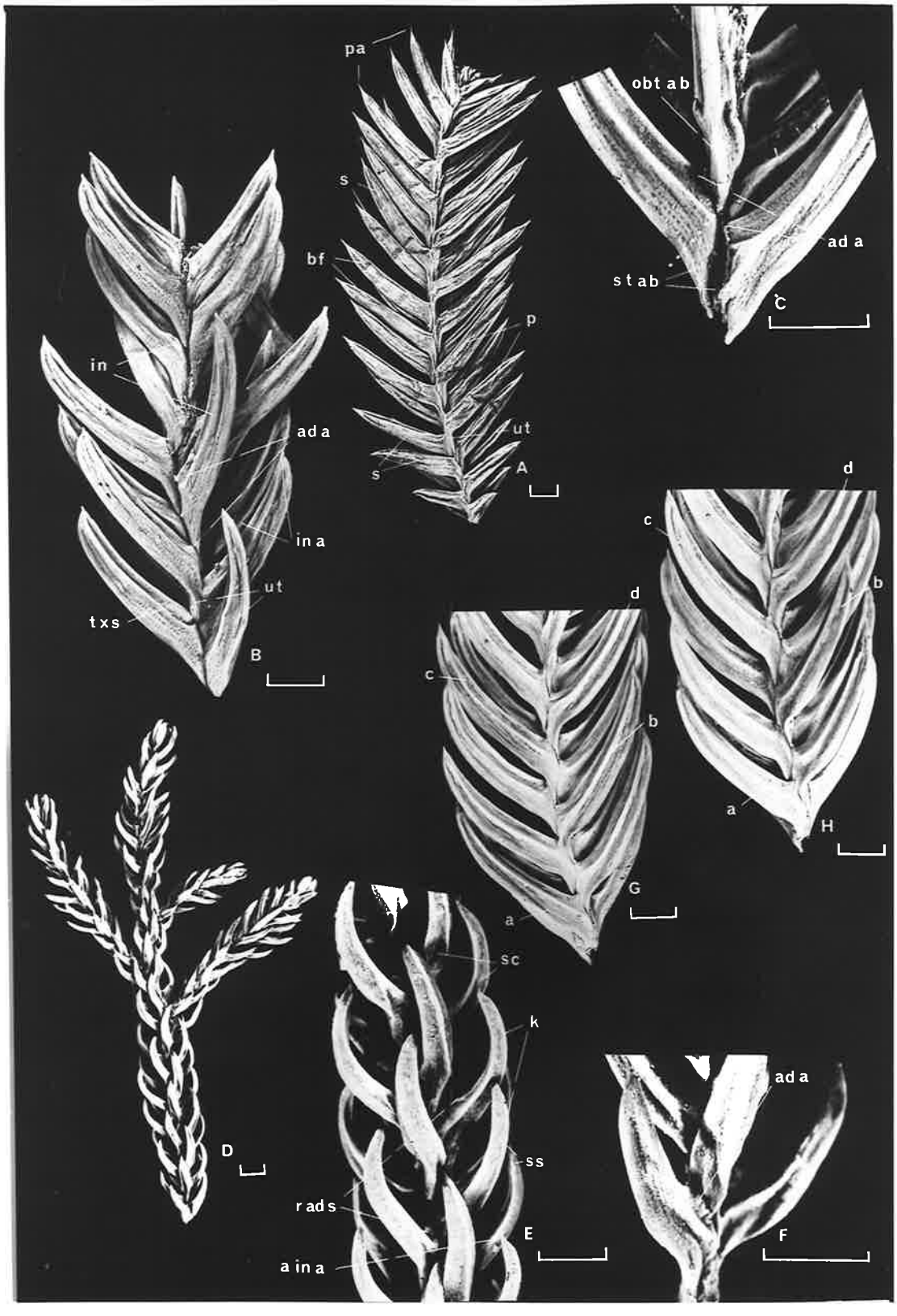
PLATE 6

A-H. *Araucaria cunninghamii.* A-C. Shoots (A,B) and an enlargement of part of a shoot (C) illustrating the juvenile foliage form of this species. Leaves are spirally inserted, but often appear distichous; note the unnatural twisting of adnate bases and blades of leaves of these specimens (A,B,ut). The adnate bases are obtriangular in face view (C,obt ab), shallowly triangular in lateral view (C, st ab); the bilaterally flattened blades (A,bf) are spreading and either straight (A,s) or incurved (B,in) and have a pungent (A,pa), sometimes incurved (B,in a) apex. Note that the blade-surfaces may be planar (A,p) or the blades may be tetragonal in cross-section (B,txs). The original adaxial surface is adnate to the axis (B,C,ad a). D-F. A branched shoot (D) and enlargements of part of a shoot (E) and a few leaves (F) of the mature foliage form. The leaves of this form are spirally inserted (D). Note the keeled abaxial surface (E,k) and steeply sloping (E,ss) or slightly concave (E,sc) lateral faces of the bifacial spreading blades, the adaxial surface becoming ridged (E,r ad s) and adnate to the axis (F,ad a) and the acute, usually incurved apices (E,a in a). G,H. A shoot of the juvenile foliage form of this species photographed before and after soaking in warm water and detergent (G and H respectively). Note that in G the leaves appear distichous, but in H this flattened appearance is not as obvious. On soaking, leaves a to d have regained their natural orientation.

Scale = 2mm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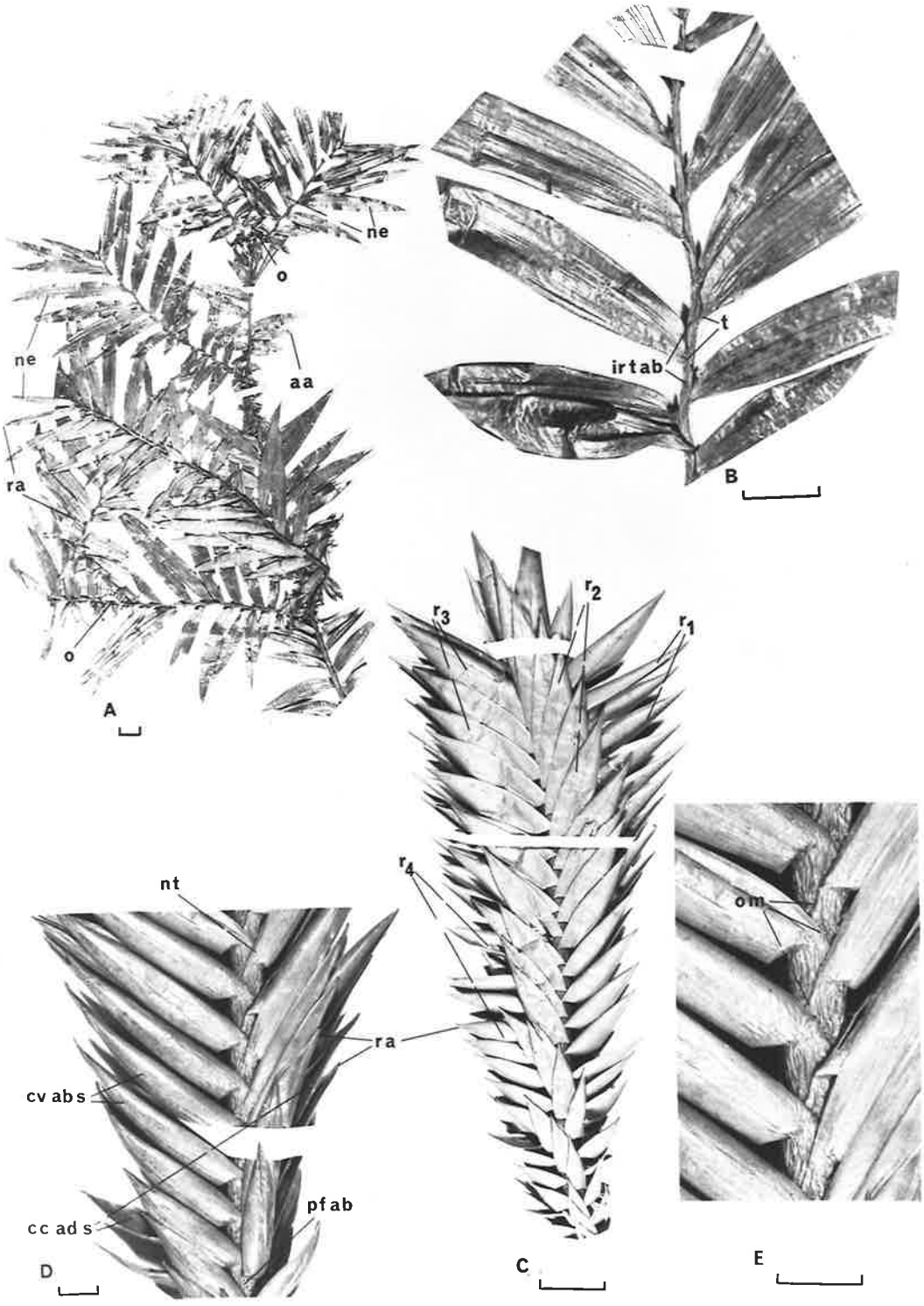
D

PLATE 7

A-E. *Araucaria hunsteinii*. A,B. A herbarium specimen (A) and an enlargement of part of it (B) of the immature foliage of this species. The leaves are spirally inserted, but distichously flattened. The variation in leaf-size is acrotonous; very few of the leaf-blades are ovate (A, o, ovate blade; ne, narrowly elliptical blade). Note the twisting of leaf-blades at their insertion (B,t), the irregularly shaped, twisted adnate bases (B,ir t ab) and the acuminate (A,aa) or rostrate (A,ra) apices. C-E. Mature foliage form. C. A shoot illustrating the acrotonous variation in leaf-size and the distinct rows of leaves (r_{1-5}) found in this foliage form. Only three rows of leaves can be seen clearly in one plane.

D,E. Enlargements of part of a shoot. Note the adnate bases with overlapping margins (E,om); some bases are partially fused to the axis (D, p f ab). The blades are neither constricted nor twisted at their insertion (D, nt), their abaxial surfaces are convex (D, cv ab s), their adaxial surfaces are concave (D, cc ad s) and their apices are rostrate (C,D,ra).

Scale = 1cm


ne
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ne
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cv abs
cc ad s
pf ab
D

PLATE 8

A-C. *Athrotaxis cupressoides.* A. A branched shoot of the mature foliage showing laterals arising in several planes. Note that lateral axes often arise in the axils of two consecutive leaves giving a pattern of three axes (ta). Sometimes a few smaller leaves are borne periodically (sl). B,C. Enlargements of parts of axes bearing mature foliage form leaves. Note the convex (C,cv l f) or irregularly concave (B,cc l f) lateral faces and the denticulate fringe on the margins of the free portion (B, df); only remnants of this remain on older leaves (C,df).

D. *Athrotaxis laxifolia.* A branched shoot illustrating the mature foliage form. This form is an intermediate one between the mature forms of *A.cupressoides* and *A.selaginoides.* Some leaves are more like those of *A.cupressoides* (c); others resemble those of *A.selaginoides* (s).

E-G. *Athrotaxis selaginoides.* E. The immature foliage form. Note the straight (sb) or only slightly incurved (ib) blades and the length of the adnate base; it is longer than that of leaves of the mature form (lab). Some blades appear almost bilaterally flattened (bb); actually these are bifacial with a deeply concave adaxial surface (cc ad s) and a convex abaxial one (cv ab s). F. A shoot illustrating the mature foliage form. Note the spreading and strongly incurved blade (s in b). G. An enlargement of the mature foliage form. Note the concave adaxial surface of these leaves (c ad s), which is adnate to the axis (ad); the basal part is ridged (r ad s), but this ridge is not prominent distally.

Scale = 2mm

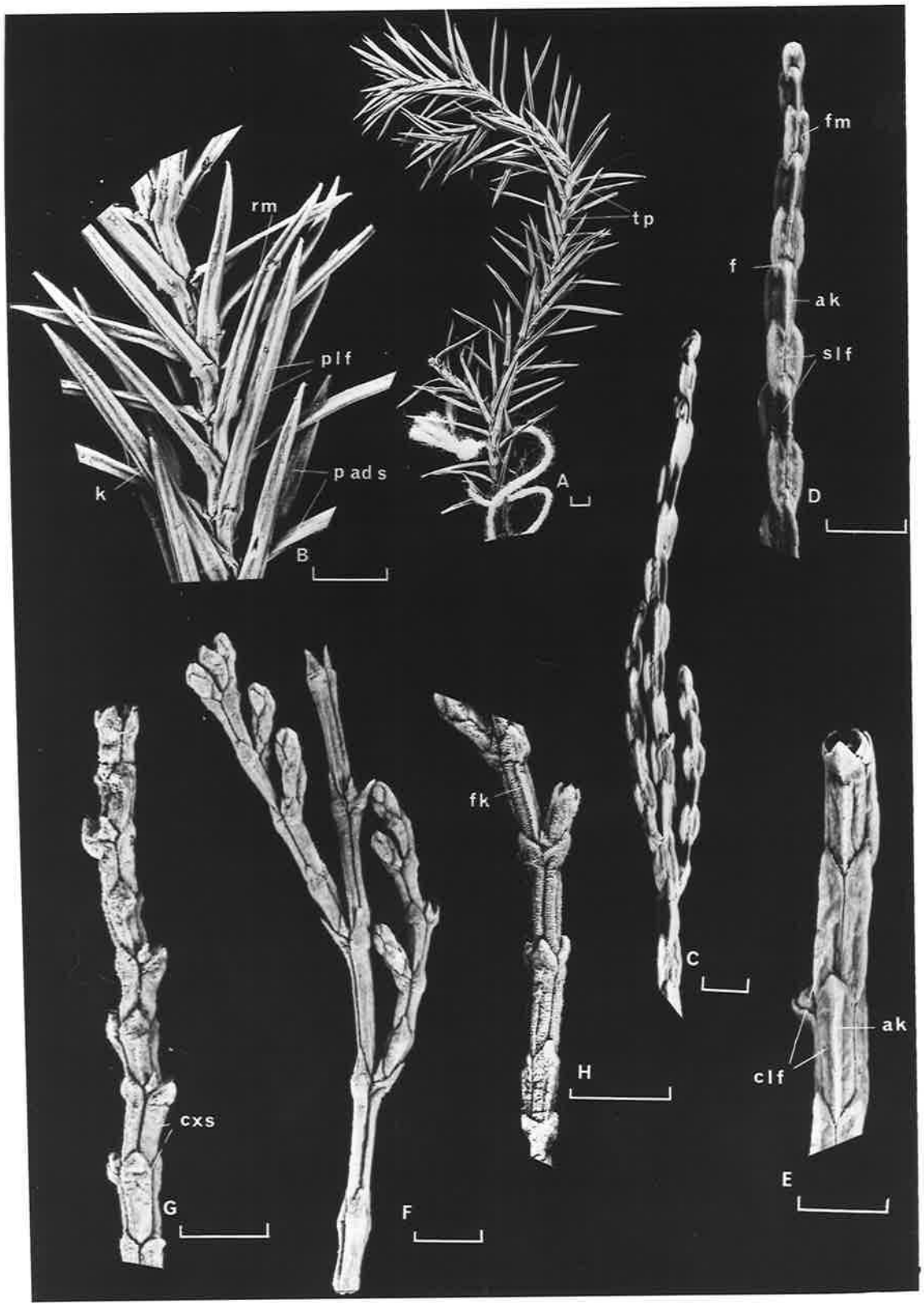

ta
sl
df
cclf
df
sl
cvlf
A
B
C
c
s
D
sinb
sb
bb
lab
ib
cvabs
ccads
E
F
rads
cads
ad
G

PLATE 9

A-E. *Callitris baileyi*. A. A seedling showing the juvenile foliage form. Note the tricussate phyllotaxis (tp). B. An enlargement of part of A. Note the keeled (k) and partially flattened leaf-blades; the lateral faces (plf) and adaxial surface (p ad s) are usually planar. Margins may be slightly revolute (rm). C. A branched shoot illustrating the mature foliage form. The branching is characteristic of that of the mature foliage forms of species of *Callitris*. Usually only a single lateral axis arises at a node. D,E. Enlargements of shoots bearing mature foliage form leaves. Leaves are actually keeled (D,E,ak) with lateral faces sloping at a constant gradient (D, slf) or slightly concave (E, clf). The free portion is flattened onto the bases of subsequent leaves (D, f) and the margins of younger leaves are fused (D,fm).

F-H. *Callitris canescens*. These three shoots illustrate the variation in leaf-size found within the mature foliage form of this species. Note the very long adnate bases of leaves on the main axis of F. Such leaves characterize rapidly developing axes. The leaves of this form are convex in cross-section (G,cxs), but occasionally a small ridge or "false" keel is evident (H,fk).

Scale = 2mm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F
E

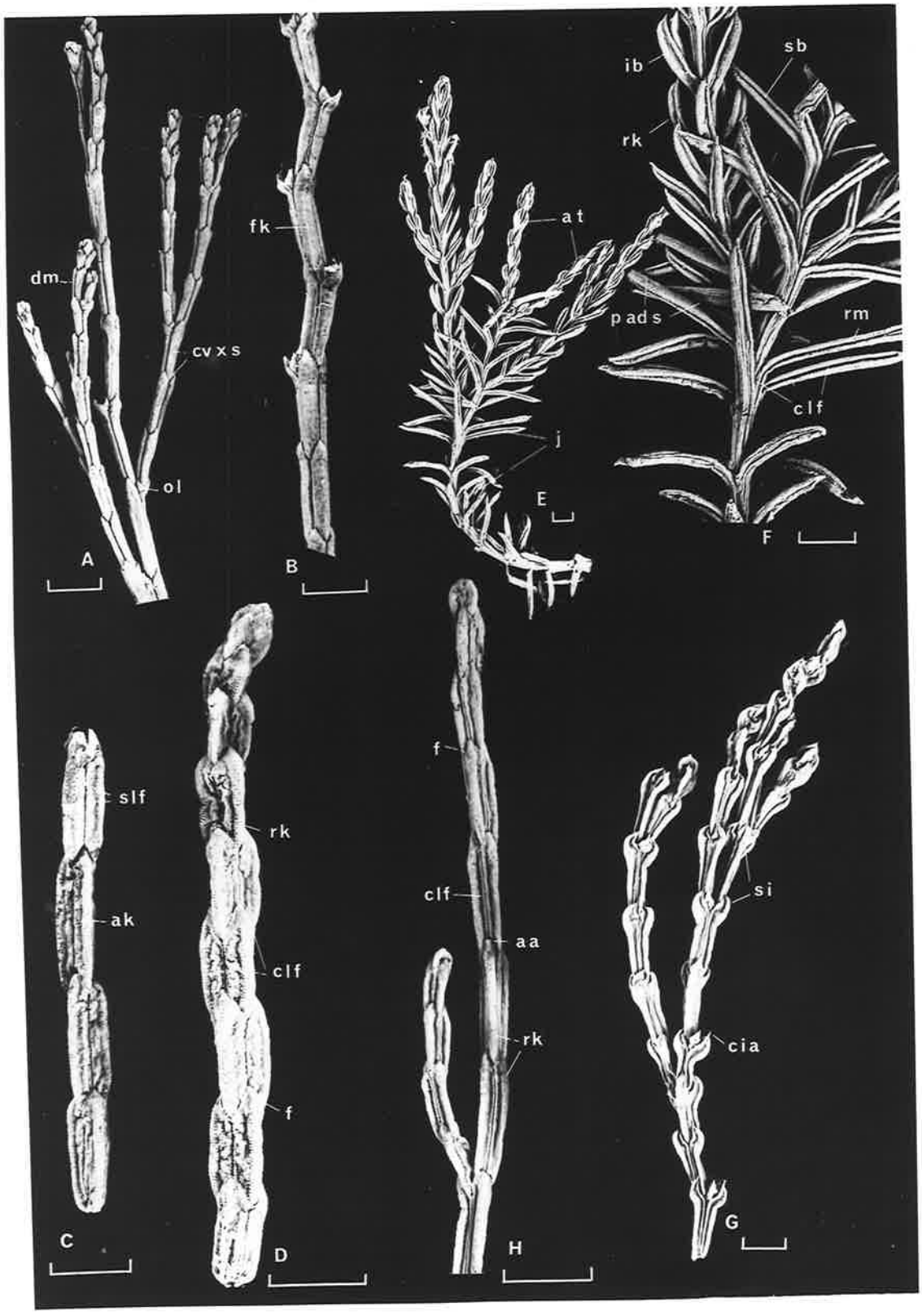
PLATE 10

A,B. *Callitris columellaris*. Branched and unbranched shoots of the mature foliage form. Note that usually only one lateral axis arises at a node (A, ol). The leaves are regular in shape and are convex in cross-section (A,cv x s) or occasionally have a small "false" keel (B,fk). Note that the margins of very young leaves are distinct (A,dm).

C,D. *Callitris drummondii*. Shoots illustrating the mature foliage form of this species. The keel of leaves is acute (C,ak), but sometimes the brow of it becomes rounded (D, rk); lateral faces are steeply sloping (C,slf) or concave above the keel (D,clf); the free portion is flattened onto the bases of subsequent leaves (D,f).

E-H. *Callitris endlicheri*. E-G. Shoots illustrating the juvenile and transitional foliage forms of this species. The gradual changes in blade-length and curvature which culminate in transitional foliage form leaves are shown in E. (j, juvenile foliage form; at, approaching transitional foliage form).
F. An enlargement of part of an axis bearing juvenile foliage form leaves. Leaves have a rounded keel (rk); lateral faces are concave and extend under the keel (clf); the adaxial surface is planar (p ad s) and the margins are revolute (rm). Note the range in blade curvature from straight (sb) to incurved (ib) and the concomitant decrease in length. G. An enlargement of a branched axis bearing transitional foliage form leaves. The characteristics of these leaves closely resemble those of leaves of the mature foliage form. Note the slightly spreading and incurved free portion (si) and the cuspidate incurved apex (cia).
H. A branched shoot of the mature foliage. Note that the free portion is flattened onto the bases of subsequent leaves (f), the keel is rounded (rk), lateral faces are concave (clf) and the apex is acute (aa).

Scale = 2mm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si
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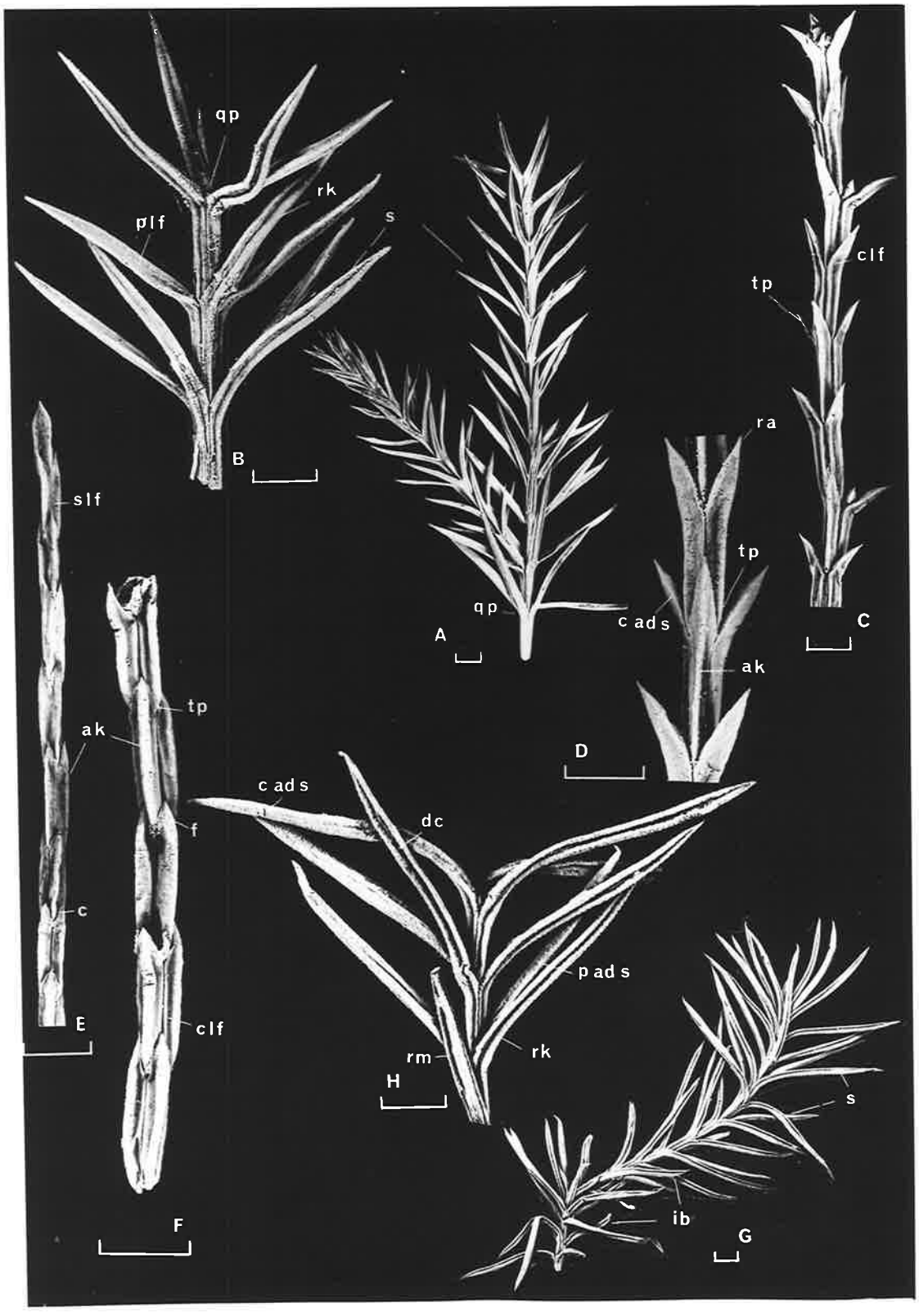
PLATE 11

A-F. *Callitris macleayana*. A,B. A branched shoot (A) of the juvenile foliage and an enlargement (B) of a few whorls of leaves. The phyllotaxis of this form is usually quadricussate (A,B,qp) and leaf-blades are straight (A,B,s). Note the rounded keel (B,rk) and the flattened, almost planar, lateral faces (B,plf). C,D. A shoot (C) and an enlargement of part of it (D) to illustrate the transitional foliage form of this species. In these illustrations the leaves are tricussately inserted (C,D,tp), but a quadricussate arrangement may occur. Note the acute keel (D, ak) and slightly concave lateral faces (C,clf) of the free portion. The adaxial surface is convex (D,c ad s) and the apex rostrate (D, ra).

E,F. Shoots illustrating the mature foliage form. Note the tricussate phyllotaxis (F,tp), acute keel (E,F,ak), and steeply sloping (E,slf) or slightly concave (F,clf) lateral faces of the adnate base. Free portions are usually not flattened onto the bases of subsequent leaves (E,c), but sometimes flattening occurs (F,f).

G,H. *Callitris muelleri*. A shoot of the juvenile foliage form (G) and an enlargement of a few whorls of leaves (H). Blades of this form are straight (G,s) or slightly incurved (G,ib). Note the rounded keel (H,rk), convex (H,c ad s) or planar (G,p ad s) adaxial surface, and the strongly revolute margins (H,rm); the latter give the lateral faces a deeply concave appearance (H,dc).

Scale = 2mm


qp
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D
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c ads
dc
f
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E
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PLATE 12

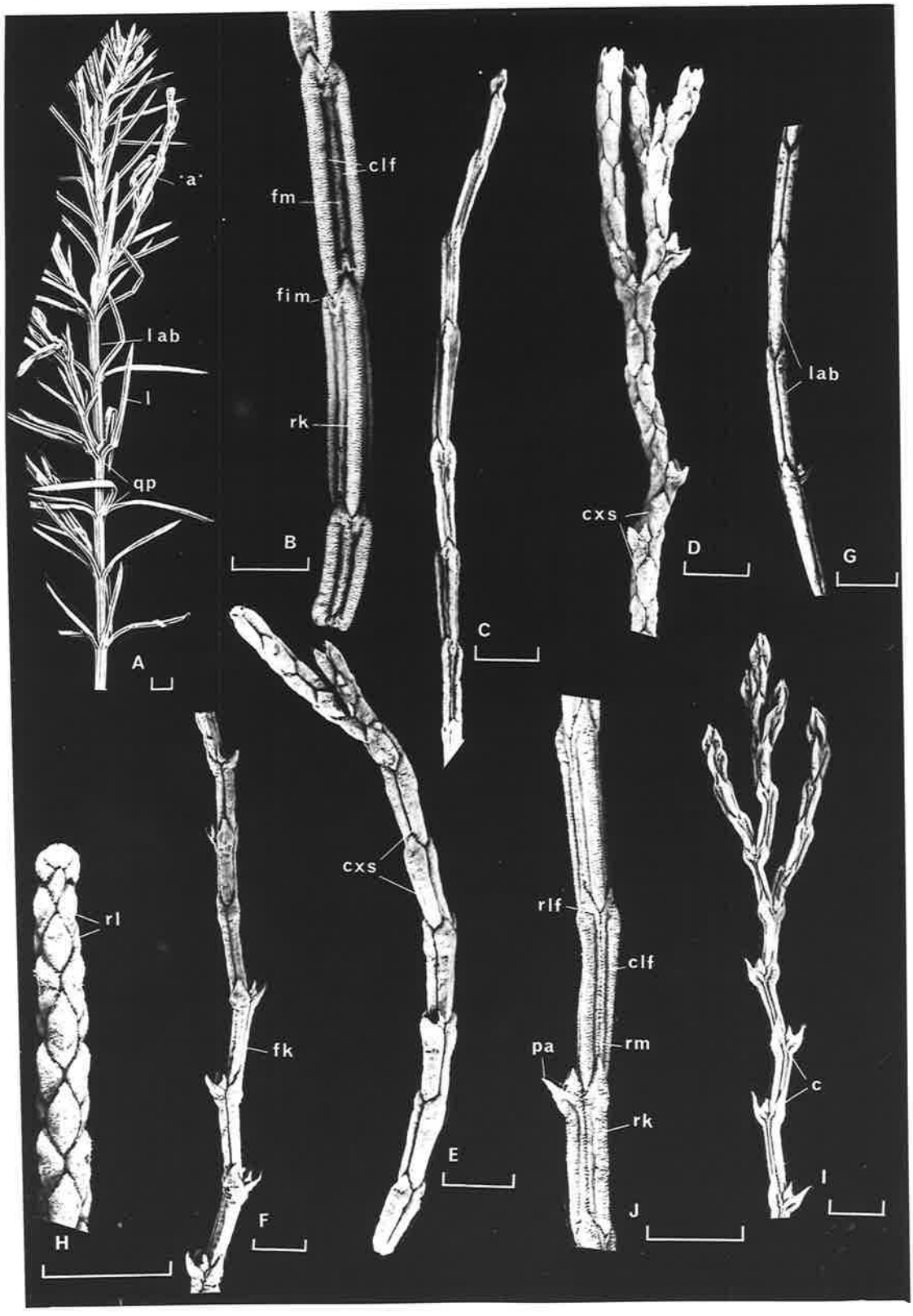
A,B. *Callitris muelleri*. A. Part of a shoot bearing leaves of the juvenile foliage form. Note the quadricussate phyllotaxis of this specimen (qp), and the very long adnate bases (lab) and blades (l) of most leaves; the latter signify a rapidly developing axis. The change from juvenile to mature forms in the space of a few internodes is illustrated (lateral a). B. A few whorls of leaves of the mature foliage form. Note the rounded keel (rk), the concave lateral faces which extend under the keel (clf), the fused margins of the adnate base (fm) and the fimbriate margins of the free portion (fi m).

C. *Callitris oblonga*. A shoot bearing leaves characteristic of the mature foliage form.

D-H. *Callitris preissii*. Shoots of the mature foliage of this species. These illustrate how differences in leaf-size alter the general appearance of the shoot. Most leaves are convex in cross-section (D,E,cxs), but sometimes thinner leaves have a "false" keel (F,fk). Note the long adnate bases of leaves borne on rapidly developing axes (G,lab) and the rhomboidal form of leaves where the internodes are very short (H,rl).

I,J. *Callitris rhomboidea*. I. A branched shoot of the mature foliage form. Note the complanate free portions (c). J. A few whorls of leaves of the mature foliage form. Note the rounded keel (rk), the concave lateral faces (clf) which become reduced distally (rlf) and the ridged margins of the adnate base (rm). The keel extends into a pungent apex (pa).

Scale = 2mm


a
lab
l
qp
A
clf
fm
fim
rk
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D
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rl
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rlf
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pa
rm
rk
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I
H
F

PLATE 13

A,B. *Callitris roei*. Shoots illustrating the mature foliage form. Note that the free portion is flattened onto the bases of subsequent leaves (A,f), the keel is acute (B,ak) or slightly rounded at the brow (A,rk), and the margins sometimes form a ridge (A,ri m).

C,D. *Dacrydium novo-guineense*. C. A shoot representing the juvenile foliage form of *D.elatum* and *D.novo-guineense*. Note the very fine, needle-like leaves with almost acicular blades.
D. An enlargement of part of C showing in particular the entire, revolute margins of the adnate base (erm) and the adaxial surface of the blade which is adnate to the axis for a short distance (a ad s). Also note the ridged abaxial surface of the blades (r), the planar (plf) or concave (clf) lateral faces and the revolute margins (rm).

E-H. *Dacrydium elatum*. I. *Dacrydium novo-guineense*.
E. A branched shoot showing the spirally inserted leaves with bifacial, spreading and incurved blades of the foliage form of *D.elatum* and *D.novo-guineense* treated in Description 1 (Chapter V,p.100). F. An enlargement of part of E showing the keeled (k ab s) or ridged (E,r ab s) abaxial surface of the leaves, the sloping (slf) or almost planar (plf) lateral faces and the slightly fimbriate margins (fm). G-I. Shoots illustrating the variation in leaf-size and blade-curvature which is found in this foliage form.

Scale = 2mm

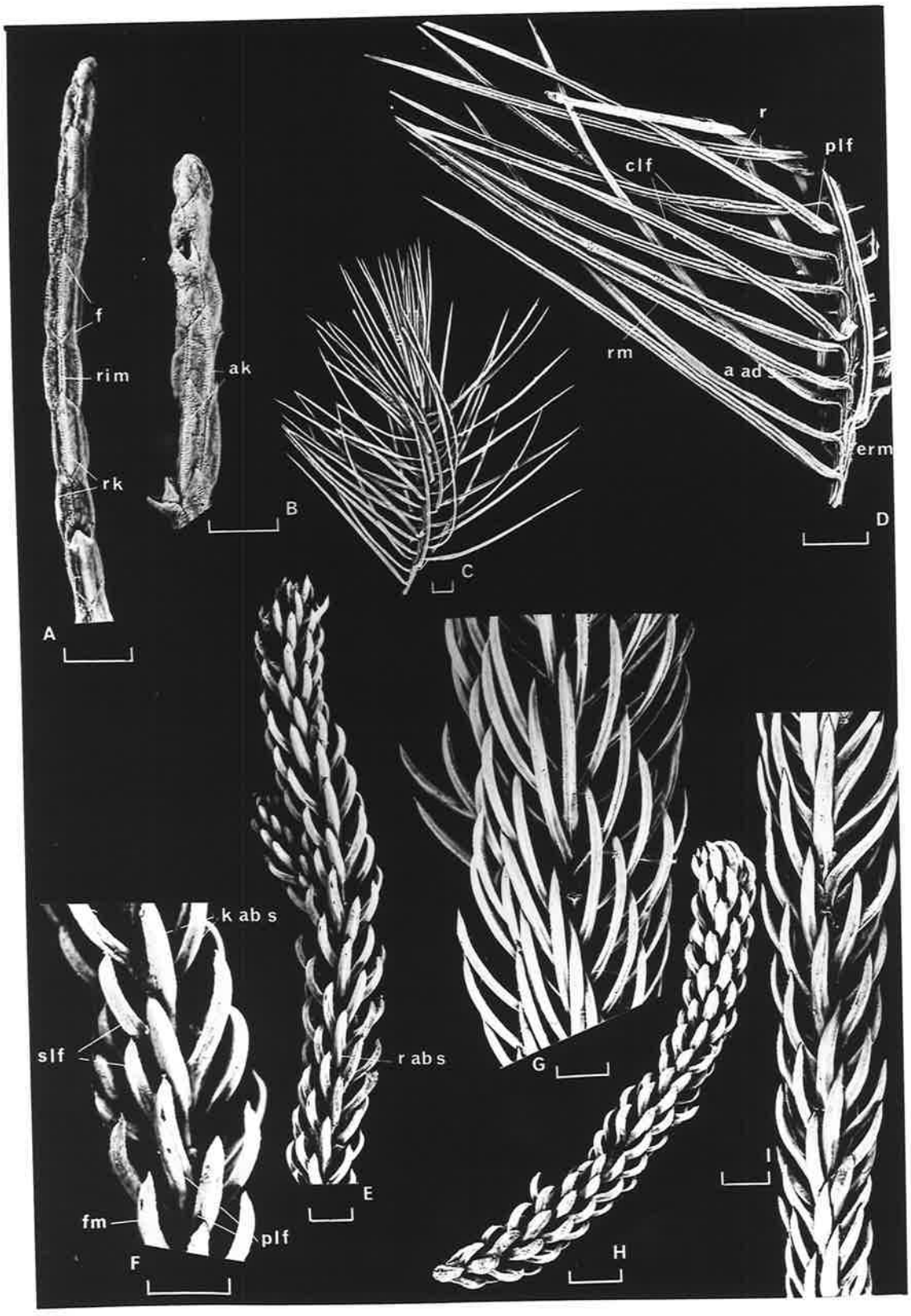
f
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PLATE 14

A. *Dacrydium novo-guineense.* A shoot bearing leaves of the foliage form treated in Description 1 (Chapter V, p.100). Note the variation in blade-length and curvature and the twisting of blades around the axis (tb).

B,C. *Dacrydium elatum.* B. A shoot showing spirally inserted leaves with blades which are spreading and incurved,or spreading and incurved distally and tetragonal in cross-section. These characterize the foliage form of *D.elatum* and *D.novo-guineense* covered by Description 2 (Chapter V, p.102). C. An enlargement of part of B. Note the keel on both the abaxial (k ab) and adaxial (k ad) surfaces which gives the tetragonal cross-section (txs), and the concave (clf) or sloping (slf) lateral faces.

D-F. *Dacrydium novo-guineense.* D. A branched shoot bearing scale-like, spirally inserted leaves characteristic of the foliage form of *D.elatum* and *D.novo-guineense* treated in Description 3 (Chapter V, p.103). E. An enlargement of part of D. The free portion of these leaves slightly overlaps the bases of subsequent leaves (so), the abaxial surface is convex (c ab s) or keeled towards the base (k), and the margins of the free portion are fimbriate (fm). F. The leaves of this shoot are twisted around the axis. The foliage form is that treated in Description 3 (Chapter V, p.103).

G,H. *Dacrydium falciforme.* Shoots illustrating the mature foliage form of this species. Leaves have bilaterally flattened blades (C,H,bf), which are slightly constricted at their insertion (H,sc) and are traversed by a median vein expressed as a fine ridge (H,rmv); this is usually more prominent on the upper surface (H,us). The adnate base is sometimes fused to the axis (H,fab). Note the small bifacial leaves (G,H,bl) and partially bilaterally flattened leaves (G,H,pbfl) which occur on these axes; also note the acrotonous growth pattern (H) and the artificial flattening of the spirally inserted leaves (G,H).

Scale = 2mm for A-F,H

Scale = 1cm for G

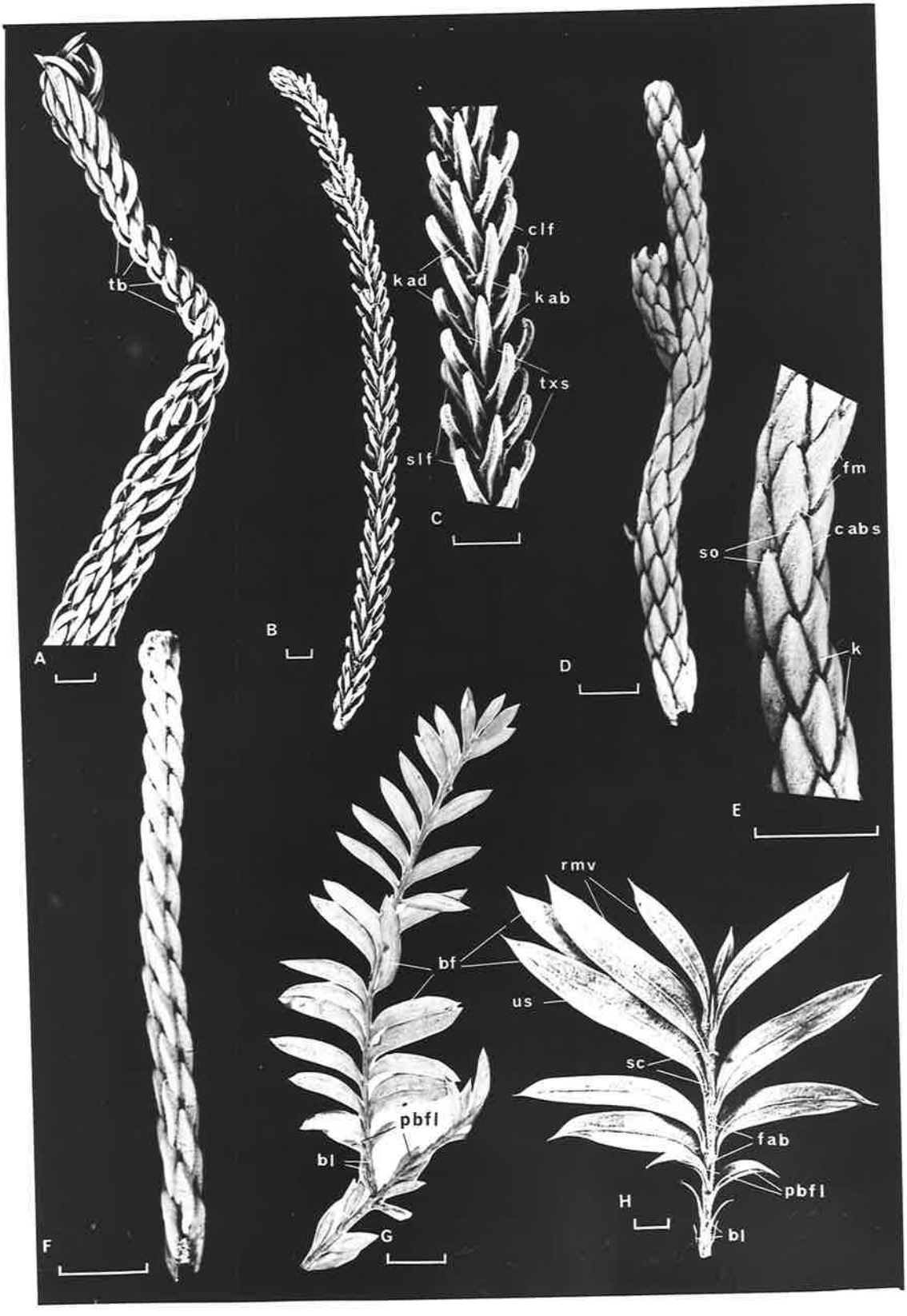
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PLATE 15

A,B. *Dacrydium falciforme.* A. Part of a shoot showing the lower surface of the bilaterally flattened leaf-blades of the mature foliage form of this species. Note the indistinct median ridge (in m r). B. An enlargement of the bifacial leaves (bl) borne at intervals along the axis (bfl, bilaterally flattened leaf).

C-G. *Dacrydium franklinii.* C. A branched shoot bearing the scale-like, spirally inserted leaves characteristic of the mature foliage form of this species. Note that the branching is not restricted to a single plane. D,E. Enlargements of shoots bearing mature foliage form leaves. These leaves may be appressed (D,al) and have complanate free portions (D,c), or have slightly spreading free portions (E,s) with convex adaxial surfaces (E,cv ad s), which are adnate to the axis (E,a ad s). The abaxial surfaces of leaves are keeled (D,E,k); the keel may be rounded apically (D,ra). The lateral faces are triangularly concave (D,E,tc). Note the fimbriate margins (D,fm) of the free portions of younger leaves. F. Mature foliage form. Note the occurrence of smaller leaves at intervals along the axis (sl). G. A branched axis of the mature foliage form. Note the larger leaves on the main axis (ll); in many cases the adnate bases (ab) of these leaves are longer than the free portions (fp).

H,I. *Diselma archeri.* A shoot (H) and an enlargement of part of it (I) illustrating the mature foliage form of this species. The free portions of leaves overlap the bases of subsequent leaves (H,I,o). The abaxial surfaces of leaves are keeled, at least distally (I,kd) and may be keeled (H,k) or grooved towards the base (I,g); the lateral faces are steeply sloping distally (I,slf). Note the decussate insertion and tetragonal axes (aba, acute basal angle).

Scale = 2mm

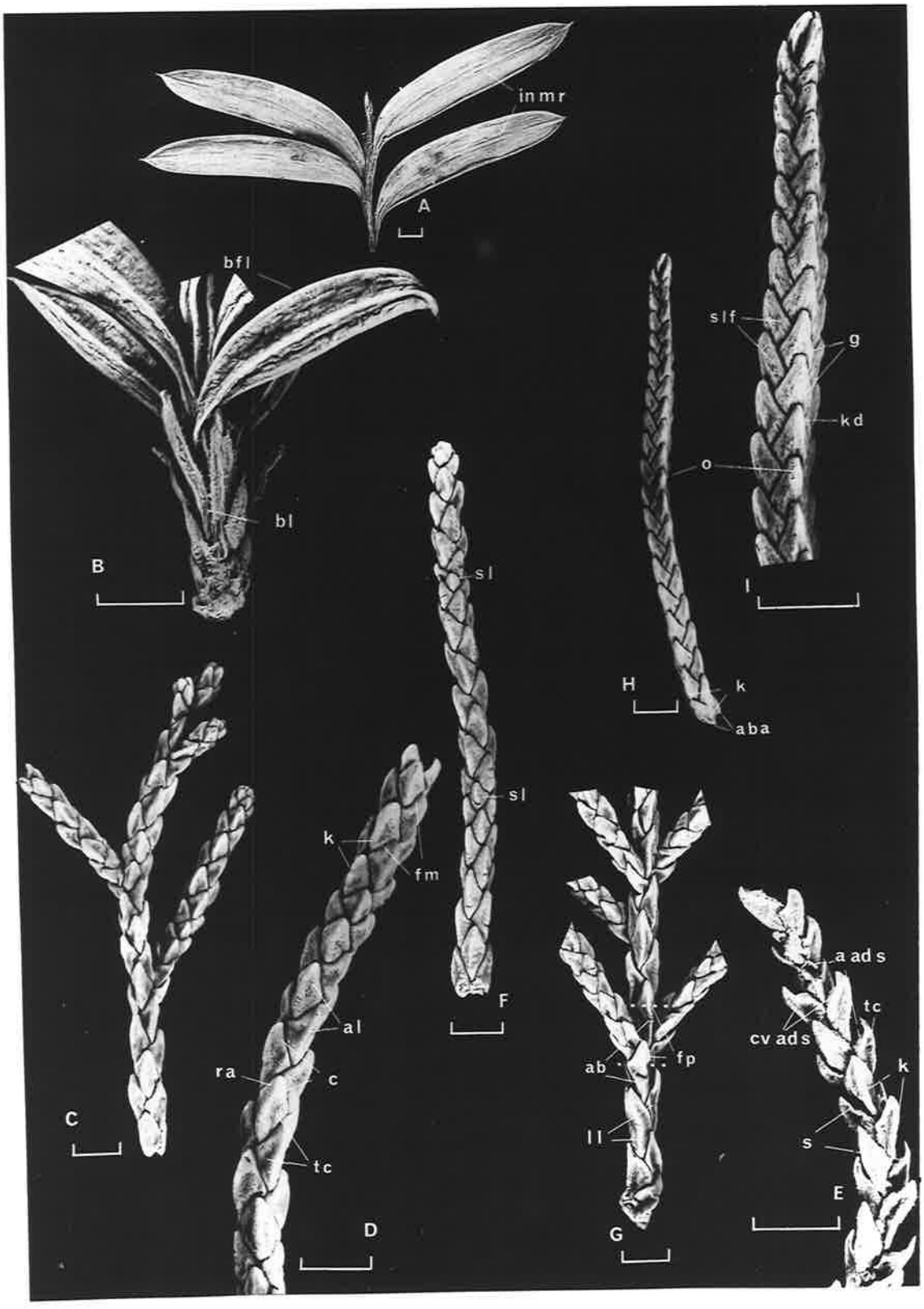
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PLATE 16

A-G. *Microcachrys tetragona*. A-C. Branched shoots of the mature foliage. The variation in appearance of these shoots is caused by small differences in leaf-shape. Note the decussate insertion, tetragonal axes (B,C,ta), and branching in several planes. D-G. Enlargements of shoots illustrating differences in leaf-shape. D,E. The leaves of these shoots are trullate; the free portions of those of D overlap the bases of subsequent leaves (D,ov), the abaxial surface is keeled distally (D,kd), but becomes grooved towards the base (D,gb), the lateral faces are convex (D,cv l f) becoming steeply sloping distally (D,slf); the free portions of leaves of E only slightly overlap the bases of subsequent leaves (E,s ov) and the abaxial surface is only slightly (E,sgb) or not (E,ngb) grooved at the base. Note the fimbriate margins of the free portions (D,fm). F. The adnate bases of leaves on the main axis are sometimes irregularly oblong (ioab); this is caused by disproportionate elongation. G. Note the approximately rhombic leaves (ar) borne on the main axis of some specimens.

H-J. *Microstrobos fitzgeraldi*. H. A branched shoot bearing spirally inserted leaves with bifacial spreading and incurved blades. These leaves characterize the mature foliage form of this species. I. An enlargement of part of H. Note the keeled abaxial surface (k ab s) and concave lateral faces (cc l f) of some leaves; the adaxial surface is concave (cc ad s), but becomes adnate to the axis for a short distance at its insertion (ad a). J. A branched shoot bearing mature foliage form leaves some of which have almost straight blades (sb), with strongly incurved mucronate apices (ma); these leaves are usually smaller and more "scale-like".

Scale = 2mm

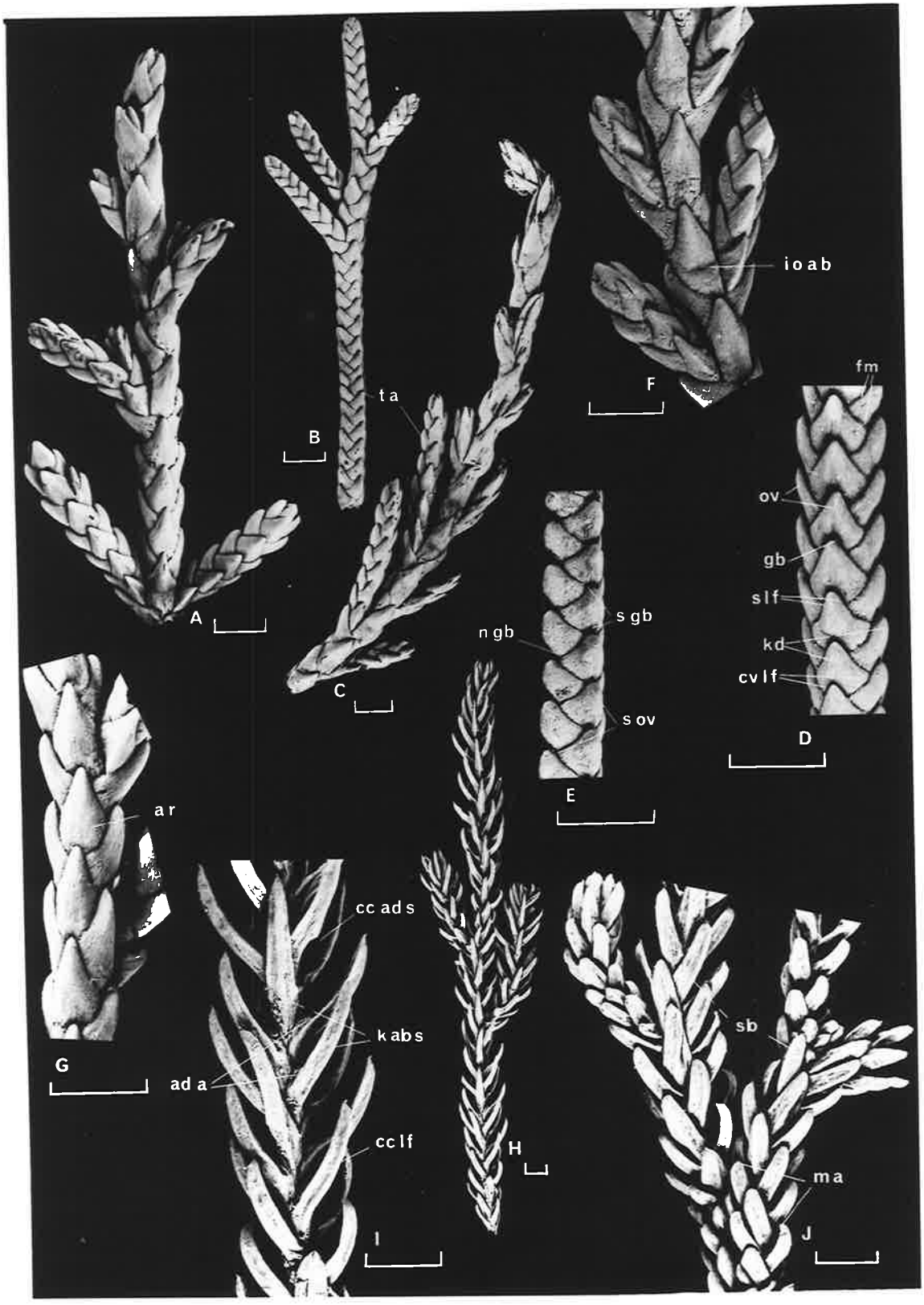
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PLATE 17

A-D. *Microstrobos niphophilus*. A. A branched shoot of the mature foliage. Note the lateral axes arising in several planes and the few smaller leaves on some axes (sl). B,C. Enlarged shoots bearing mature foliage form leaves. The leaves of B are scale-like and trullate, with the free portion flattened onto the bases of subsequent leaves (B,f); they are characteristic of the mature foliage form. Those borne on C are larger and are found infrequently on rapidly developing axes. Note that they are either rhombic (C,r) or have an irregularly oblong adnate base (C,ioab);; the free portion is complanate (C,c) and sometimes the apex is incurved (C,in a). Smaller leaves are borne on the central axis of B (sl). D. *Curtis*, Jan. 1942, specimen 1(AD). Note the leaves on the lower axes with spreading and incurved blades (l). These rapidly grade into those of the mature foliage (ml).

E-G. *Papuacedrus sp.* E. A seedling bearing the juvenile foliage of this genus. F. An enlargement of part of E. Note the quadricussate phyllotaxis (qp), the narrowly elliptical, bifacially flattened, spreading leaf-blades (ne) and the approximately linear adnate bases (al); the median vein appears as a ridge on the abaxial surface (rmv). G. A slightly older seedling than E. The juvenile foliage (j) has been replaced by the transitional foliage (t) on developing lateral axes.

Scale = 2mm for A-C, E-G

Scale = 1cm for D

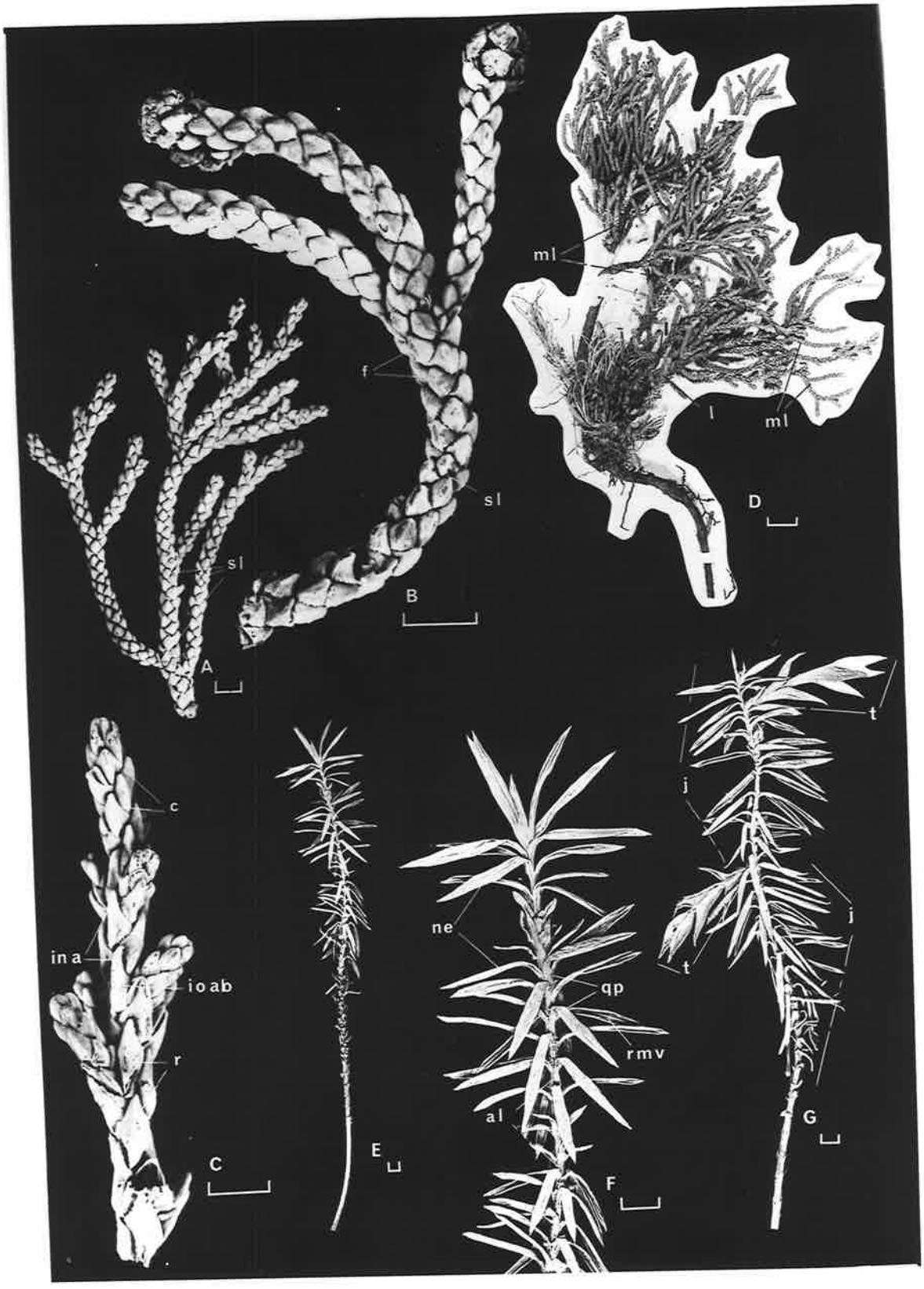
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PLATE 18

A-H. *Papuacedrus sp.* A. Part of a seedling showing the gradual change from the juvenile (rj, reduced juvenile form) to transitional (t) foliage form leaves on the main axis (b, blade). B-H. Shoots and enlargements of parts of them illustrating the variation in leaf-shape found in the transitional foliage form. (ml, marginal leaf; fl, facial leaf; cp, connate pair; al, apical lobe). B. Note that the lateral axes arise in one plane in the axils of marginal leaves and commence with a pair of facial leaves. C,D. Enlargements of B. Note the short, appressed and rounded apical lobes of C; these may (C,f) or may not (D,nf) appear distinctly free. In D a connate pair of marginal leaves occur at the apex of the shoot. Note the indistinct emarginate apex (D,ea). E,F. Enlargements of the upper (E) and lower (F) surfaces of marginal leaves with long, spreading apical lobes (al). The upper surface is astomatic; stomates are borne in rows on the lower surface. Note the revolute margins (F,rm). G. The lower surface of a branched shoot. Note that the leaves curve towards the lower surface; the lower surface of the connate pair of marginal leaves is concave (cc s) and the upper one is convex (cv s). Also note the apical lobes of leaves borne on the main axis; they are only partially flattened (ad s, adaxial surface) and are spreading and incurved (s in). H. The leaves of this specimen are only partially bilaterally flattened. Note the incurved apical lobes of the marginal leaves (in a l).

Scale = 2mm

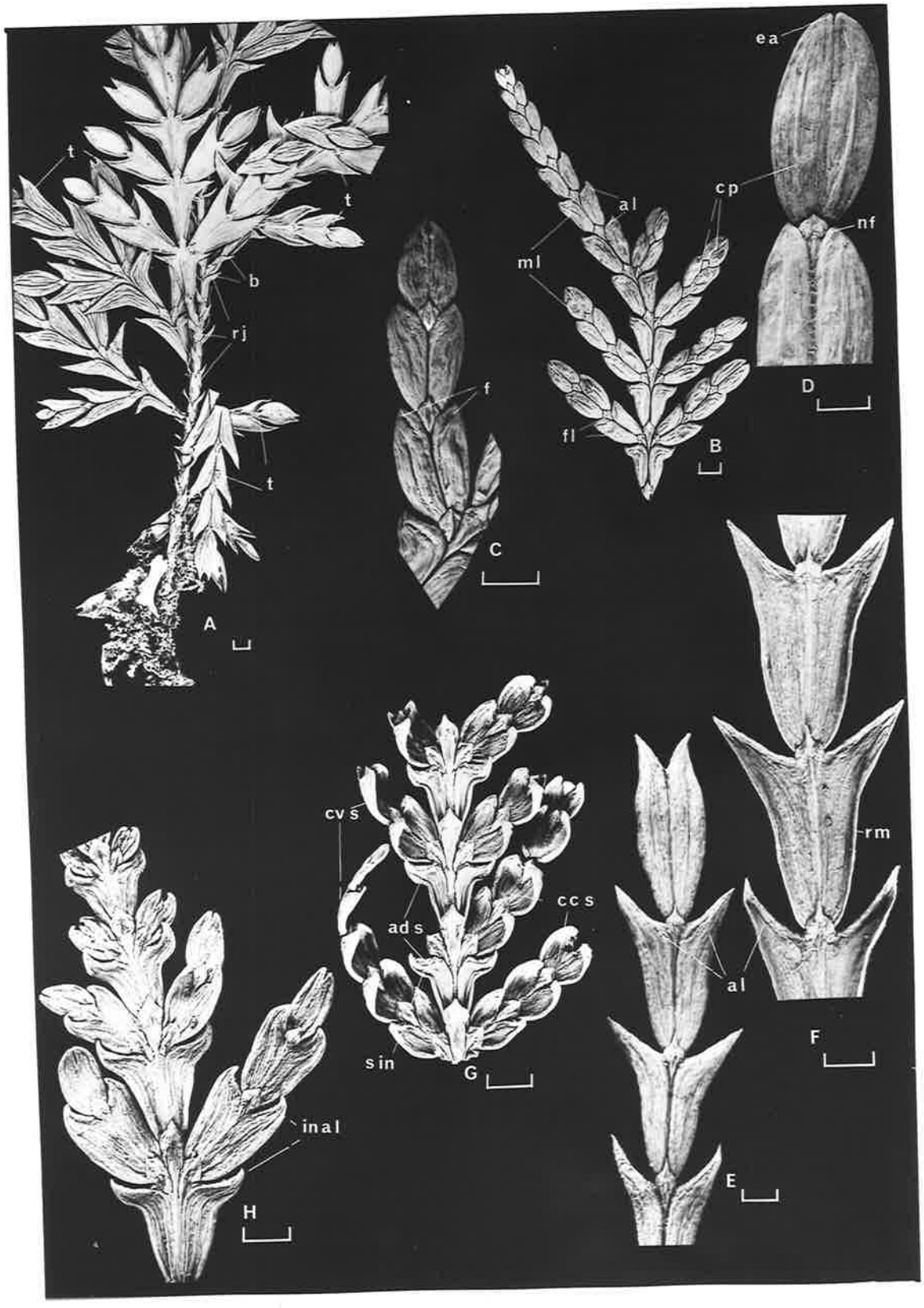
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PLATE 19

A-D. *Papuacedrus sp.* A. A branched shoot of the dimorphic mature foliage of this genus. Note that branching is restricted to a single plane and that lateral axes arise in the axils of marginal leaves (ml) and commence with a pair of facial leaves (fl).

B,C. Enlargements of part of A showing subtetragonal axes (B,sa), spreading and incurved free portions of leaves of main axes (C,s in) and the increased size of the facial leaves of main axes (C,lfl). Also note the difference in size of facial and marginal leaves (B,ml, fl); marginal leaves are larger and bifacial (B,b), and their surfaces are not differentiated. D. Part of a branched shoot; the homomorphic mature foliage form of this genus is borne on the lateral axes (hm). Note the subtetragonal axes (sa) and the absence of distinct facial and marginal leaves.

E-G. *Phyllocladus asplenii folius.* E. A seedling bearing leaves of the juvenile foliage form (j) and two cladodes (c). Note the spirally inserted leaves with bifacially flattened, spreading blades (bs).

F. An enlargement of part of A showing in particular the approximately oblong adnate base (ao), the ridged abaxial surface (r ab s), the adaxial surface of the blade with no vein visible (ad s) and the revolute margins (rm). G. Part of a shoot showing incompletely formed cladodes. Note the deeply serrated, irregular margins (sim) and the unfused ends of leaf-blades (lb).

Scale = 2mm

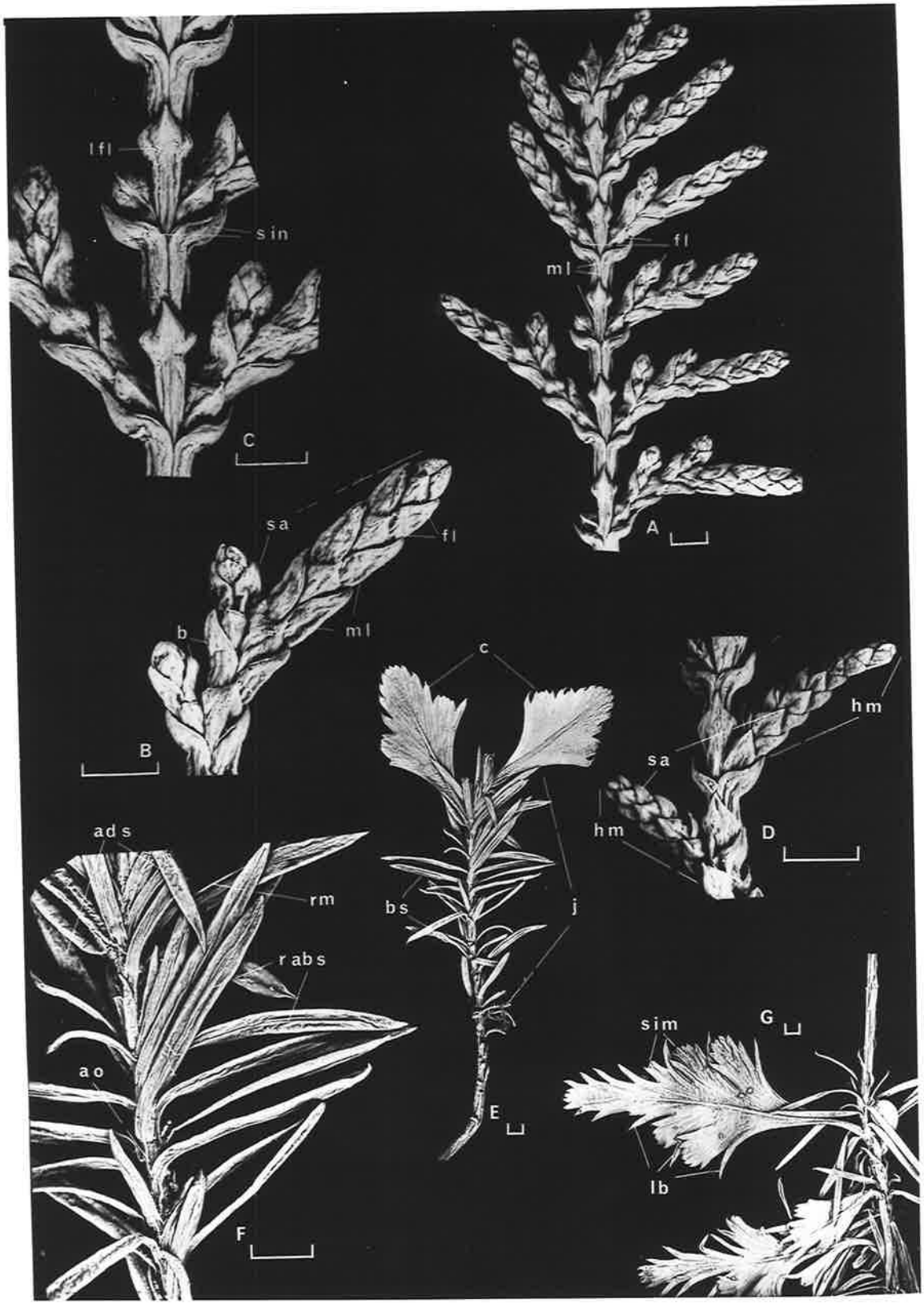
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PLATE 20

A-C. *Phyllocladus asplenii folius*. A. A shoot illustrating the mature foliage form of this species. Note the scale-leaves inserted spirally on the axis (sl) and the approximately rhombic cladodes (c) with partly entire (em) and partly serrated (sm) margins. B. An enlargement of part of the axis of A showing the linear-triangular to narrowly triangular free portions of the scale-leaves (fp), and the ridge or keel on their abaxial surface (r). This ridge or keel persists (pr) after fusion of the remainder of the adnate base (fab). Note that each cladode is borne in the axil of a scale-leaf. C. Cladodes of the mature foliage form illustrating the variation in shape and secondary lobing of the distal part of the cladode (sc l).

D,E. *Phyllocladus hypophyllus*. D. A sapling showing the remnants of the juvenile foliage form of this species (j), scale-leaves (sl) and the cladodes which characterize the transitional foliage form (c). Note that the cladodes appear distichous. E. An enlargement of a cladode of the transitional form. Note the approximately trullate shape (tc), the irregularly incised or lobed distal margins (im) "toothed" by the remains of true leaves (t) and the distinct free portion of the first scale-leaf (D,fsl); this may dry and drop off (E,dsl).

Scale = 1cm

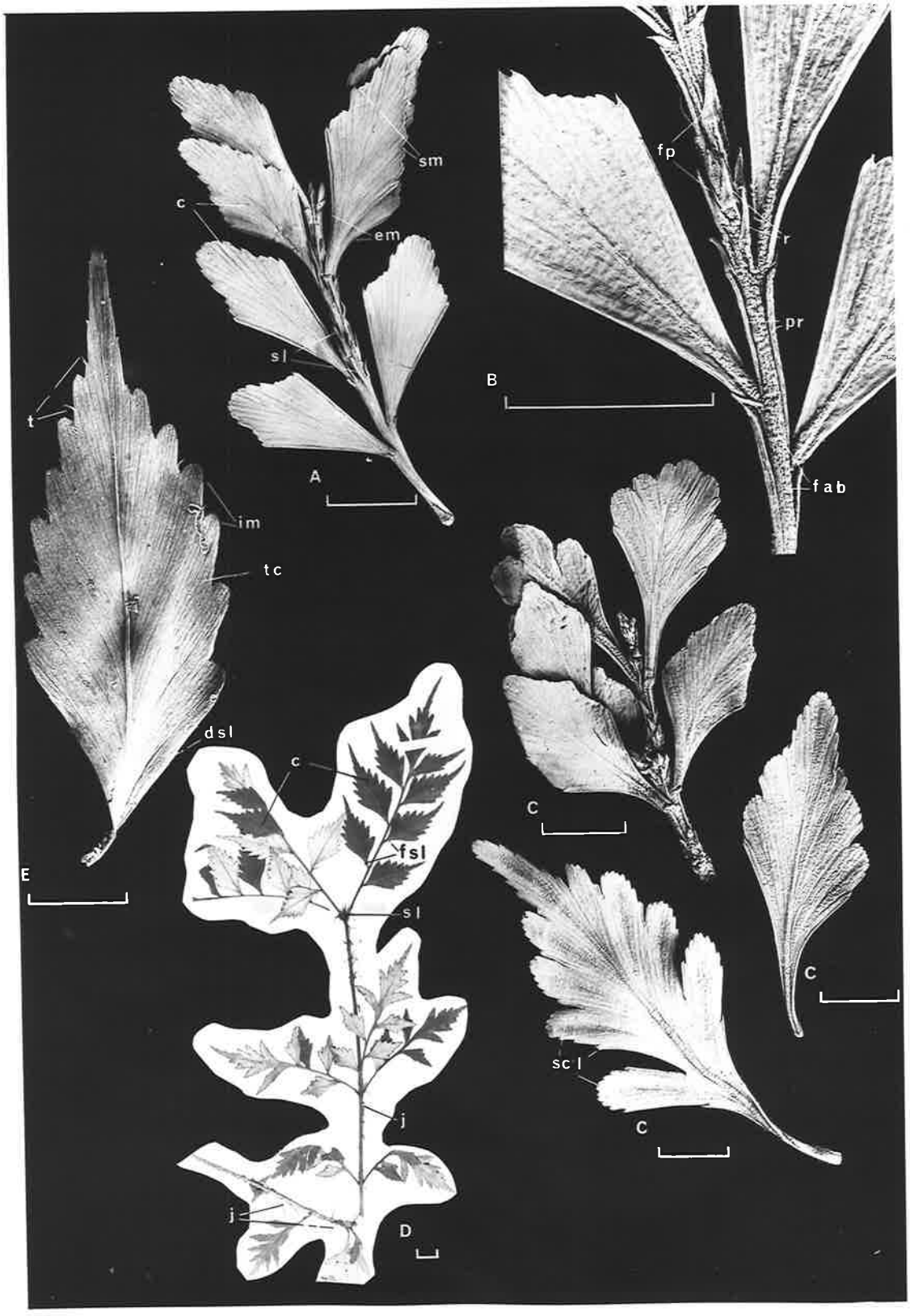
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PLATE 21

A-C. *Phyllocladus hypophyllus*. A. Part of a herbarium specimen of the mature foliage form. Note that the approximately trullate cladodes (c) have been distichously flattened, thus appear to be inserted alternately. B. An enlargement of an axis of the mature foliage form. Note the vein as a ridge (r) and the distinct fusion lines (fl) on the upper surface of the cladode(c). The rounded keel of the adnate base of the scale-leaves persists on the axis (rk) and the distal part of the scale-leaf remains unfused on the side of the cladode (usl). The distal margins of the cladodes are slightly crenate (cm). C. Cladodes illustrating some of the variation in size, lobing and margins found in the mature foliage form.

D-F. *Podocarpus alpinus*. D. A branched axis showing the spirally inserted leaves of the mature foliage form. Note that the leaves are not pseudowhorled, that the distinct adnate bases (ab) are irregular in shape (ir) and variable in length (F,vl). Also note that the blades are usually not twisted at their insertion (nt) and are only slightly constricted (sc). E. Enlargements of leaf-blades of D showing the adaxial surface (ad s) with an invisible median vein and the abaxial surface (ab s) with the median vein as a broad ridge (rmv). Note the absence of a "false" petiole (nfp) and the broadening of the median vein towards the centre of the blade (b).
F. An axis devoid of leaf-blades. Note the distinct adnate bases of varying lengths (vl).

Scale = 2mm for D-F

Scale = 1cm for A-C

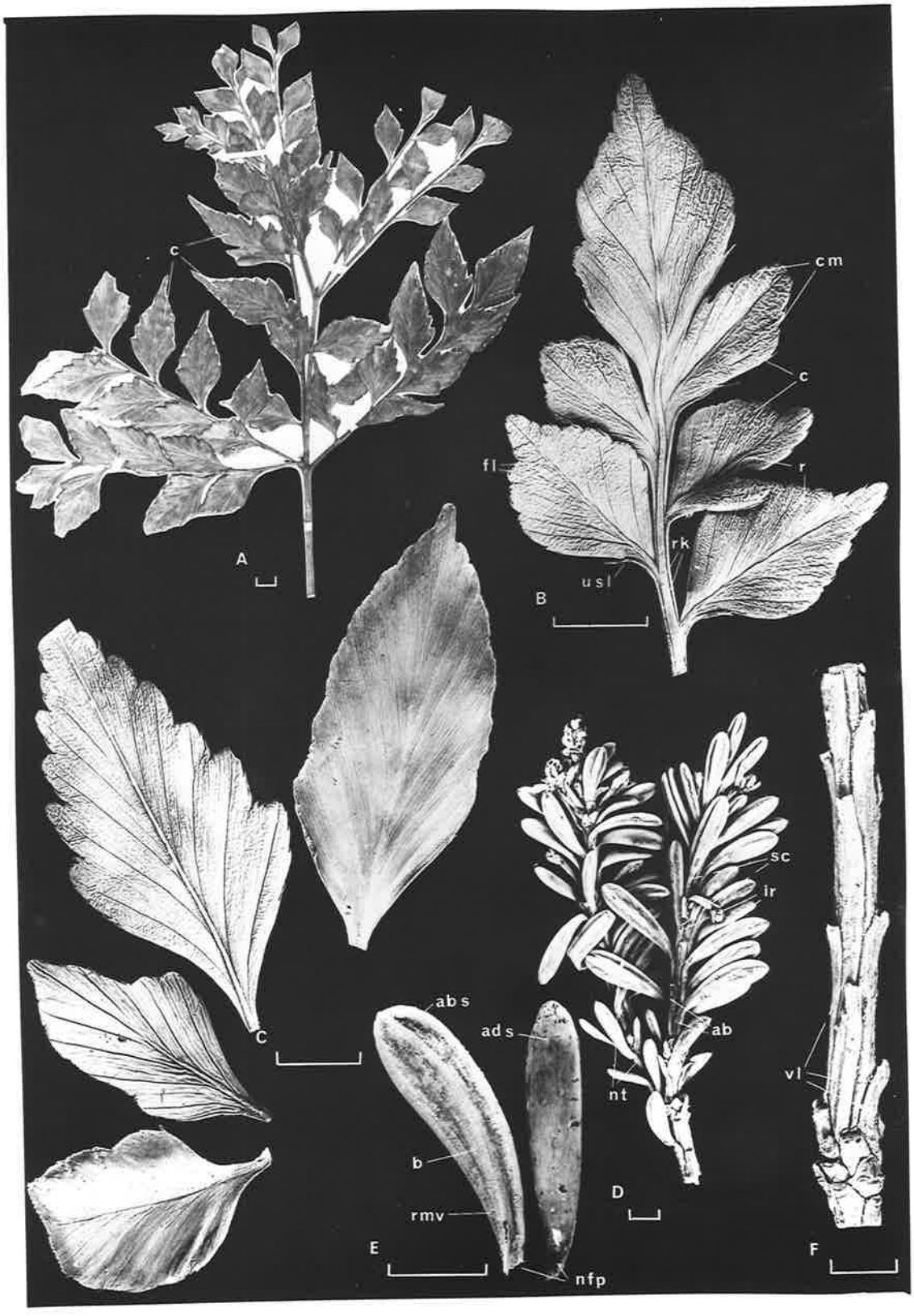
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PLATE 22

A,B. *Podocarpus amarus*. A. A shoot illustrating the mature foliage form. Note that the adnate bases are indistinct (iab) and that the leaf-blades are twisted at their insertion (t) and constricted to form a "false" petiole (p). B. Enlargements of leaf-blades of A showing the adaxial surface (ad s) with the median vein impressed (imv) and the abaxial surface (ab s) with a ridged median vein (rmv). Note the slightly revolute margins (rm) and the acuminately-obtuse apex (aoa).

C-E. *Podocarpus archboldii*. C. A young shoot of the mature foliage of this species. Note the distinct adnate bases (dab) and the short "false" petiole (sp); twisting and constriction of the leaf-blades at their insertion is only slight (st). Also note the scale-leaves at the apex of the axis (sl).
D. Enlargements of leaf-blades of C showing the adaxial surface (ad s) ridged by the median vein (rmv) and the impressed vein (imv) on the abaxial surface (ab s). Note the variation in size exhibited by these leaf-blades. E. Leaf-blades of *P.archboldii* var. *crassiramosus*. Note that these are slightly longer than leaf-blades of specimens of the species.

F. *Podocarpus blumei*. A shoot of the immature foliage. Note the decussate-distichous insertion of leaves (dd), the narrowly elliptical blades (ne) striated by many veins (s) and the rostrate apex (ra).

Scale = 1cm

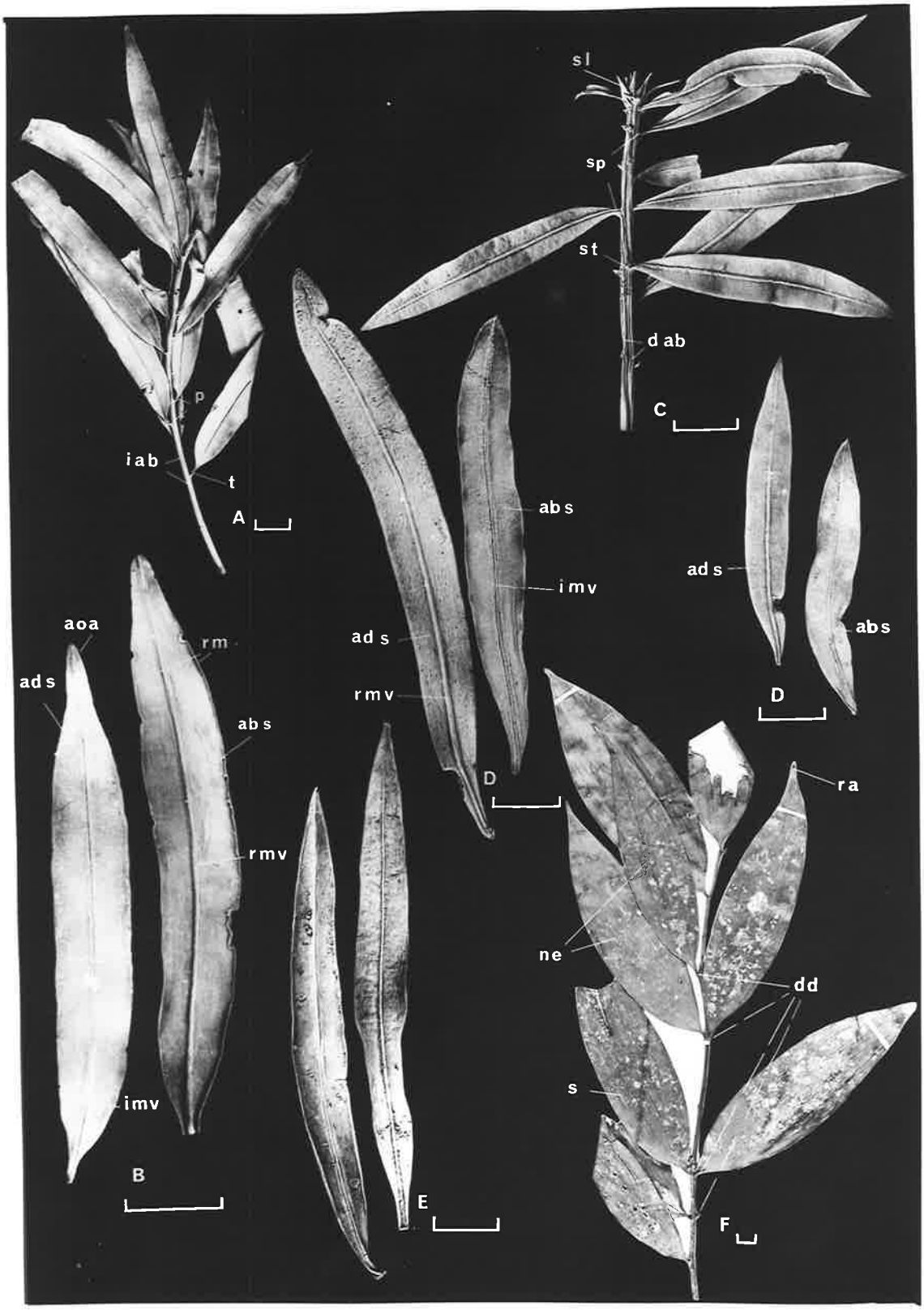
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PLATE 23

A,B. *Podocarpus blumei*. A. A shoot illustrating the mature foliage form. Note the decussate-distichous insertion (dd), the fused adnate bases (fab) and the blades, twisted at their insertion (t) and constricted to form a short "false" petiole (p). B. Enlargements of leaf-blades of A illustrating the range in size encountered in this foliage form. Note the striated, planar surfaces (s; ad s, adaxial surface; ab s, abaxial surface).

C-E. *Podocarpus brassii*. C. A shoot of the mature foliage of this species showing the grouping of leaves towards the apex (gl), the distinct, approximately narrowly oblong adnate bases (ab) and the elliptical blade(e). Note the revolute margins of the adnate base (rm) and the absence of a "false" petiole at the base of the blade (np); only slight constriction and twisting (t) occurs. Also note the cupsidate apices (ca). D. Enlargements of leaf-blades of C. Note the ridged (rmv) adaxial surface (ad s) and the impressed median vein (imv) becoming finely ridged near the insertion (r) on the abaxial surface (ab s). Also note the revolute margins (rm) and the variation in twisting and constriction of the leaf-blades near their insertion when compared with leaf-blades of C. E. An enlargement of a shoot apex showing narrowly triangular scale-leaves (sl). Note the ridged median vein (rmv) and the rostrate apex(ra).

F,G. *Podocarpus* sect. *Dacrycarpus*. A shoot (F) and an enlargement of part of it (G) of the foliage form designated as Description 1 (juvenile foliage form, Chapter V, p.144). The spirally inserted leaves of this form appear distichous. Note that the adnate base may be bifacial (G,bab) and that the blade is bilaterally flattened and incurved distally (G, in d). A few bifacial leaves occur at the base of F (bl).

Scale = 2mm for D-G

Scale = 1cm for A-C

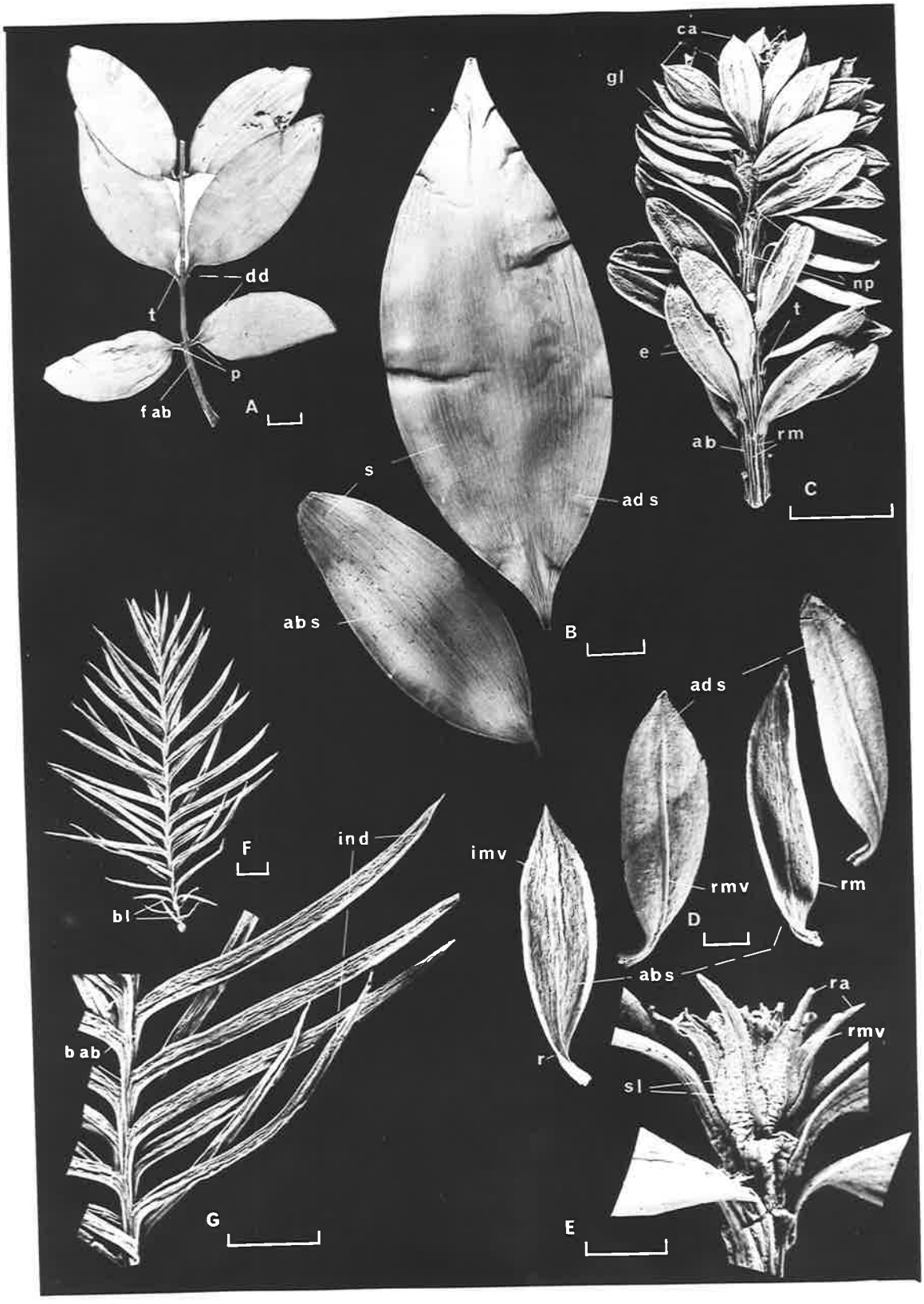
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PLATE 24

A-C. *Podocarpus* sect. *Dacrycarpus*. A,B. A shoot (A) and an enlargement of part of it (B) illustrating the foliage form designated as Description 2 (juvenile foliage form, Chapter V, p.146). The spirally inserted leaves appear distichous. Note that both the adnate base (A,ab) and the blade (A,b) are bilaterally flattened; the blade is narrowly oblong (B,no), with planar (B,ps) or occasionally slightly convex (B,scs) surfaces.

C. Part of a seedling showing the first formed bifacial leaves of the main axis (bl) replaced on lateral axes by the bilaterally flattened form (Description 2), (bfl). This also occurs in the foliage form treated in Description 1. (Plate 23 F,G)

D-G. *Podocarpus* sect. *Dacrycarpus*. Shoots (D,F) and enlargements of part of them (E,G), illustrating the foliage form designated as Description 3 (Chapter V, p.148) and some of the variation within this form. Note the spirally inserted, slightly spreading (D,F,ss), narrowly rhombic (D,F,nr), scale-like leaves. The abaxial surface of the leaves is keeled (E,G,k) and has steeply sloping lateral faces (E,G,s) which are concave near the axil (E,G,c); the adaxial surface is planar (E,p ad s), but becomes convex (G,c ad s); the apex is pungent (E,pa), but becomes incurved and uncinate (G,in u a).

H,I. *Podocarpus* sect.*Dacrycarpus*. A shoot (H) and an enlargement of part of it (I) illustrating the foliage form designated as Description 4 (Chapter V, p.150). The spirally inserted leaves appear distichous and are bilaterally flattened. Note the very shallowly triangular adnate base (H,ab) and the linear to narrowly oblong blade (H,b) with an uncinate apex (I,ua). The original adaxial surface is adnate to the axis for a short distance (I, ad). Also note the few bifacial leaves at the base of the axis (H,I,bl) and the acrotonous pattern of size variation (H).

Scale = 2mm

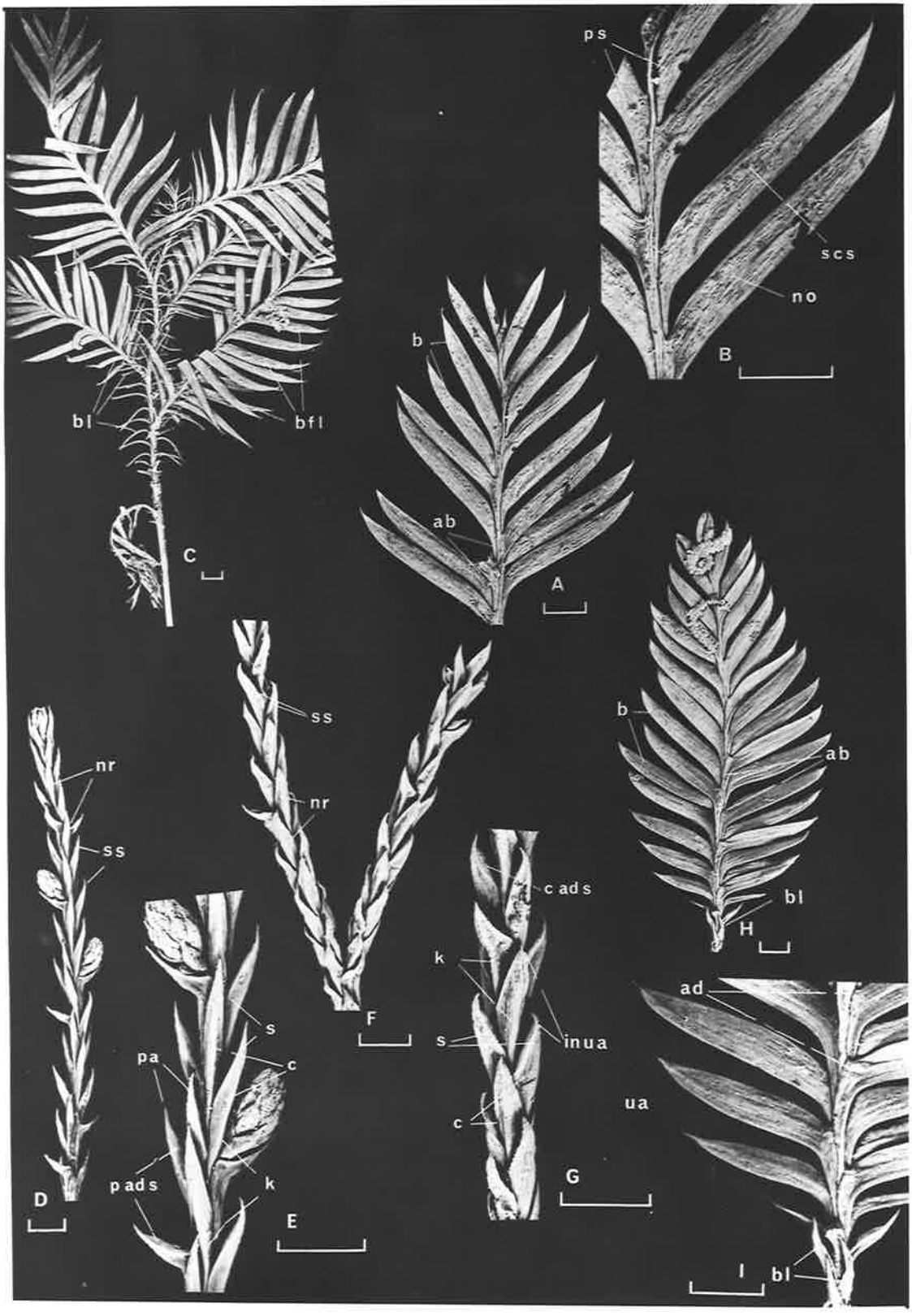
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PLATE 25

A,B. *Podocarpus* sect. *Dacrycarpus*. A shoot (A) and an enlargement of part of it (B) illustrating the foliage form designated as Description 5 (Chapter V, p.151). The spirally inserted leaves are tetragonal in cross-section (A,B,txs) and have incurved, uncinate apices (B,in u a); two ridges of the tetragon (B,r) are more prominent than the other two (B,or) and the lateral faces are convex (B,cv l f), or those of the upper-half may be concave (B,cc l f). Note the bifacial leaves at the base of A (bl) (see Chapter X, Fig.23 for discussion).

C. *Podocarpus* sect. *Dacrycarpus*. An illustration of a shoot bearing leaves of the form designated as Description 6 (Chapter V, p.153). Note the bifacial, spreading and incurved leaf-blades (s in) with keeled abaxial surfaces (k), concave (clf) or flattened (flf) lateral faces, and incurved, rostrate apices (in r a).

D-F. *Podocarpus dispermus*. D. A shoot bearing leaves of the mature foliage form. Note the narrowly oblong, bifacially flattened, spreading leaf-blades (no).

E, Enlargements of leaf-blades showing the median vein as a ridge (rmv) on the adaxial surface (ad s) and impressed (imv) on the abaxial surface (ab s). Note the "false" petiole (D,E,fp).

F. An enlargement of part of an axis; the leaf-scars (ls) indicate that leaves are borne in groups, that is, are pseudowhorled (w).

G,H. *Podocarpus drouynianus*. Part of a shoot (G) and an enlargement of leaf-blades of varying lengths (H) illustrating the mature foliage form. The leaves of this form are not pseudo (G); the leaf-blades are linear (G,l) and the adnate bases are distinct (G,dab). Note that the median vein is expressed as a ridge (G,H,rmv) on both the adaxial (H, ad s) and abaxial (H,ab s) surfaces. Also note that both constriction and twisting at insertion are slight (no "false" petiole formed, G,nfp), and that the blade margins are revolute (G,rm).

Scale = 2mm for A-C

Scale = 1cm for D-H

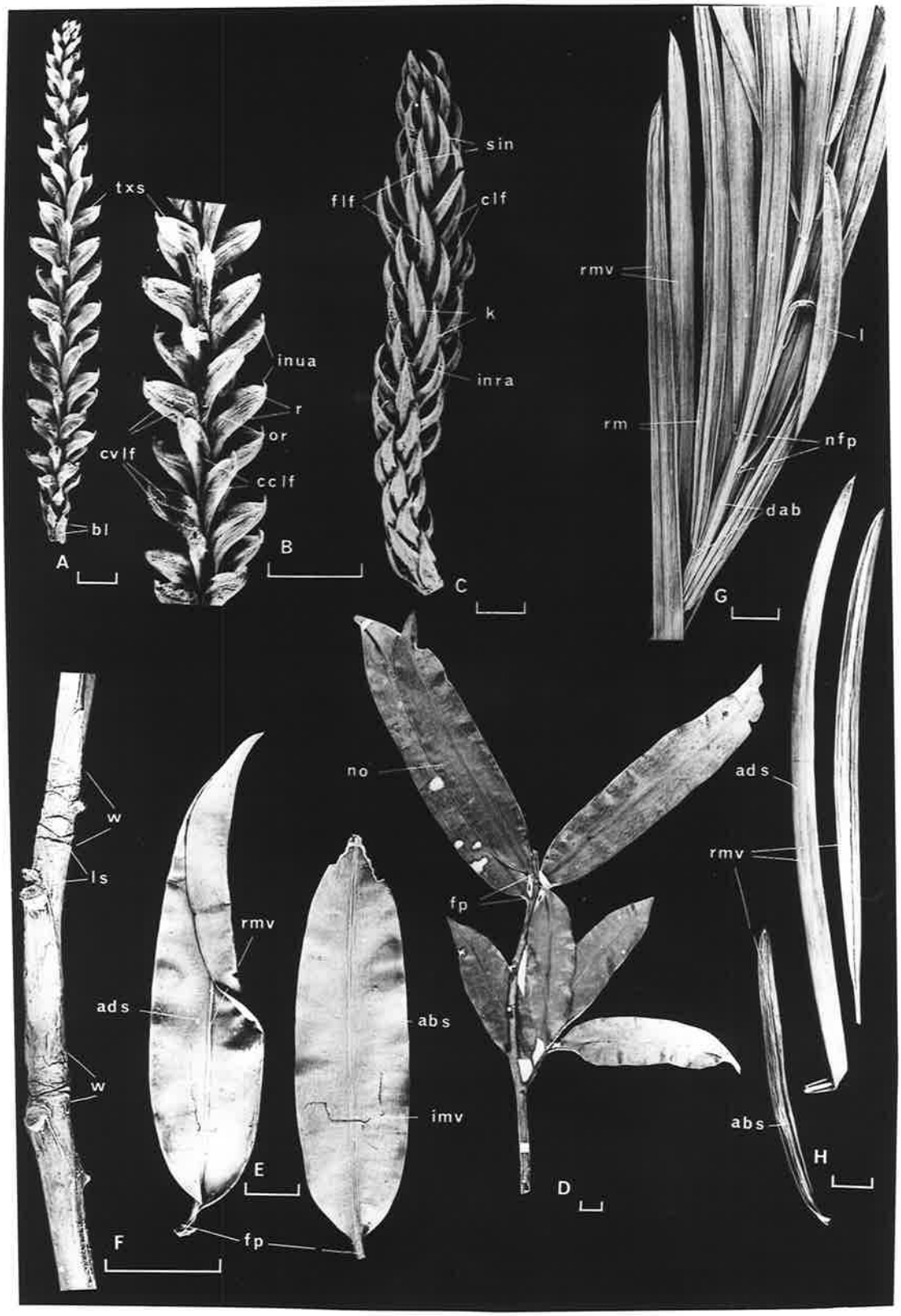
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PLATE 26

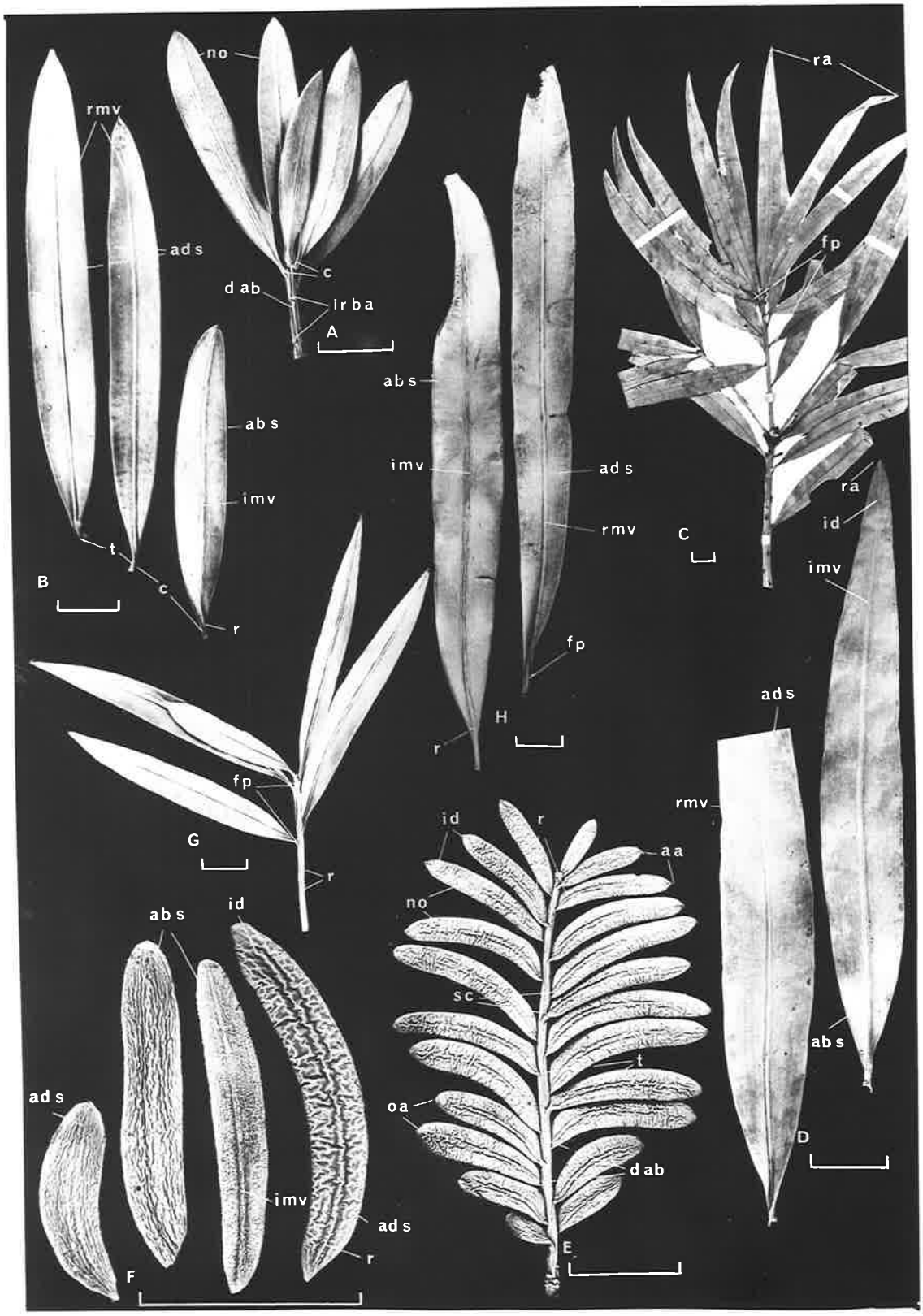
A,B. *Podocarpus elatus.* A. A shoot bearing leaves of the mature foliage form; B, single leaf-blades illustrating the variation in length within this foliage form. Note the distinct adnate bases (A,dab) and narrowly oblong blades (A,no) of leaves. At their insertion the blades are sometimes twisted (B,t) and constricted (A,B,c) forming a "false" petiole; their adaxial surfaces (B,ad s) are ridged by the median vein (B,rmv) and the vein is impressed (B,imv) on the abaxial surfaces (B,ab s) but becomes ridged near the insertion (B,r). Note the irregular basal angle (A,ir b a).

C,D. *Podocarpus idenburgensis.* Part of a herbarium sheet (C) and leaf-blades (D) of the mature foliage form. Note the "false" petiole (C,fp) formed by twisting and constriction of the leaf-blade at its insertion. The median vein is expressed as a ridge (D,rmv) on the adaxial surface of the blade (D,ad s) and is impressed (D,imv) on the abaxial surface (D,ab s) but may be indistinct distally (D,id); the apex is rostrate (C,D,ra).

E,F. *Podocarpus ladei.* E. A lateral axis of the mature foliage form. The spirally inserted leaves are not pseudowhorled and appear distichous; the leaf-blades are only slightly constricted at their insertion (sc), but are usually twisted (t) (no "false" petiole is formed). Note the distinct adnate bases (dab) and narrowly oblong blades (no) with acute (aa) or obtuse (oa) apices. F. Leaf-blades of E illustrating the variation in length within this form and the adaxial (ad s) and abaxial (ab s) surfaces. The median vein is impressed on the abaxial surface (imv); on the adaxial surface it is usually invisible distally (E,F,id) but is expressed as a ridge near the insertion (E,F,r). Note the rugose surfaces (F).

G,H. *Podocarpus neriifolius.* A shoot (G) and enlargements of leaf-blades (H) of the mature foliage form. Note the ridges on the axis (G,r); these correspond to the margins and median veins of the fused adnate bases. Also note the "false" petiole (G,H,fp), the median vein expressed as a ridge (H,rmv) on the adaxial surface (H,ad s) and impressed (H,imv) except near the insertion where it forms a ridge (H,r) on the abaxial surface (H,ab s).

Scale = 1cm


no
rmv
ads
c
dab
irba
A
abs
imv
t
c
r
B
abs
ads
rmv
fp
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fp
C
ra
id
imv
ads
rmv
abs
D
fp
r
G
id
r
aa
no
sc
t
oa
dab
E
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imv
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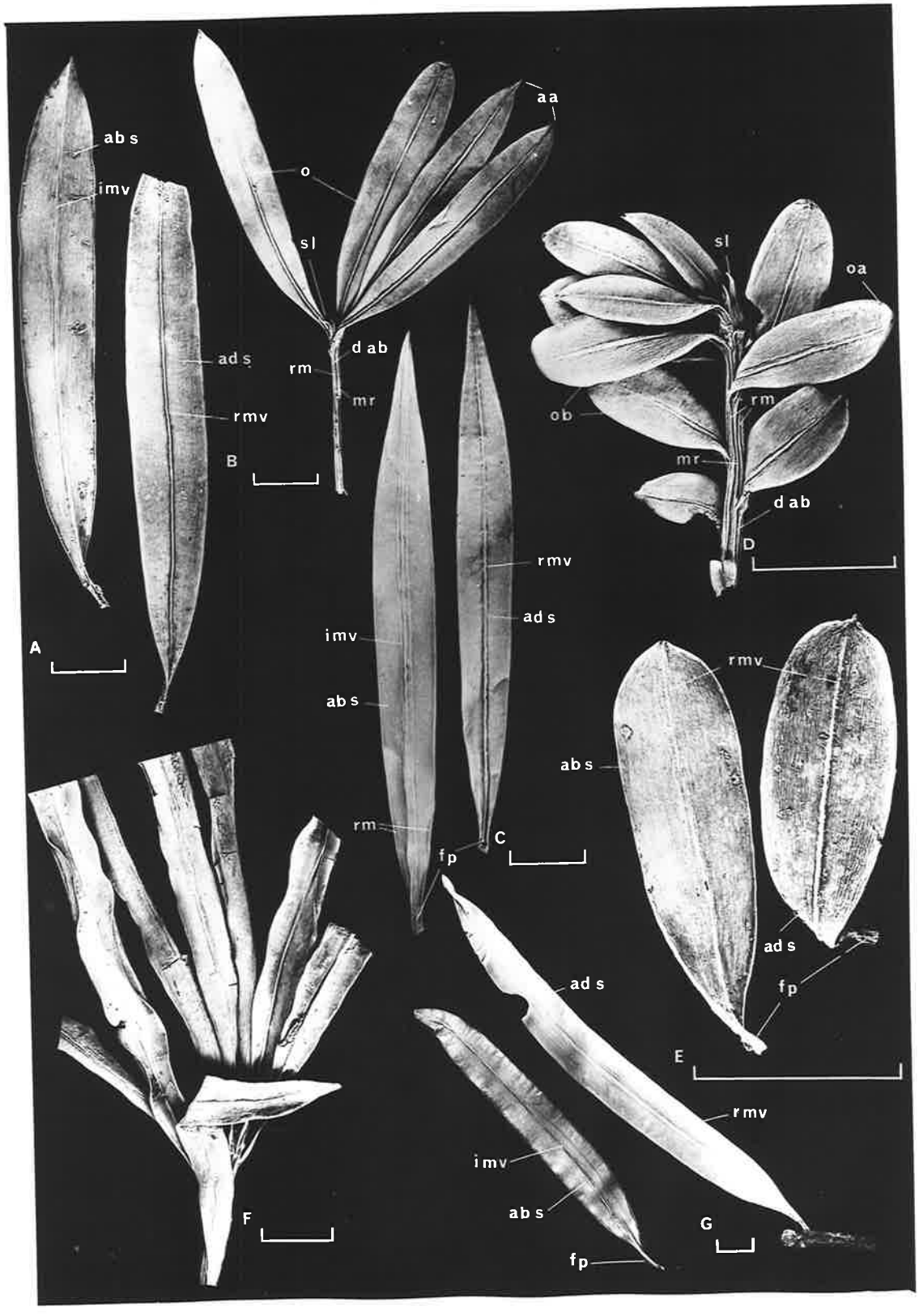
r
F

PLATE 27

A-E. *Podocarpus pilgeri*. (ad s, adaxial surface; ab s, abaxial surface; rmv, ridged median vein; imv, impressed median vein). A. Leaf-blades of the immature foliage form. These blades are thinner than those of the mature foliage form and have rostrate apices. B-E. Shoots (B,D) and enlargements of leaf-blades (C,E respectively) illustrating variation within the mature foliage form. The adnate bases of leaves are distinct (B,D,dab); they are ridged medially(B,D, mr) and have revolute margins (B,D,rm). The blade is oblong (B,o) or obovate (D,ob) with acute (B,aa) or obtuse (D,oa) apices, and has a "false" petiole (C,E,fp). Note that the median vein can be impressed (C) or finely ridged (E) on the abaxial surface, that the blade margins are sometimes revolute (C,rm) and that scale-leaves are borne at the apices of shoots (B,D,sl).

F,G. *Podocarpus rumphii*. Part of an axis (F) and leaf-blades (G) of the mature foliage form. Note the impressed median vein (G,imv) on the abaxial surface (G, ab s) and the vein as a prominent ridge (G,rmv) on the adaxial surface (G,ad s). Leaf-blades are constricted and twisted into a "false" petiole at their insertion (G,fp).

Scale = 1cm


abs
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rmv
A
aa
o
sl
dab
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mr
B
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mr
dab
D
rmv
ads
imv
abs
C
rm
fp
rmv
abs
ads
fp
E
ads
rmv
imv
abs
fp
F
G

PLATE 28

A,B. *Podocarpus spinulosus*. Illustrations of a shoot (A) and leaf-blades (B) of the mature foliage form. In this form, the adnate base is distinct (A,dab) and may have slightly revolute margins (A,rm); the blade is linear (A,B,l) with a ridged median vein (B,rmv) on both surfaces (B,ab s, abaxial surface; ad s, adaxial surface). The vein may be impressed distally (A,id). Note the rostrate apex (A,ra)and the absence of a "false" petiole (A,np).

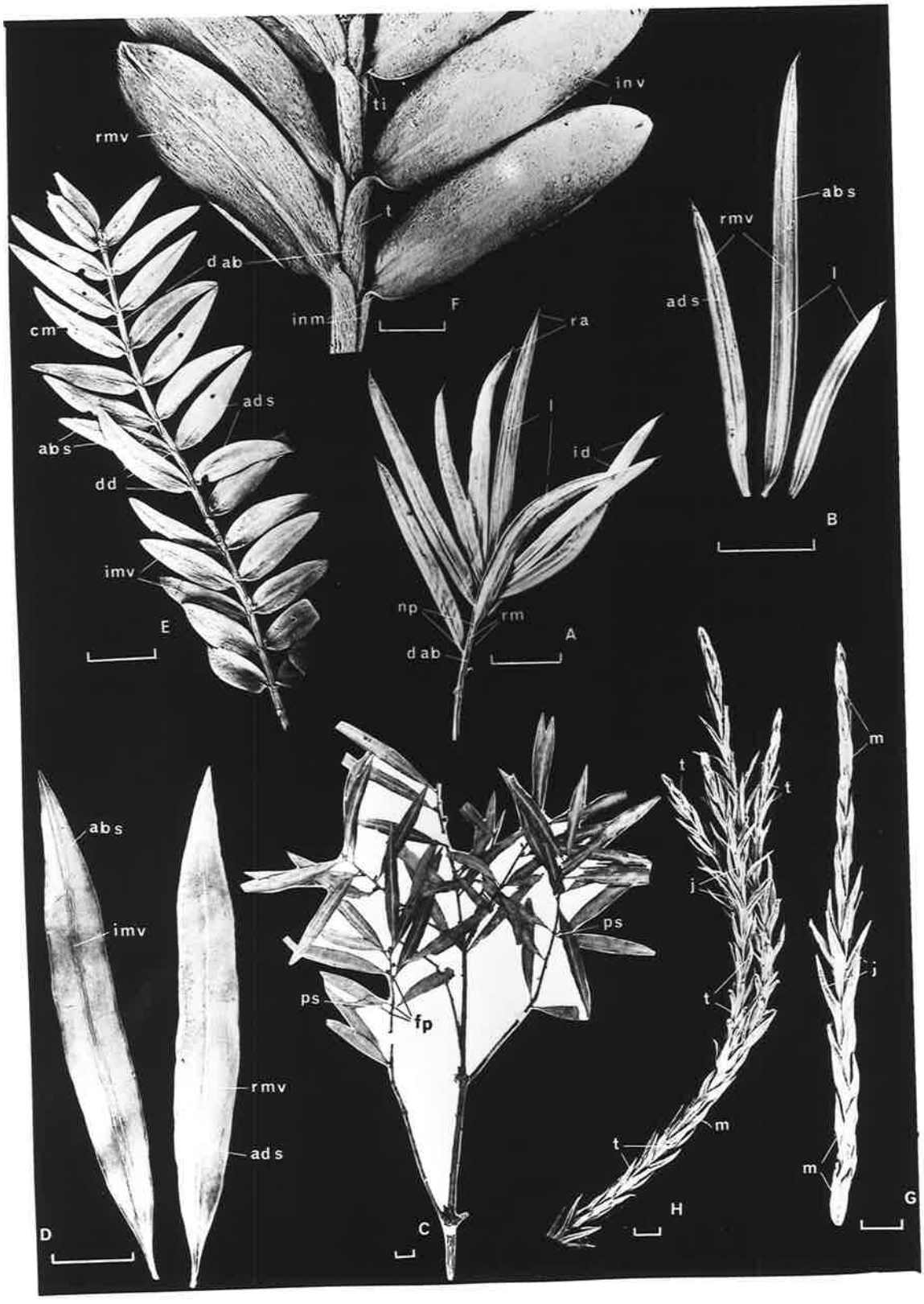
C,D. *Podocarpus thevetiifolius*. A herbarium specimen (C) and both surfaces of a leaf-blade (D) showing the features of the mature foliage form. The leaves of C are pseudowhorled (ps) and have distinct "false" petioles (C,fp). Note the median vein as a ridge (D,rmv) on the adaxial surface (D,ad s) and impressed (D,imv) on the abaxial surface (D,ab s).

E,F. *Podocarpus vitiensis*. The leaves of the mature foliage of this species are inserted decussate-distichously (E,dd) with opposite blade surfaces exposed on either side of the axis (ad s, adaxial surface; ab s, abaxial surface). The adnate base is distinct (E,F,dab) and is twisted around the axis (F,t); the margins are involute (F,in m) and on younger axes are contiguous (E,cm). The blades are twisted at their insertion (F,ti), but no "false" petiole is formed; the abaxial surface is usually ridged by the median vein (F,rmv), but the vein may be indistinct (F,in v); the vein is impressed on the adaxial surface (E,imv). The blade margins may be involute near their insertion (F,in m).

G,H. *Callitris macleayana*. (j, juvenile foliage form; t, transitional foliage form; m, mature foliage form).
G. A shoot illustrating a reversal of the juvenile to mature foliage form sequence along an axis. H. A shoot illustrating a change from the juvenile to mature foliage forms in the space of a few internodes.

Scale = 1cm for A-E

Scale = 2mm for F-H


inv
ti
rmv
t
dab
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ra
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B
imv
rmv
ads
D
ps
ps
fp
C
t
t
j
t
m
t
H
m
m
j
G

PLATE 29

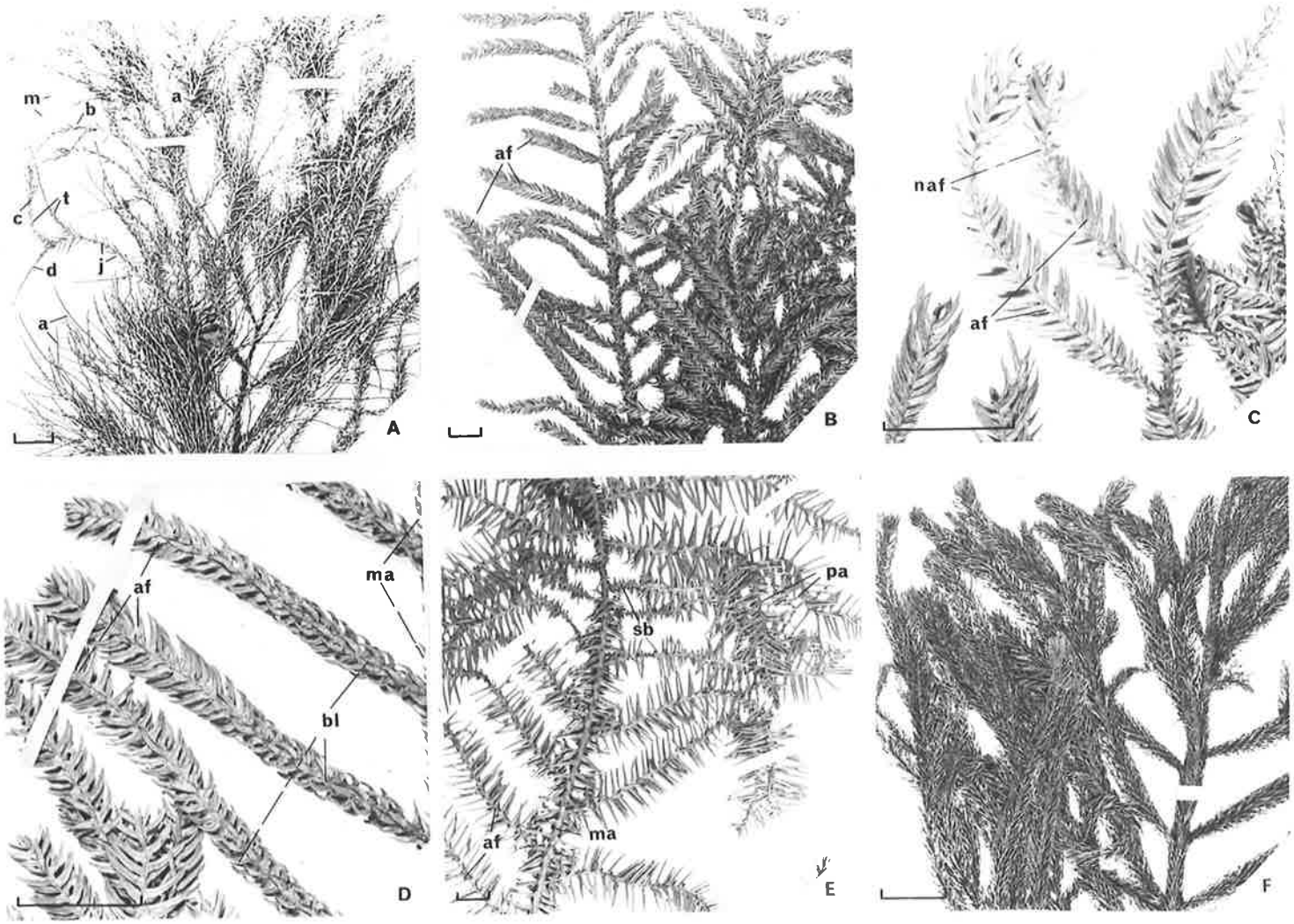
A. *Callitris macleayana*. Part of a herbarium specimen (*Booth*, 5.iii.1944 (AD)) illustrating the variation in foliage form borne by a single specimen. Note that single axes may bear only one of the three foliage forms (axis a), all three foliage forms (axis b), the juvenile and transitional forms (axis c), or the transitional and mature forms (axis d). Other combinations of forms do occur, but these were not found on this specimen. (j, juvenile foliage form; t, transitional foliage form; m, mature foliage form).

B-E. *Araucaria cunninghamii*. Illustrations of parts of herbarium specimens showing particular features of the variation in foliage form exhibited by this species. B. *Darbyshire 301* (CANB). Note the variation in blade-length and curvature of leaves. When the blade reaches a certain length it becomes susceptible to artificial flattening (af). Leaves of forms b to f (Fig.20) are borne on this specimen.

C. *Siebenhaar BW5121* (CANB). The leaves of this specimen are bilaterally flattened (Fig.20, forms b,c), but only those with leaf-blades exceeding a certain length are artificially flattened (af, artificially flattened; naf, not artificially flattened). Note the acrotonous growth pattern of this foliage. D. *Hoogland 5170* (CANB). The axes of this specimen are lateral ones (ma, main axis). Note that the leaves with bifacial, incurved blades (bl) (Fig.20, forms e,f) are not affected by artificial flattening. In addition, note that an increase in blade-length along these axes, is accentuated by the commencement of artificial flattening (af) at equivalent distances on all axes. E. *Brass 22941* (CANB). A specimen bearing the juvenile foliage form (Fig.20, form a). Note that artificial flattening is inoperative on the main axis (ma), where leaf-blades are short (sb) and where axes are protected from pressing (pa) (af, artificially flattened).

F. *Dacrydium elatum*. The first of four illustrations (see Plate 30A-C for the other three) of parts of herbarium specimens showing one of the foliage forms recognized for *D.elatum* - *D.novo-guineense* (Chapter V, pp.100-105) borne to the exclusion of the others. Part of a specimen (*Pullen 2680* (CANB)), bearing the foliage form treated in Description 1 (Chapter V, p.100).

Scale = 2cm


m
b
a
c
t
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j
a
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af
B
naf
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ma
bl
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sb
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ma
E
F

PLATE 30

A-C. *Dacrydium elatum - D.novo-guineense.* One foliage form borne to the exclusion of the others (see caption for Plate 29F). A. *D.elatum - Koster BW 1182* (CANB). The foliage form borne on this specimen is treated in Description 2 (Chapter V, p.102). B. *D.novo-guineense - Koster BW 6885* (CANB). The foliage form illustrated in this specimen is covered by the variation included in Description 3 (Chapter V, p.103). It is represented diagrammatically in Fig.22. C. *D.novo-guineense - Versteegh BW 262.* The foliage form borne on this specimen is treated in Description 3 (Chapter V, p.103).

D-F. *D.novo-guineense.* Parts of herbarium specimens to illustrate the appearance of specimens which bear more than one of the foliage forms described for *D.elatum - D.novo-guineense.* D. *Sleumer & Vink BW 14231* (AD). The foliage forms treated in Descriptions 1 and 3 ("1", "3") are borne on this specimen. Gradation occurs between them. E. An enlargement of part of D showing the gradation between the forms treated in Descriptions 1 and 3 ("1", "3") occurring on a shoot. F. *Robbins 598* (CANB). The foliage forms treated in Descriptions 1 and 3 are also borne on this specimen ("1", "3"), but no gradation occurs between them.

Scale = 2cm

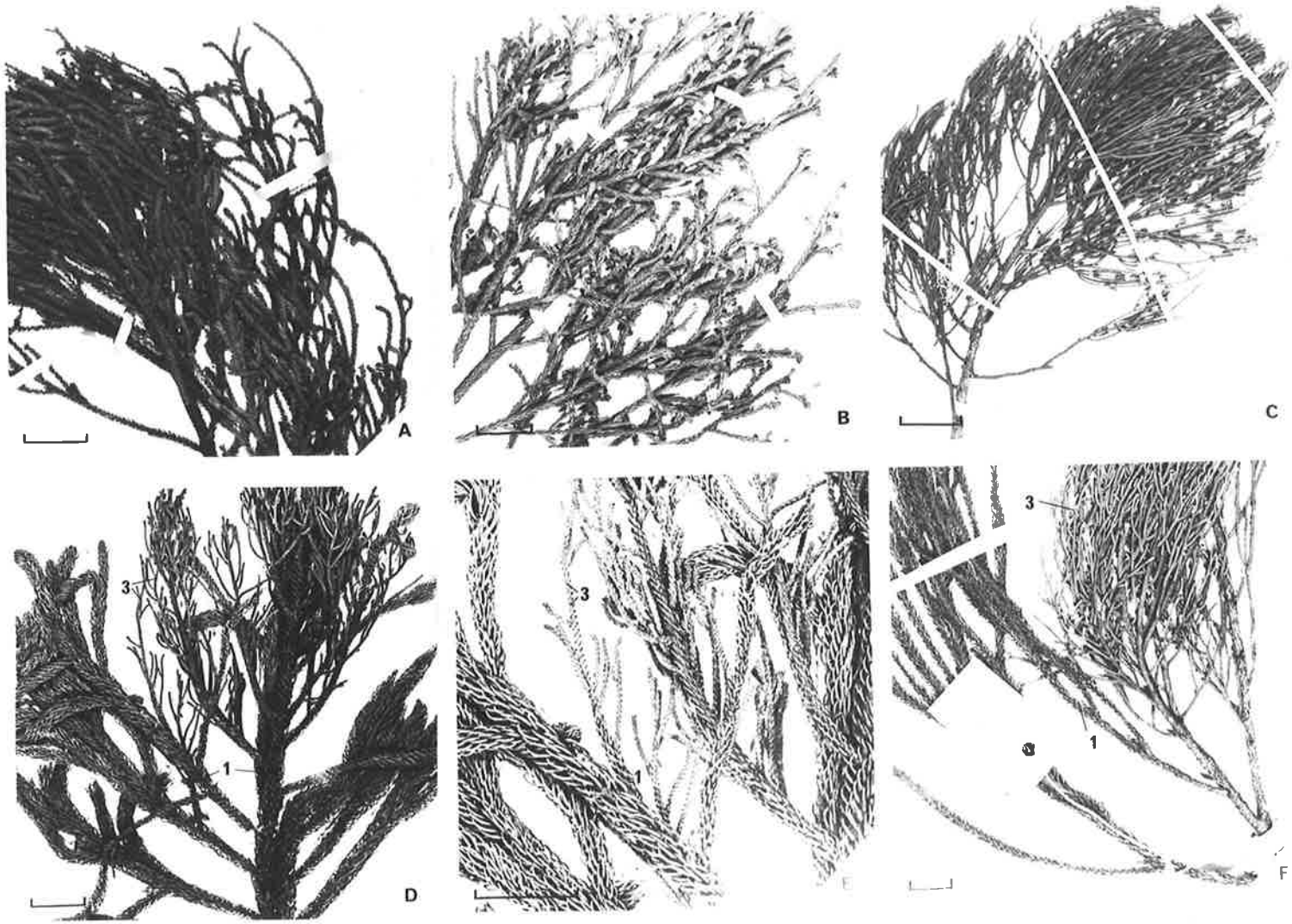

A
B
C
3
1
D
3
1
E
3
1
F

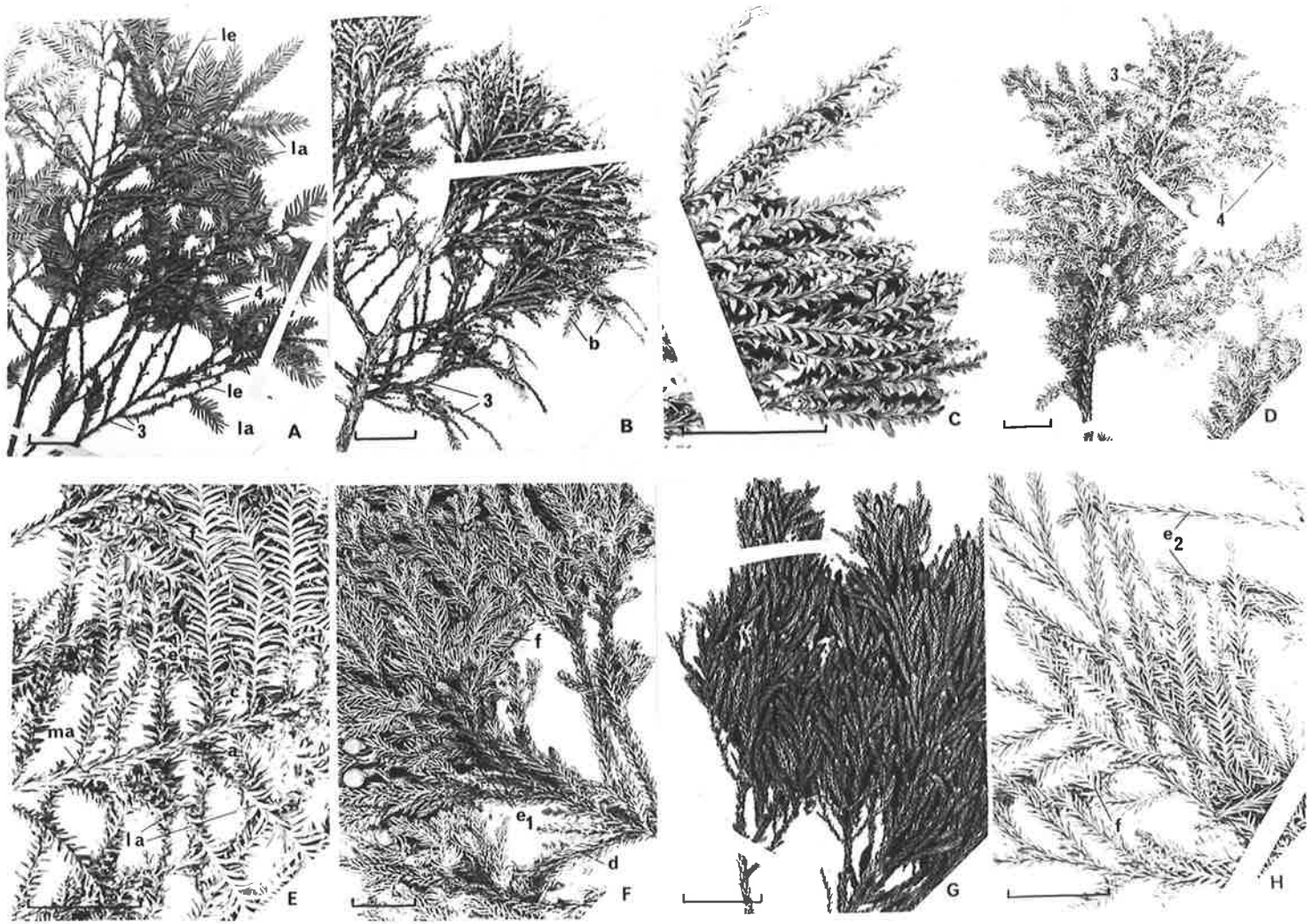
PLATE 31

A-H. *Podocarpus* sect. *Dacrycarpus*. A-E. Parts of herbarium specimens to illustrate a few of the combinations of the foliage forms covered in Descriptions 2 to 5 (Chapter V, pp.146-152, Foliage form sequence, Fig.23). A. *Robbins 1084* (CANB). Foliage forms covered in Descriptions 3 and 4 ("3", "4") are borne on this specimen. Note the difference in foliage form of leader shoots (1e) and lateral axes (1a). B. *Womersley NGF 9430* (CANB). The foliage form covered in Description 3 ("3") dominates the foliage of this specimen. Leaves on a few of the lateral axes ("b") have become bilaterally flattened (Fig.23,"b") and will eventually develop into the bilaterally and artificially flattened form of Description 4. C. *Karstel BW 5441* (CANB). The foliage form of this specimen is covered in Description 5 and is borne to the exclusion of the other forms. D. *Robbins 3209* (CANB). The foliage form treated in Description 4 ("4") predominates on this specimen. Some leaves of the form covered in Description 3 occur on main axes ("3"), but even there the leaves have become bilaterally flattened. The amount of artificial flattening is variable, thus all of the intermediate forms (Fig.23, b,d,e) are represented.

E. *Pullen 2716* (CANB). The foliage form treated in Description 3 is borne on the main axes (ma) of this specimen; foliage of the lateral axes (1a) follows the gradation from Description 3 Fig.23, a, through c and e to Description 4, Fig.23, f. ("a", "c", "e", "f"). Note the variation in appearance of leaves classified as Description 4 (cf.A,D).

F-H. Parts of herbarium specimens to illustrate a few of the variant forms (Fig.24, c-f) of the foliage form treated in Description 6 (Chapter V, p.153). F. *Pullen 313* (CANB). Leaves of form "e" (Fig.24) occur on this specimen, but the variant forms "c", "d" and "f" (Fig.24) predominate. G. *Millar NGF 14671* (CANB). The foliage of the form treated in Description 6 (form e_1,Fig.24) is generally similar to that of this specimen. H. *Robbins 2940* (CANB). Most of the leaves of this specimen are of the forms "f" and "e_2" (Fig.24). Note the difference in appearance of shoots of this specimen and those of specimen G.

Scale = 2cm


le
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4
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A
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3
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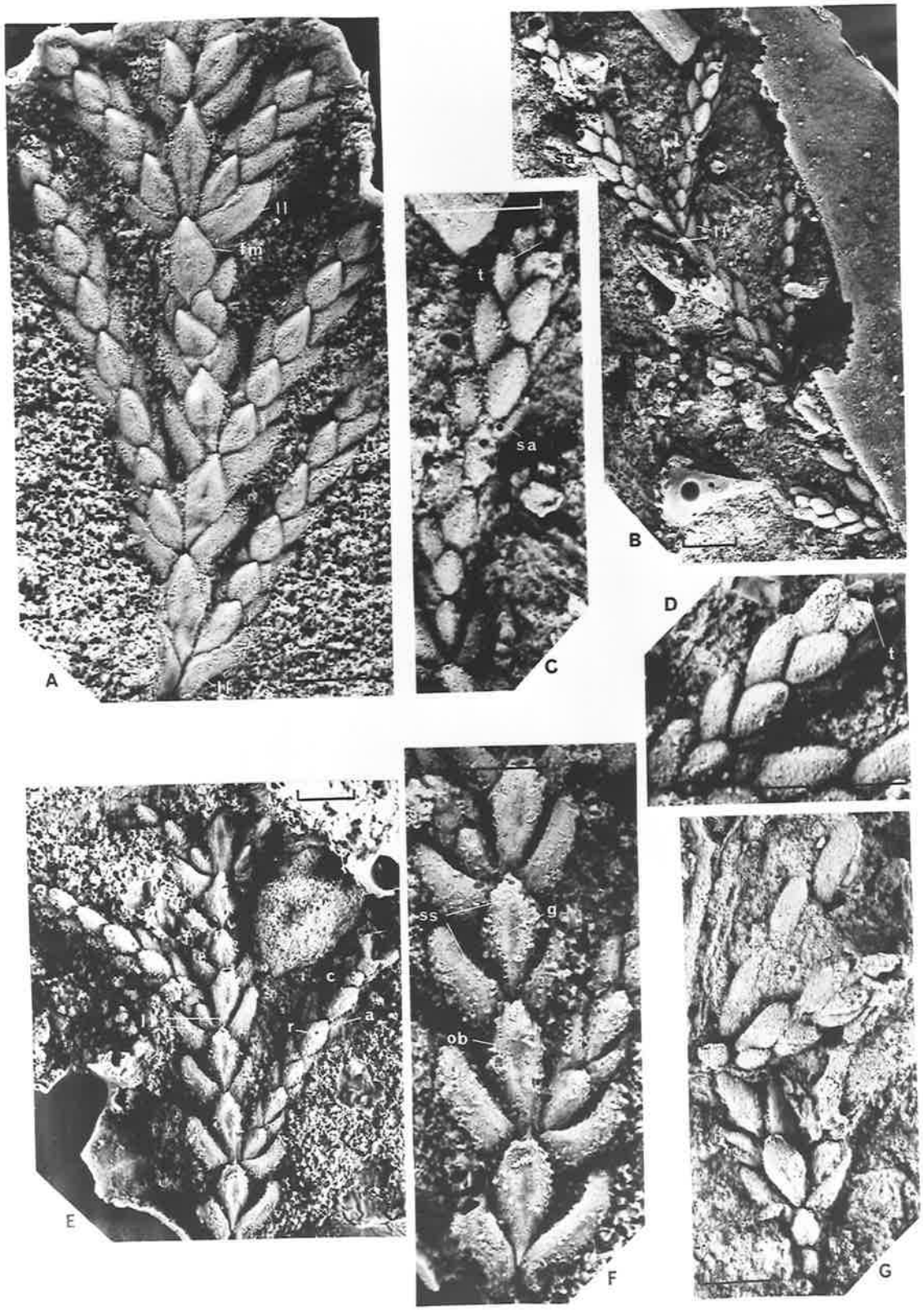
e1
d
F
G
e2
f
H

PLATE 32

A-G. FORM I. In this form the lateral axes arise in pairs or singly with equal frequency, and branching is restricted to a single plane (A,B,E). Note that leaves are larger when lateral axes arise in their axils (A,B,E,11). A. *P13596B*. A branched axis. Note the fimbriate margins of a few of the leaves of this specimen (fm). B-D. *P13637A*. A branched axis (B) and enlargements of two of its lateral axes (C,D). Note the thickness of the leaves (D) and the subtetragonal axes (B,C,sa) which have become more tetragonal distally (C,D,t).

E,F. *P13597*. A branched axis (E) and an enlargement of part of the main axis (F). The adnate base and free portion characteristic of leaves of this form, and the variation in the form of leaves borne on main and lateral axes, can be seen in this specimen. Leaves of the main axis are often larger than those of lateral axes; they are obtrullate (F,ob cf. E, r, rhombic), slightly spreading and incurved (F, ss cf. E,a, appressed) and grooved medially on their abaxial surfaces (F,g cf. E,c, convex). G. *P13598A*. A fragment of an axis.

Scale = 2mm


ll
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D
t
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c
r
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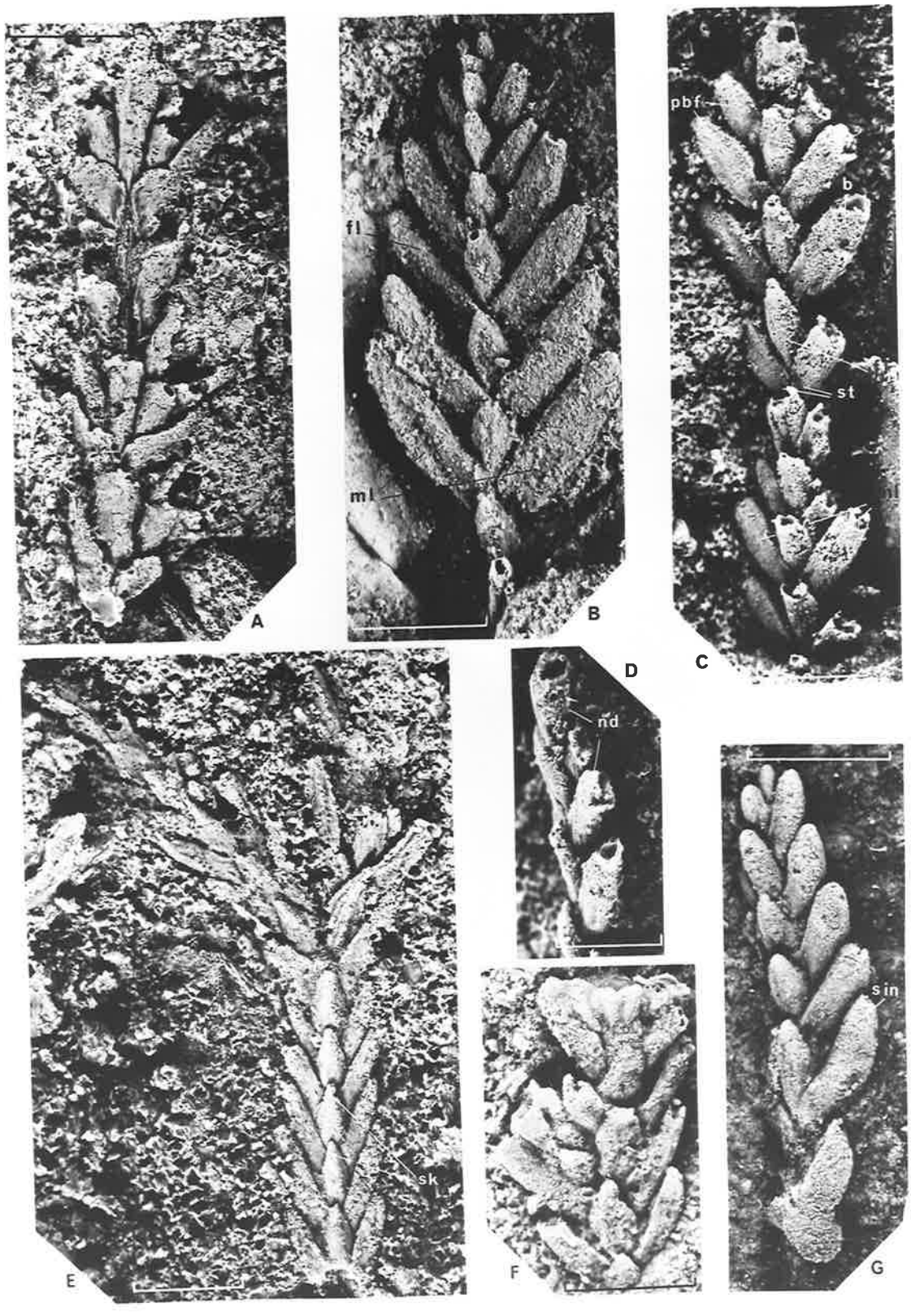
G

PLATE 33

A. FORM I. *P13966A*. A poorly preserved fragment probably of a main axis.

B-G. FORM II. The axes of this form are flattened (C,D,G); the leaves are dimorphic and are differentiated into facial (fl) and marginal (ml) leaves (B,C). Lateral axes arise in the axils of marginal leaves and commence with a pair of facial leaves (E,F). B. *P13639A*. An unbranched, terminal axis. Note that the lateral faces of the facial leaves are sloping and that the adaxial surfaces of the marginal leaves have become convex. C,D. *P13599*. An unbranched axis (C) and a side view of part of it (D). Note the distinct adnate base and free portion or blade of the leaves. The marginal leaves are bifacial (C,b) or partially bilaterally flattened (C,pbf); their adnate bases are shallowly triangular in lateral view (C,st) and the surfaces of their blades are undifferentiated (D,nd) - the adaxial surface may be slightly concave. Two growth pulses are exhibited by C. E. *P13602*. A branched axis. Note that the facial leaves are slightly keeled near the apex (sk) and that the blades of the marginal leaves are appressed. The leaves are thinner than those of the other specimens. F. *P13638*. A small fragment of a main axis and one lateral axis. Note that the blades of each pair of marginal leaves extend beyond that of the subsequent facial leaf. G. *P13600*. An unbranched, terminal axis oriented at an angle to the bedding plane (only one of each pair of marginal leaves is preserved). Note the thick decurrent leaves. The adnate base and blade of the marginal leaves are visible; the blades are slightly spreading and incurved distally (s in) and their surfaces are undifferentiated.

Scale = 2mm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pbf
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D
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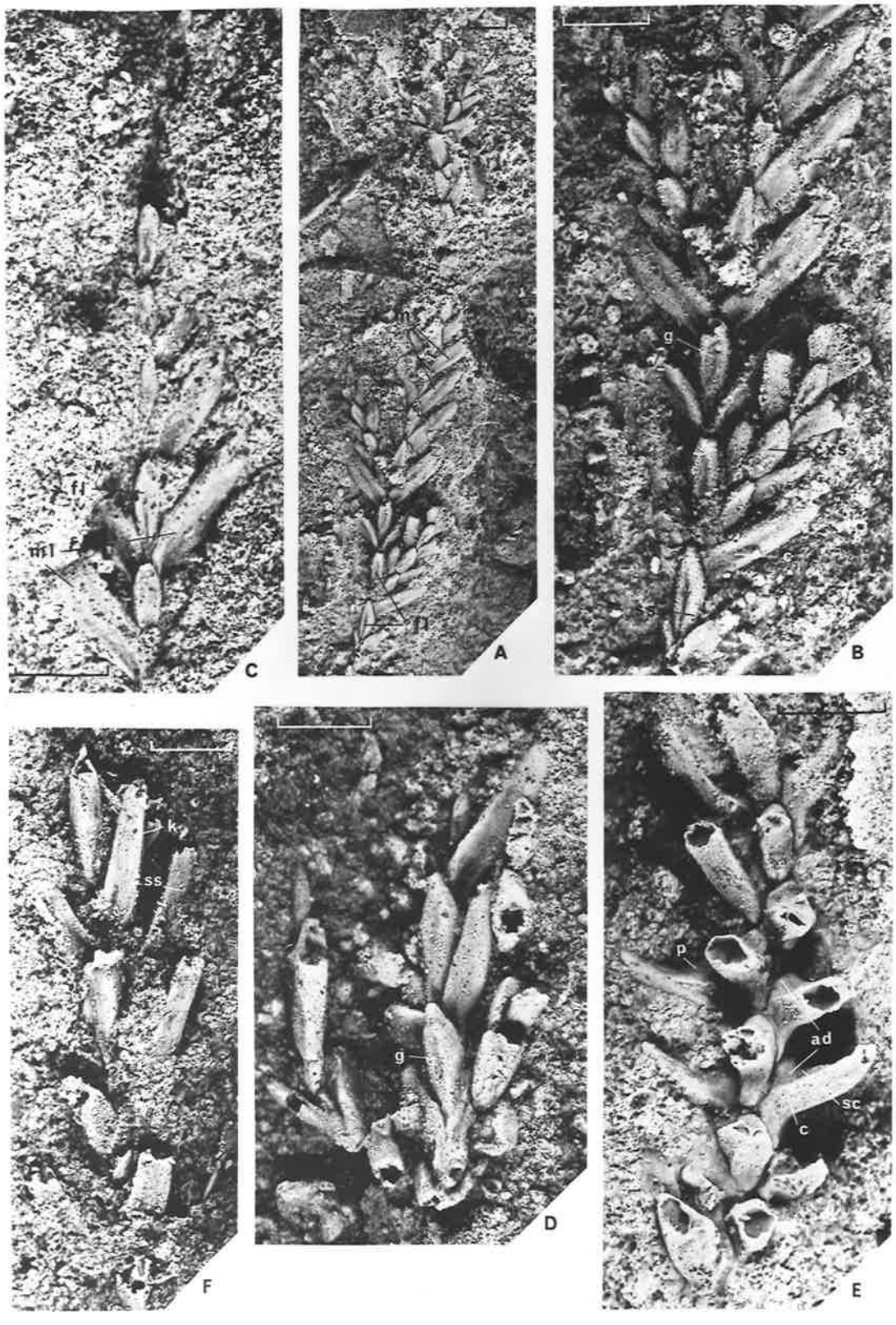
sk
E
F
sin
G

PLATE 34

A-D. FORM III. The leaves of this form are dimorphic and are differentiated into facial (fl) and marginal (ml) leaves (A,C). The facial leaves overlap the bases of the subsequent pair of marginal leaves (A,C) and sometimes part of the base of the subsequent facial leaf (D). Lateral axes arise in the axils of marginal leaves and commence with a pair of facial leaves (A). A,B. *P13637B*. A branched axis (A) and an enlargement of part of it (B). Note the slightly spreading facial leaves (B) with convex cross-sections (B,cxs) or median grooves (B,g), and lateral faces which slope steeply distally (B,ss). Marginal leaves are partially bilaterally flattened and concave medially (B,c). C. *P13640*. A partly preserved, unbranched axis. D. *P13601*. A fragment of an axis. Note the obtrullate facial leaves with only slight median grooves (g). The surfaces of the marginal leaves are not grooved.

E,F. FORM IV. Leaves of this form are spirally inserted and have spreading blades which are either incurved (Plate 35C) or incurved distally (E, Plate 35A).
E. *P13606*. An unbranched axis. Note that the leaves have a distinct adnate base and blade and that the adnate base is obtriangular or obdeltate. Also note that the narrowly triangular blades are incurved distally and have convex (c) lateral faces on their abaxial surface and a planar (p) or slightly convex (sc) adaxial surface which is adnate to the axis (ad). F. *P13963B*. Partly preserved leaf-blades of an unbranched axis. Note the acute keel (k) and steeply sloping (ss) lateral faces of the abaxial surface. These leaf-blades are preserved in face view.

Scale = 2mm


C
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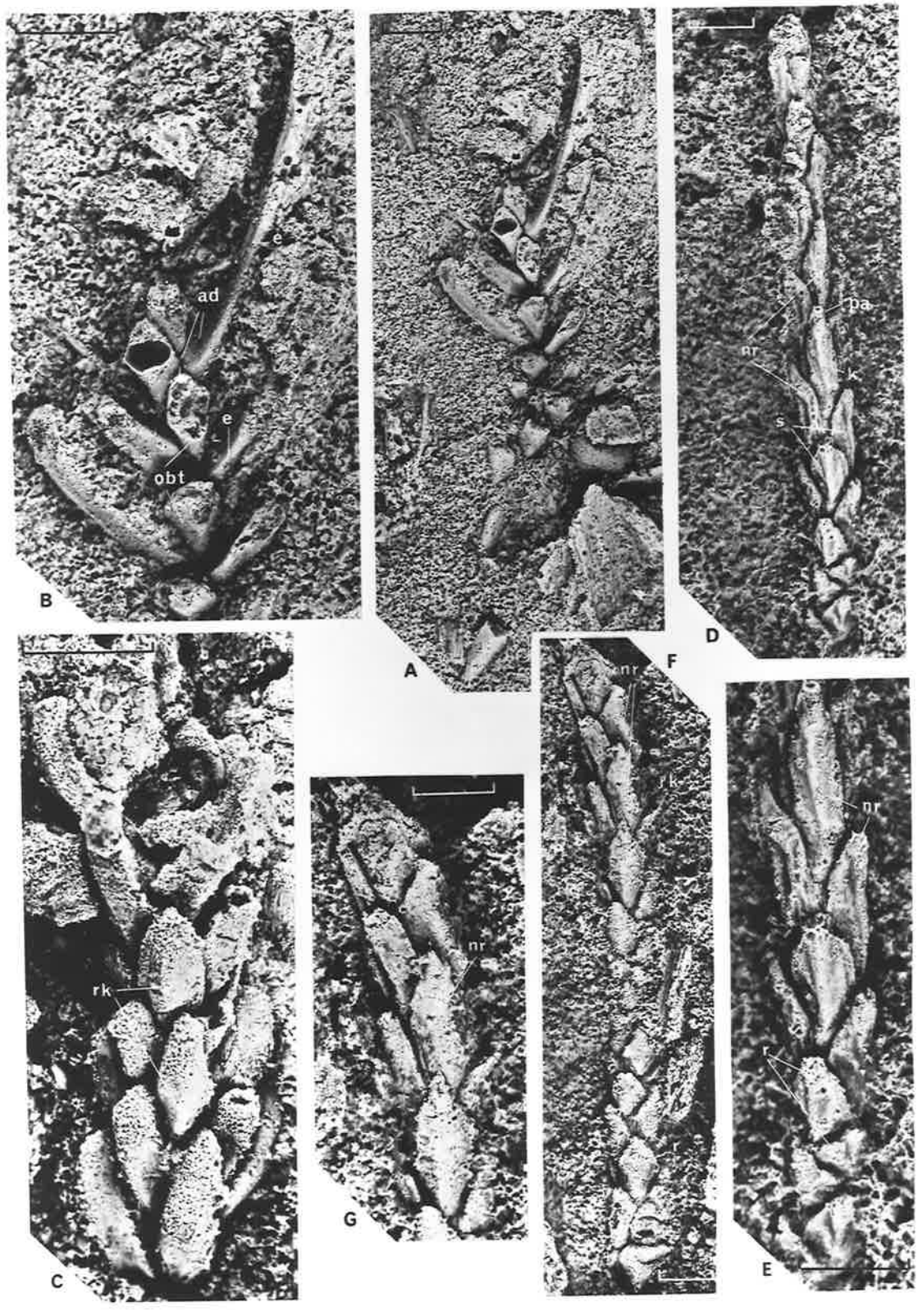
k
ss
D
g
E
p
ad
sc
c

PLATE 35

A-C. FORM IV. A,B. *P13607*. An unbranched axis (A) and an enlargement of part of it (B). Note the obtriangular or obdeltate adnate base of the leaves (B,obt) and the leaf-blades which are preserved edge-on (A,B,e) and are incurved distally. Also note that the adaxial surfaces of the leaf-blades are adnate to the axis (B,ad). C. *P13642B*. An unbranched axis bearing leaves with triangular incurved overlapping blades. Note the slightly rounded keel (rk) of their abaxial surface. The leaves are more closely inserted than those of other specimens and are preserved in face view. In lateral view they appear unguiform.

D-G. FORM V. This form is characterized by spirally inserted, scale-like leaves. D,E. *P13965*. An unbranched axis (D) and an enlargement of part of it (E). Note the acute keel (D,k), sloping lateral faces (D,s) and pungent apices (D,pa) of the leaves. The leaves are mainly narrowly rhombic (D,E,nr), but a few rhombic leaves occur at the base of the specimen (E,r). F,G. *P13960*. An unbranched axis (F) and an enlargement of part of it (G). Note the rounded keel of leaves of this specimen (F,rk). As for specimen *P13965* many of the leaves are narrowly rhombic (F,G,nr), but some rhombic leaves are borne towards the base of the axis (F,r).

Scale = 2mm


B
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r

PLATE 36

A. FORM VI. This form is characterized by spirally inserted, scale-like leaves. The free parts of the leaves are complanate with the adnate base or flattened onto the bases of subsequent leaves; the abaxial surfaces of leaves are convex.

A. *P13964*. Two fragments of axes which are preserved close together, but are not joined. Note that the leaves do not overlap.

B-E. FORM V. B,C. *P13643*. An unbranched axis (B) and an enlargement of part of it (C). Most leaves are rhombic, but a few narrowly rhombic ones (B,nr) are borne near the base of the axis. The abaxial surfaces of leaves are keeled and the keels are rounded and usually flattened medially (B,C,fm); the lateral faces of the adnate base are steeply sloping (C,ss). Note the group of smaller leaves (B,sl). D,E. *P13644*. A poorly preserved, unbranched axis (D) and an enlargement of part of it (E). Only the outlines of leaves remain. These show that the leaves were mainly rhombic. Note the few narrowly rhombic leaves (D,E,nr) and the group of smaller leaves (D,E,sl).

F,G. FORM IV. F. *P13627*. A poorly preserved, unbranched axis. Most of the leaf-blades are preserved in lateral view (l). Note that the blades are narrowly triangular (nt) and appear to be slightly tetragonal in cross-section (txs).

G. *P13629*. An unbranched axis, again poorly preserved. Note that the abaxial surface of the blade is acutely keeled (k) and that the adaxial surface is adnate to the axis (ad).

Scale = 2mm

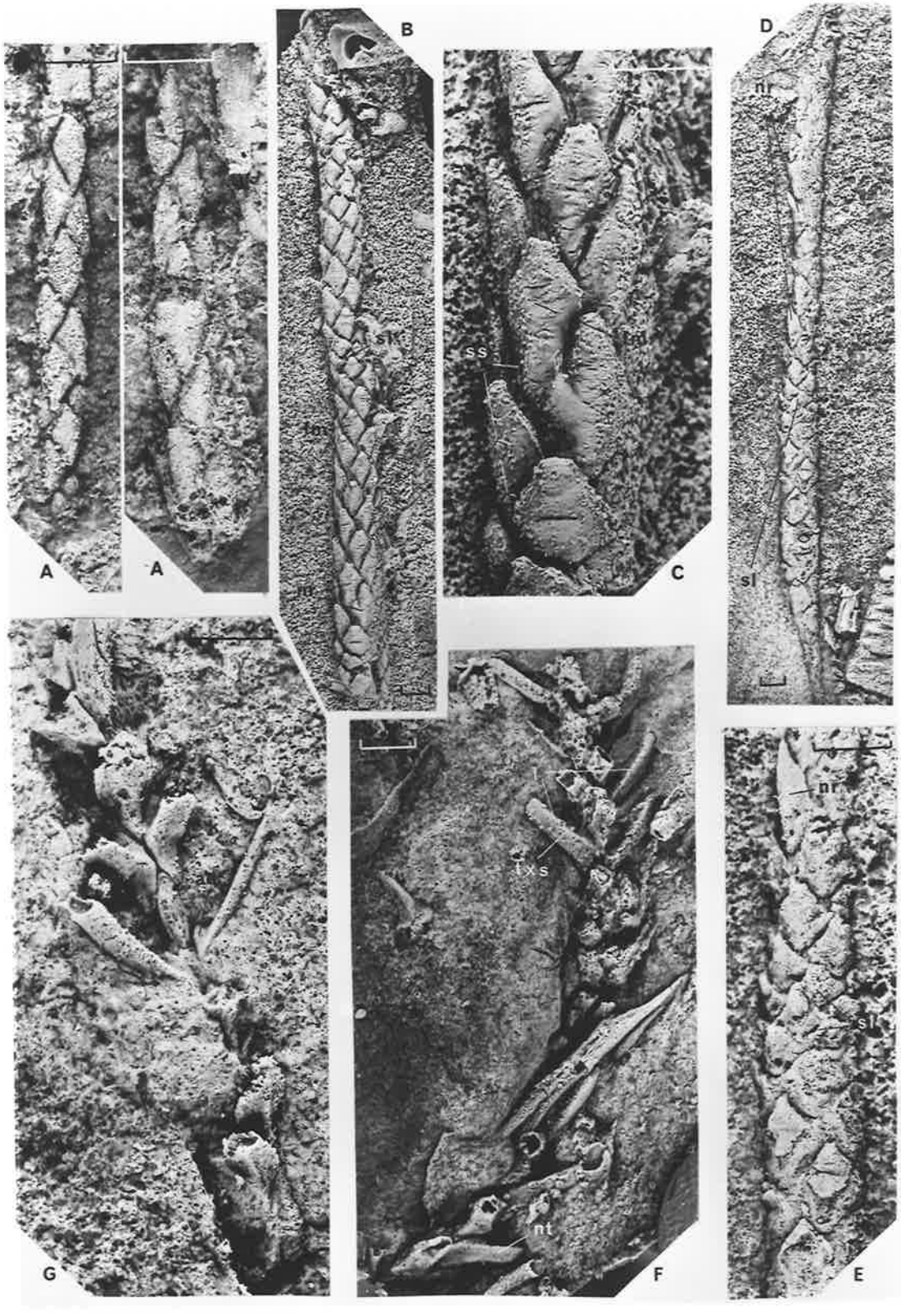

A
A
B
slK
lm
lm
C
ss
D
nr
sl
G
F
l
txs
nt
E
nr
sl

PLATE 37

A-H. FORM VI. A. *P13603A*. An unbranched axis. Note that the leaves are rhombic and have convex lateral faces. The basal angles are acute (aba) and the apices are acute and slightly incurved. The free portions overlap the bases of subsequent leaves.
B. *P13966B*. An unbranched axis bearing spirally arranged rhombic leaves. Other details of the leaf morphology have been destroyed.
C,D. *P13596A*. An unbranched axis (C) and an enlargement of the distal half of it (D). Note the rhombic leaves with convex lateral faces (C, bottom half), the acute basal angles and acute, sometimes incurved apices (D,a in a). The leaves are overlapping and the margins of the free portion are fimbriate (C,D,fm). The variation in leaf-shape and size within this specimen could reflect a seasonal change, or the distal half of the axis may represent young foliage. E. *P13628*. A poorly preserved fragment of an axis. F. *P13604*. An unbranched axis. Note the convex lateral faces of the abaxial surface of the leaves. The leaves do not overlap. G,H. *P13641A*. An unbranched axis (G) and an enlargement of part of it (H). Note that the abaxial surface of the adnate base is often steeply sloping near the margins (H,ss) and the basal angle is pungent (G,H,pba).

Scale = 2mm

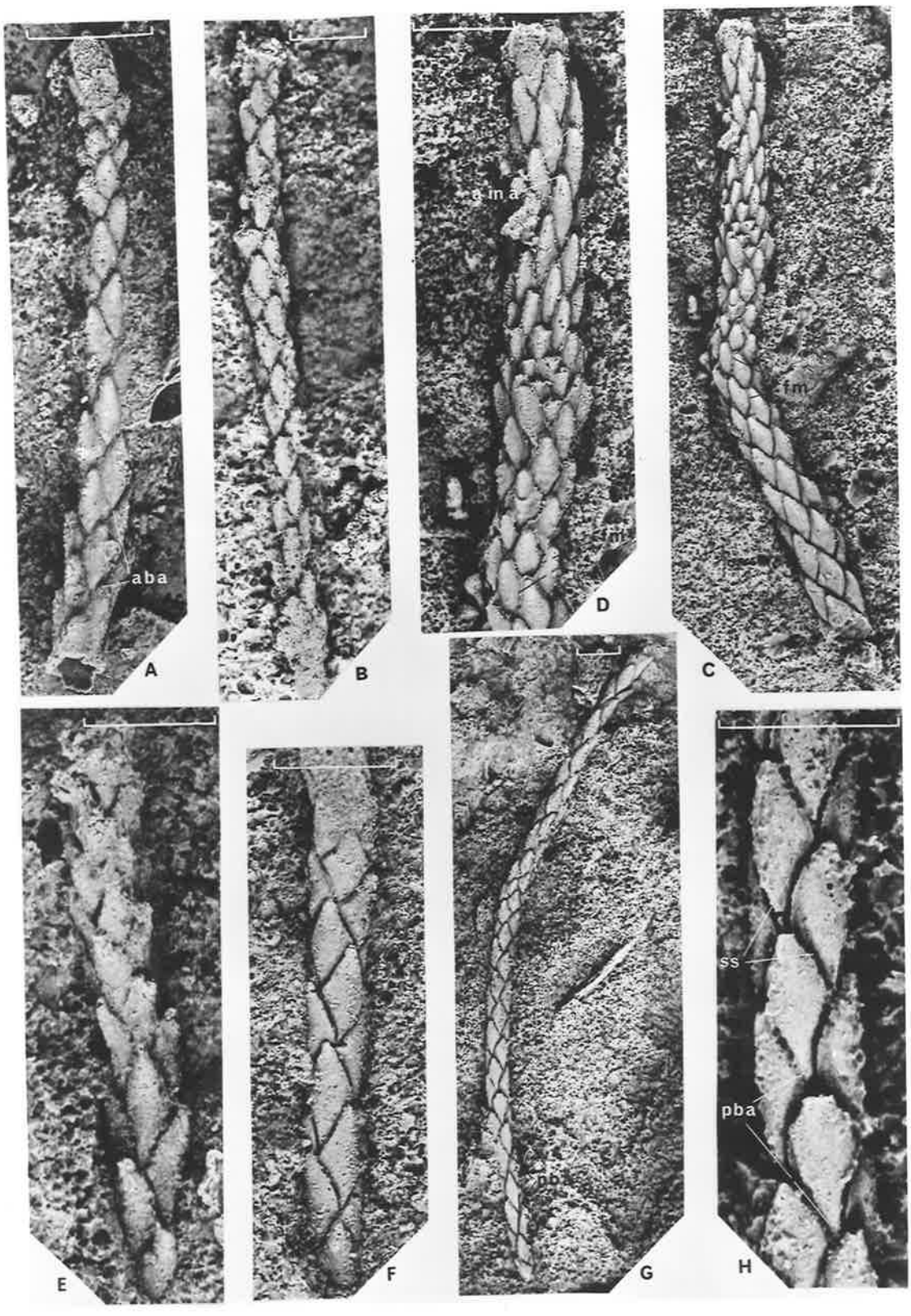

aba
A
B
a in a
D
fm
C
E
F
pba
G
ss
pba
H

PLATE 38

A-D. FORM VI. A. *P13642A*. An unbranched axis. Note the spirally inserted rhombic leaves with convex abaxial surfaces. The leaves do not overlap subsequent leaves. B. *P13966C*. An unbranched axis bearing narrowly rhombic leaves with pungent basal angles (pba) and apices (pa). C. *P13605*. An unbranched, poorly preserved axis. The leaves are mostly narrowly rhombic and their basal angles and apices are often pungent. D. An unbranched, poorly preserved, fragment of an axis.

E. FORM VIII. The leaves of this form are spirally inserted. They have appressed or slightly spreading free portions and in shape range from linear-obtrullate to narrowly obtrullate or narrowly rhombic (in face view), or in lateral view, the adnate base is approximately linear and the free portion narrowly oblong.
E. *P13630*. An unbranched axis bearing leaves with slightly spreading free portions (ss). Most leaves are preserved in lateral view. Note the approximately linear (al) adnate base and the narrowly oblong free portion (no). In face view the leaves would be narrowly obtrullate.

F-I. FORM VII. This form is characterized by spirally inserted scale-like leaves with appressed to slightly spreading free portions. The adaxial surface of the free portion is usually convex, thus the free portion has a tetragonal cross-section. F,G. *P13611*. An unbranched axis (F) and an enlargement of part of it (G). Some of the leaves are preserved in lateral view and appear partially bilaterally flattened (G,pbf); they have been compressed. Note the concave lateral faces of the leaves (G,c). Also note the small rhombic leaves at the base of the axis (F,G,r); the free portions of these are slightly spreading (G,ss). H. *P13633*. A poorly preserved, unbranched axis. The leaves of this axis have slightly spreading free portions which are not tetragonal in cross-section and are approximately rhombic in shape.
I. *P13608*. An unbranched axis. Note the obtrullate leaves with slightly spreading free portions; their abaxial surfaces are keeled, the keel is acute (ak) and the lateral faces are steeply sloping (ss). The free portions are tetragonal in cross-section; their adaxial surfaces are convex (c) and adnate to the axis (ad).

Scale = 2mm

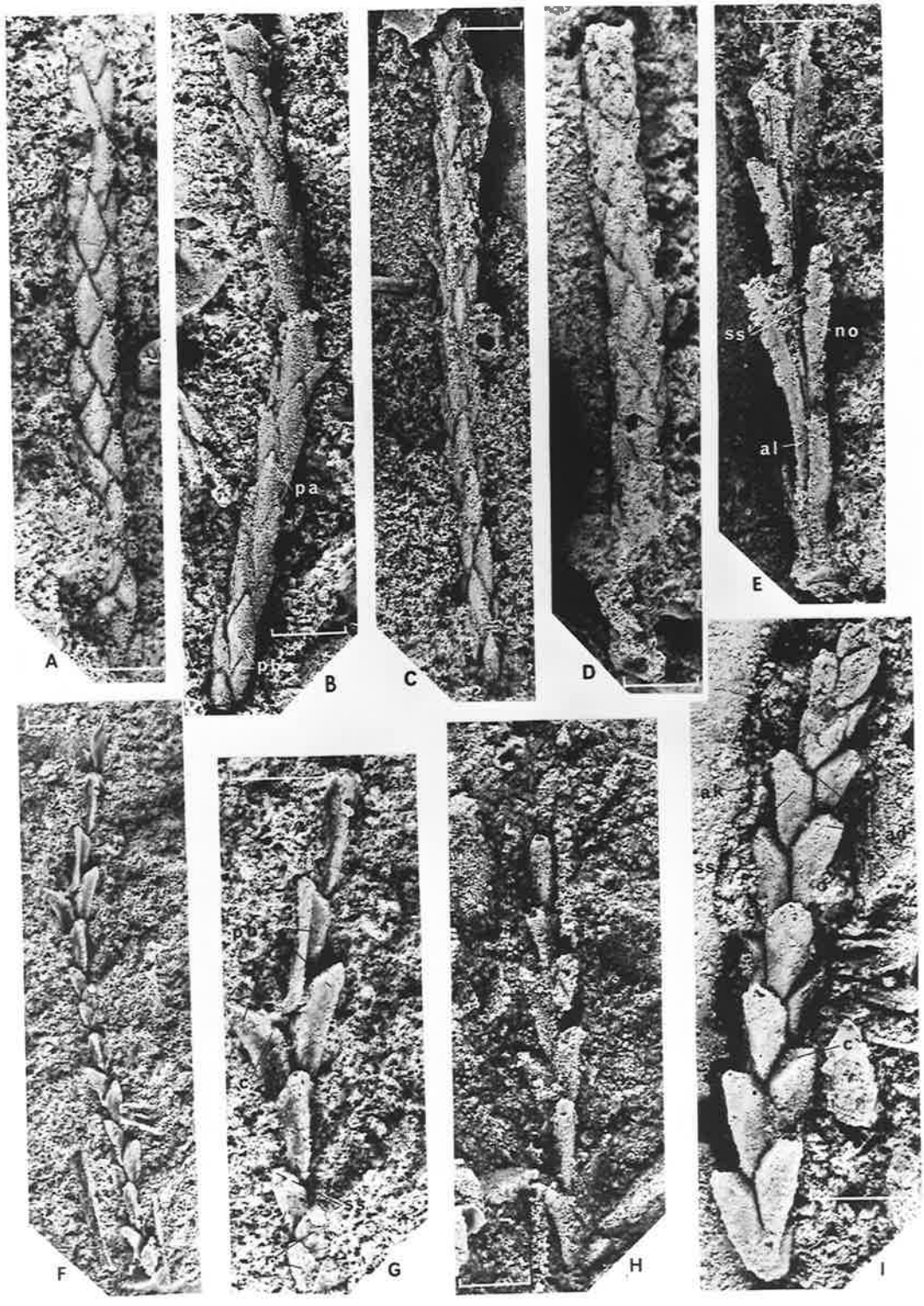

A
B
pa
ph
C
D
E
ss
no
al
F
G
pa
H
I
ak
ad
ss
c

PLATE 39

A,B. FORM VII. A. *P13609*. An unbranched axis. Note the obtrullate leaves with slightly spreading, tetragonal free portions. The abaxial surfaces of the leaves are steeply sloping (ss) and some leaves appear to be slightly bilaterally flattened (sbf). This is probably not a result of compression of the specimen (cf. specimen *P13611*, Plate 38F,G).
B. *P14112*. An unbranched axis. The free portions of some leaves are slightly longer than those of leaves of other specimens of this form (sl).

C-F. FORM VIII. C. *P13961*. An unbranched axis bearing leaves which are linear-obtrullate to narrowly obtrullate in face view (l ob). Note that the leaves are thinner than those borne on other specimens of this form. D. *P13641B*. An unbranched axis bearing rhombic (r) to narrowly rhombic (nr) leaves. The free portions of a few leaves are slightly spreading (ss); these leaves slightly resemble those of form VII. E. *P13639B*. A fragment of an axis, probably a terminal one. Note the leaves of form VIII (l) and the small rhombic leaves (r) at the apex of the axis. F. *P13615*. A poorly preserved fragment of an axis. Note the approximately linear adnate bases (al) and the narrowly oblong free portions (no) of leaves preserved in lateral view. Also note the thinness of the leaves.

G,H. FORM VII. G. *P13612*. An unbranched axis. The distal part of this axis has been compressed; the outlines of compressed leaves account for its unique appearance (cl). The amount of compression has been reduced towards the base of the axis; note the partially bilaterally flattened leaves (pbf).
H. *P13613*. A poorly preserved, unbranched axis.

I,J. FORM VIII. I. *P13632*. An unbranched axis. The leaves are narrowly rhombic (nr) to narrowly obtrullate (n ob); the basal angle is acute. Note the small leaves at the base of the axis (sl).
J. *P13610*. Part of an unbranched axis. The leaves are narrowly rhombic to narrowly obtrullate; the free portions are only slightly spreading (ss). Note the pungent basal angles (pba).

Scale = 2mm

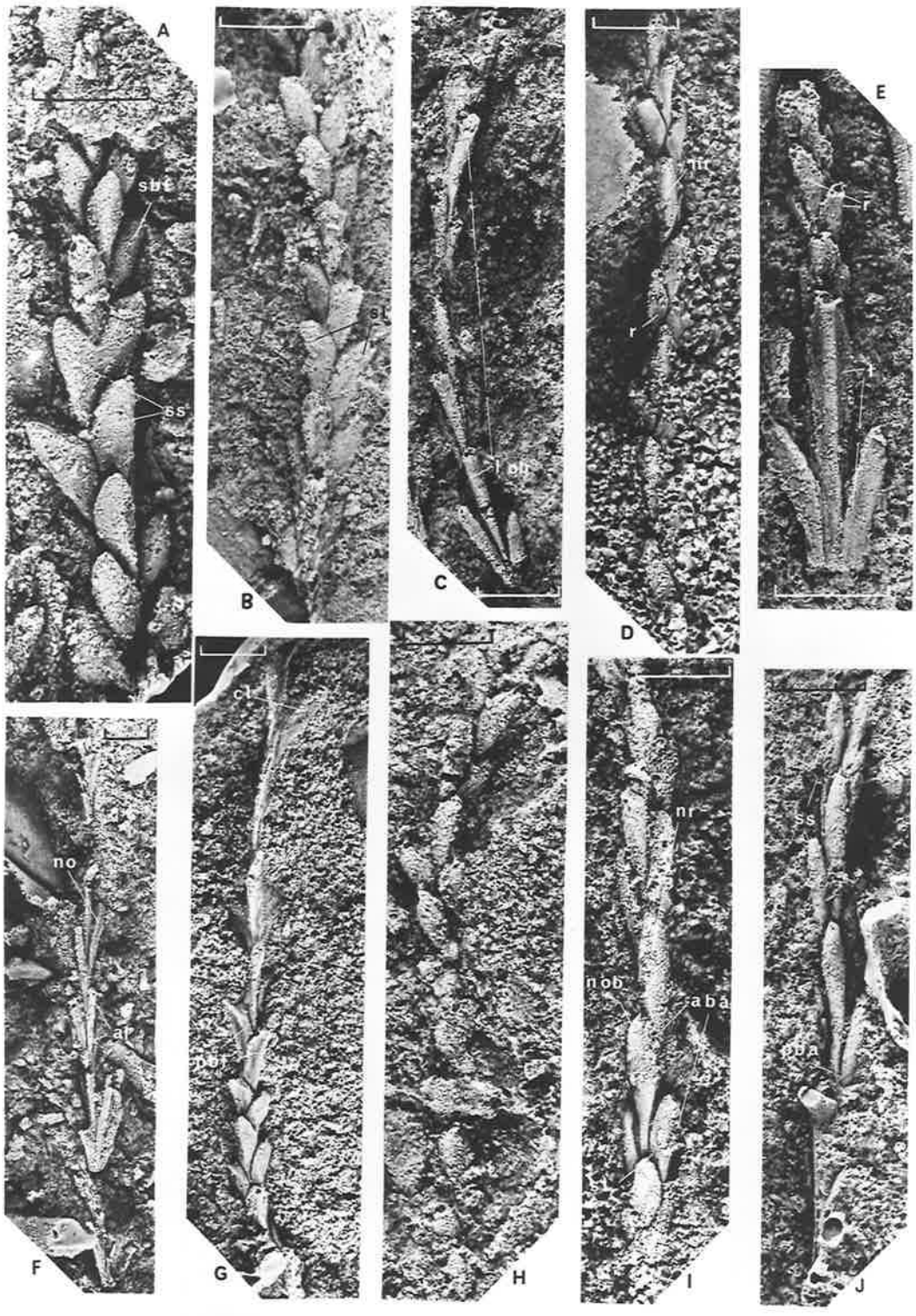

A
sbt
ss
B
st
C
obl
D
ttr
r
E
r
F
no
al
G
cl
H
I
nr
nob
aba
J
ss
pba

PLATE 40

A-E. FORM VIII. A,B, An unbranched axis (A) and an enlargement of part of it (B). The leaves of this axis are mainly narrowly rhombic. Note that their abaxial surfaces are keeled (B,k) and have steeply sloping lateral faces (B,ss). The free portions of many of the leaves are slightly spreading (A,B,ssp) and resemble those of leaves of form VII. C-E. *P13614A* and *B*. A branched (*P13614A*) and a single axis (*P13614B*) (C) and enlargements of part of *P13614A* (D) and of *P13614B* (E). The leaves of these specimens are linear-obtrullate to narrowly obtrullate in face view (D,ob); in lateral view the adnate base is approximately linear (F,al) and the free portion narrowly oblong (E,no). Note the keeled abaxial surface (D,E,k) and the acute or pungent basal angle (D,E,ba). The length-ratio of the adnate base and free portion is greater for some of the leaves (C,l). D. *P13614A* — Note that the lateral faces of the free portion are slightly concave (ss, and that the apex is acute (aa). E. *P13614B* — Note that the acute keel has become rounded distally.

F. FORM IX. This form is characterized by spirally inserted leaves which consist of a bifacial adnate base and a partially bilaterally flattened, spreading blade. F. *P13618*. An unbranched, terminal axis. The adnate bases of leaves are bifacial and are keeled on their abaxial surfaces (k); the blades are partially bilaterally flattened and are not twisted or constricted at their insertion. Note that the lateral faces of the blades are slightly concave (sc) near the median ridge (mr) and that the original adaxial surface is apparently adnate to the axis (a ad). Variation in the amount of bilateral flattening is exaggerated because the blades have been preserved at different angles.

G. FORM VIII. *P13962*. An unbranched axis. Note the slightly spreading (ss) free portions of the leaves.

H. FORM IX. *P13619*. An unbranched, terminal axis. The leaf-blades range from small, slightly spreading and bifacial (bb) to large, spreading and partially bilaterally flattened (pbfb). Note the short adnate bases (sab), the median ridge (mr) of partially bilaterally flattened blades and the obtuse apex (oa). Some blades are approximately tetragonal in cross-section.

Scale = 2mm

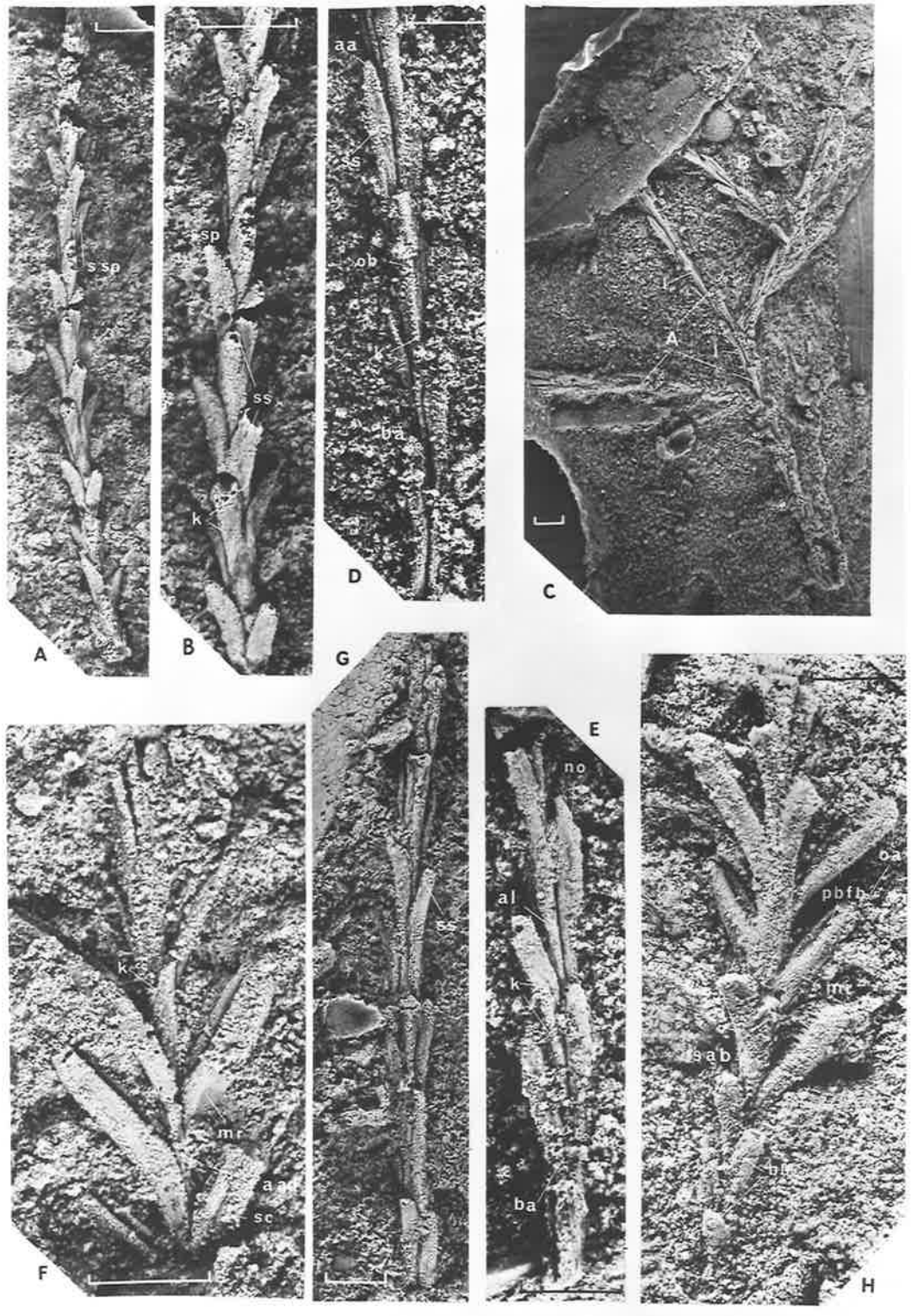

A
ssp
B
sp
ss
k
D
aa
ob
ba
C
A
E
no
al
k
ba
G
ss
F
k
mr
aa
sc
H
oa
pbfb
mr
sab
bb

PLATE 41

A-D. FORM VIII. A-C. *P13642C*. A. A number of fragments of axes. Many of the leaves are only partly preserved and the axes are not in contact. Note axes "a" and "b". B,C. Enlargments of parts of A and in particular of axes "a" (B) and "b" (C). Many of the leaves of B are linear-obtrullate to narrowly obtrullate in face view (B,ob). Note the convex abaxial surface of the leaves (B,c ab s) and the greater adnate base to free portion length-ratio for some leaves (B,l). In particular note the small, rhombic, scale-like leaves (r) borne towards the apices of axes "a" (B) and "b" (C). D. *P13642D*. A branched axis bearing narrowly rhombic leaves (nr) which have been replaced by rhombic, scale-like leaves (r) towards the apices.

E-H. FORM IX. E. *P13635*. A fragment of an axis. Note the short blades (sb). F. *P13616*. An unbranched axis bearing leaves with almost completely bilaterally flattened blades (bfb). Note that the leaves are large when compared with those of other specimens of this form. G. *P13603B*. Part of an unbranched axis. The leaf-blades have undergone different amounts of bilateral flattening. Note the short adnate bases of leaves (sab). H. *P13621*. A poorly preserved, unbranched axis. Many of the leaf-blades are only partly preserved.

Scale = 2mm

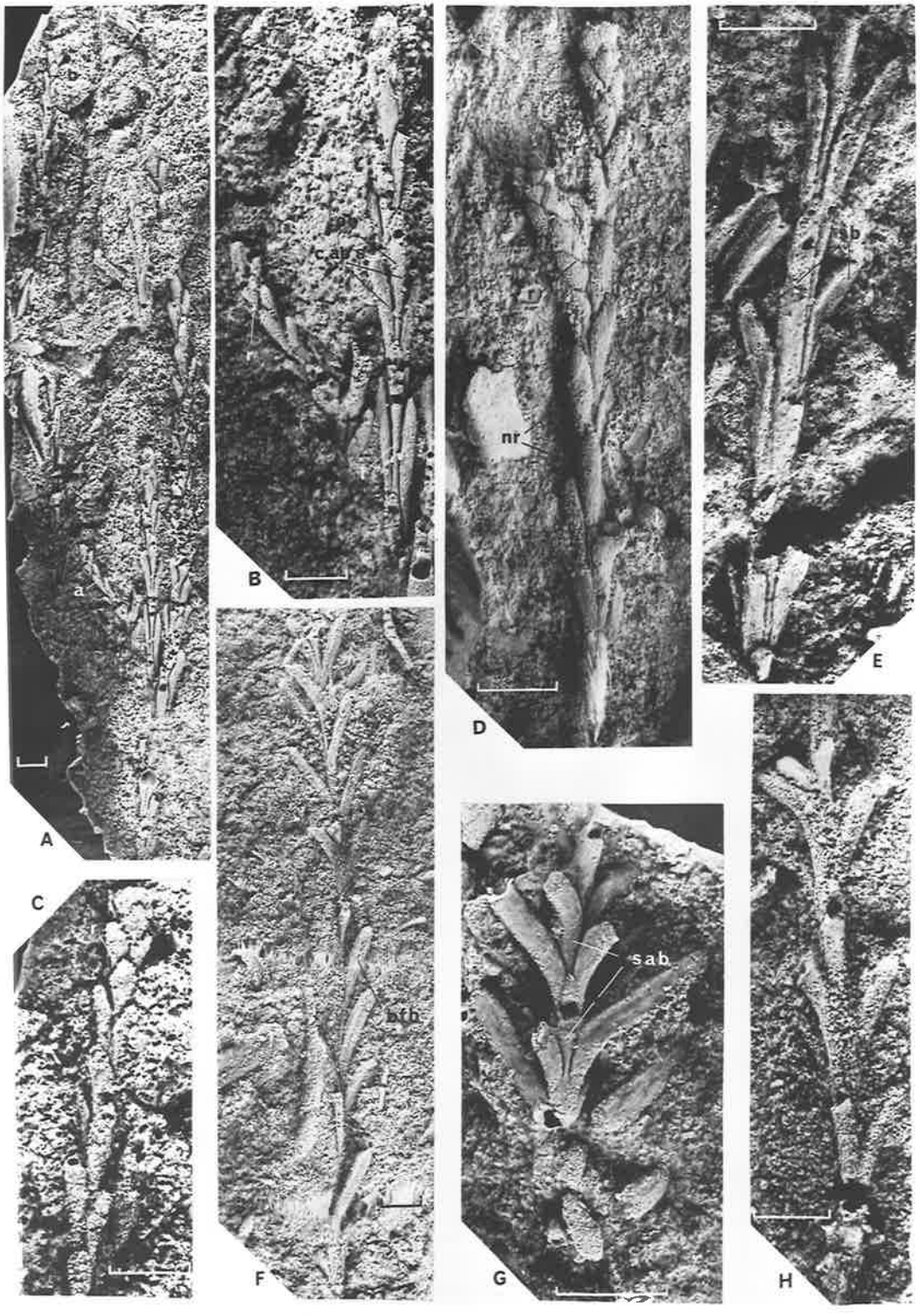

a
B
nr
E
A
C
bth
F
sab
G
H

PLATE 42

A-C. FORM IX. A,B. *P13636*. An unbranched axis (A) and an enlargement of part of it (B). The leaf-blades are bifacial (A,b), but many of them have been only partly preserved. Note the long adnate bases (A,B,lab) terminated by a pungent basal angle (B,pba). Also note the lack of constriction and twisting of the leaf-blades at their insertion. C. *P13622*. An unbranched axis. The leaves of this specimen are thin.

D-F. FORM X. This form is characterized by spirally inserted leaves which consist of a bifacial or bilaterally flattened adnate base and a bilaterally flattened, spreading blade. Some axes have been flattened by compression, thus the leaves appear distichous. D. *P13598C*. An unbranched, terminal axis which has been partially artificially flattened (compressed); some of the leaves appear distichous. Note the bifacial adnate bases (bab) and the blades with planar, striated surfaces (pss) and acute (aa) or obtuse (oa) apices. The bifacial adnate bases indicate that the leaves are not as strongly bilaterally flattened as those of other specimens of this form, for example, *P13967*, Plate 43C,D. E,F. *P13617*. An unbranched axis (E) and an enlargement of part of it (F). Note the bifacial adnate bases and the blades which are slightly constricted at their insertion (E,sc) and are traversed by a median ridge (F,mr). Some of the leaf-blades have been preserved edge-on (E,e).

G. FORM IX. *P13598B*. A poorly preserved, unbranched axis. Note that the leaves are smaller than those of most other specimens of this form.

Scale = 2mm

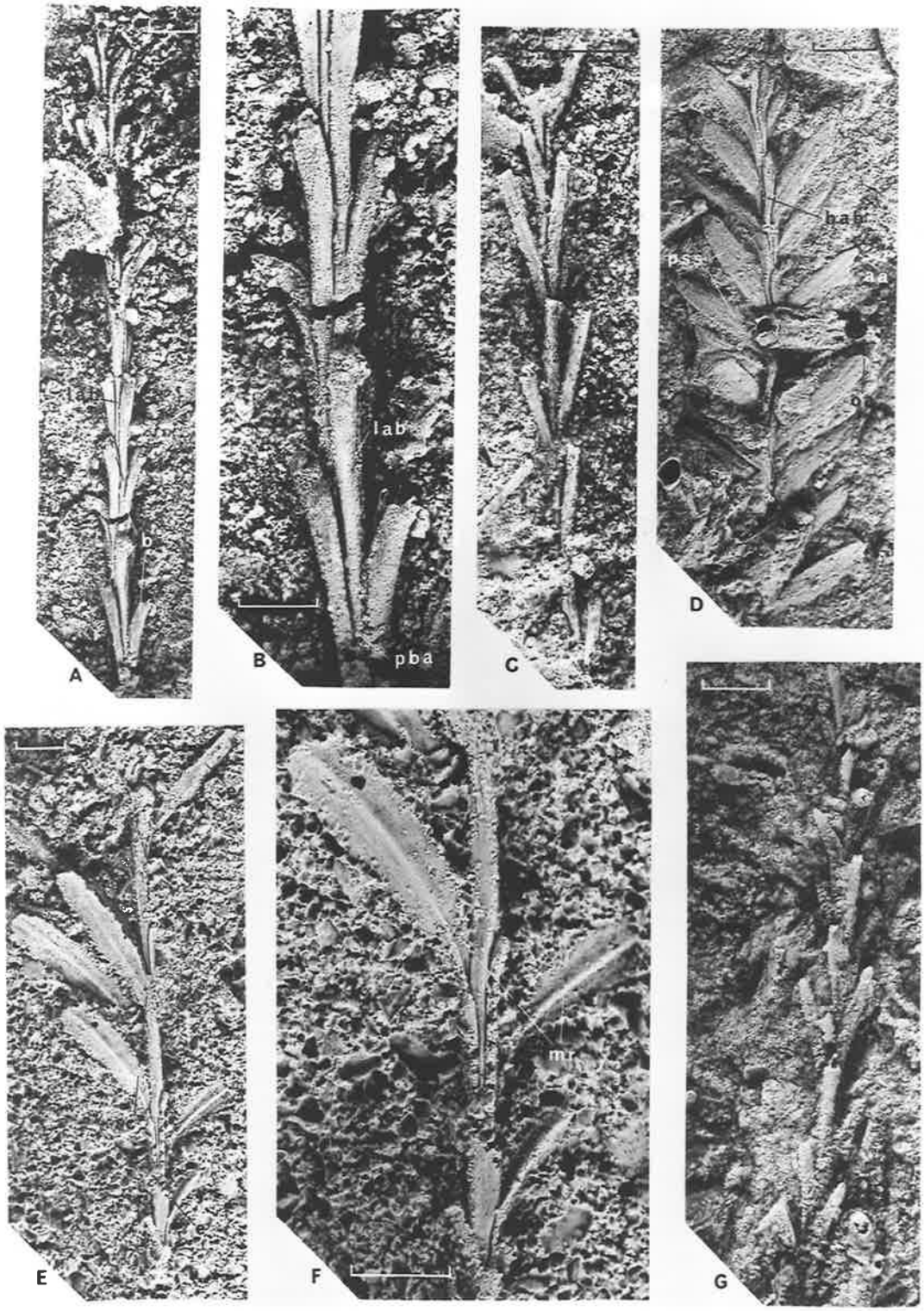

A
lab
b
B
lab
pba
C
D
hab
pss
aa
o
E
F
mr
G

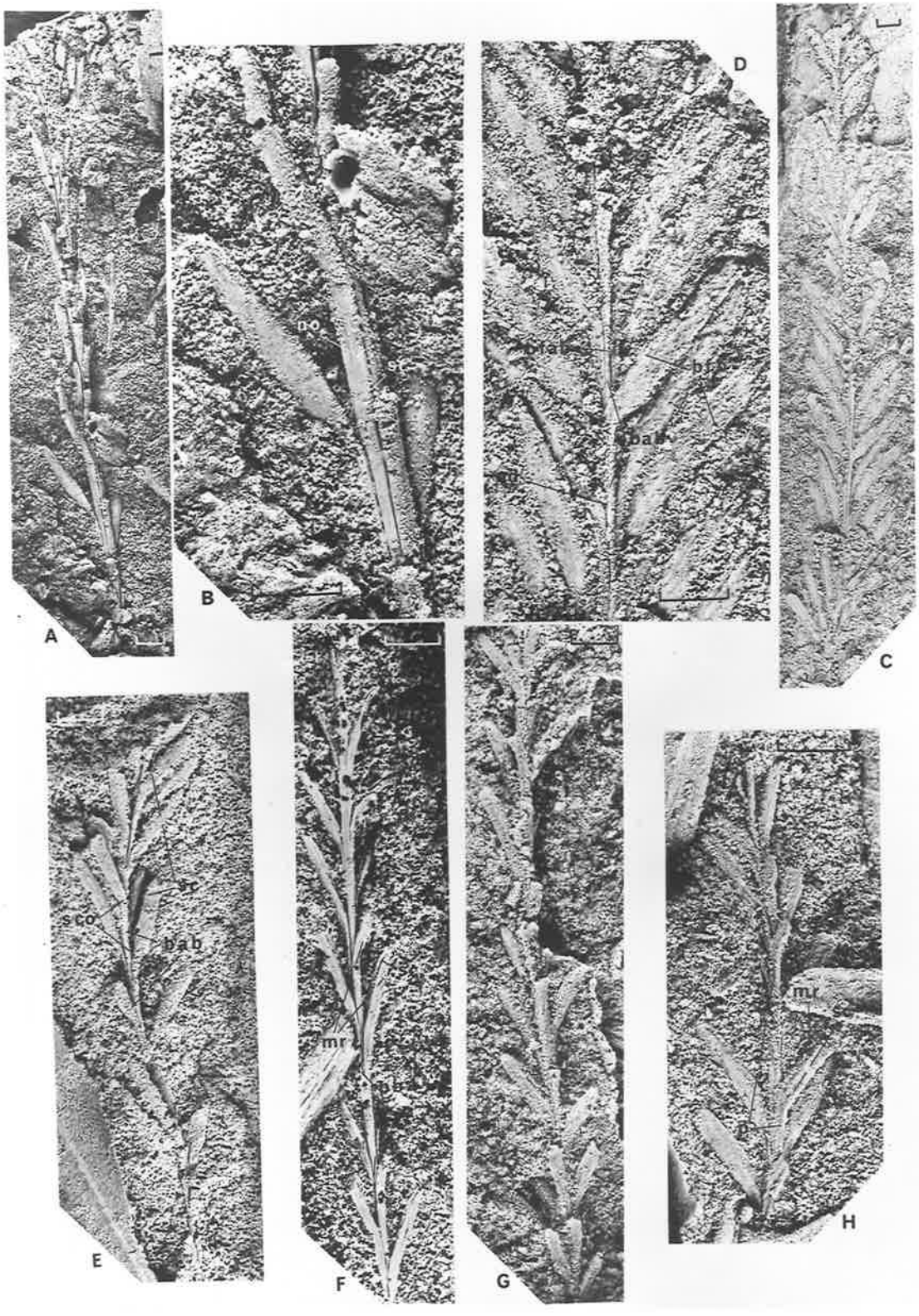
PLATE 43

A-E. FORM X. A,B. *P13626* An unbranched axis (A) and an enlargement of part of it (B). Many of the leaf-blades have been destroyed or only partly preserved; others have been preserved edge-on (A,e). Note the approximately narrowly oblong, bifacial adnate bases (B,no) with flattened abaxial surfaces and the bilaterally flattened blades with slightly convex surfaces (B,sc); no markings can be seen on the surfaces of these leaves (A,B). C,D. *P13967*. An unbranched axis (C) and an enlargement of part of it (D). The leaves are strongly bilaterally flattened and appear distichous. Note the bilaterally flattened adnate bases (D,bfab) (rarely bifacial, D, bab) and blades (D,bfb); the surfaces of both are planar and no markings are visible. The blades are not constricted, but occasionally appear adnate to the axis (D,ad); all blades have been preserved in lateral view. E. *P13625*. An unbranched axis. The leaves are not strongly bilaterally flattened. The adnate bases are bifacial (bab) and are convex in cross-section; the blades are bilaterally flattened, but have slightly convex surfaces (sc). Note that the blades are slightly constricted at their insertion (sco) and that no markings are visible on their surfaces.

F,G. FORM IX. F. *P13623*. An unbranched axis bearing thin leaves with long, bifacial adnate bases and blades with a median ridge (mr). Note the pungent basal angle of the adnate base (pba) and the lateral faces of the blade which are slightly concave near the median ridge (sc). G. *P13624*. An unbranched axis. The leaves of this specimen are large when compared with those of other specimens of this form.

H. FORM X. *P13620*. An unbranched, terminal axis. Some of the leaf-blades have been destroyed or only partly preserved. Note the bilaterally flattened adnate bases with planar surfaces (p) and the bilaterally flattened blades which are ridged medially (mr). The blades have not been constricted near their insertion and their lateral faces are slightly concave near the median ridge (sc).

Scale = 2mm


A
B
po
sc
D
prab
bf
bab
C
E
sc
sco
bab
F
mr
G
H
mr