

29.10.82

A STUDY OF THE PRIMARY VASCULAR SYSTEM  
AND EVOLUTION IN THE FAMILY CUPRESSACEAE

by

Anne Pillman, B.Sc. (Hons.)

Thesis submitted for the degree of Master of Science,  
University of Adelaide

May, 1978

## TABLE OF CONTENTS

	<u>Page No.</u>
LIST OF ILLUSTRATIONS	i
LIST OF TABLES	ii
SUMMARY	iii
DECLARATION	iv
ACKNOWLEDGEMENTS	v
CHAPTER I INTRODUCTION	1
1. THE FAMILY CUPRESSACEAE	1
2. PAST STUDIES IN THE PRIMARY VASCULAR SYSTEM	4
3. THE PRIMARY VASCULAR SYSTEM AND TAXONOMY	11
CHAPTER II MATERIALS AND METHODS	13
1. MATERIALS	13
2. TECHNIQUES	20
3. DATA RECORDING	21
4. TERMINOLOGY	27
a. Leaf trace	27
b. Leaf gap	28
c. Sympodium	28
d. Orthostichy	29
e. Open and closed systems	29
CHAPTER III VASCULAR PATTERNS IN THE CUPRESSACEAE	31
1. TYPES OF VASCULAR PATTERNS	31
a. Pattern type (a)	31
b. Pattern type (b)	37

TABLE OF CONTENTS (cont.)

	<u>Page No.</u>
c. Pattern type (c)	37
d. Pattern type (d)	37
e. Pattern type (e)	38
2. ABERRATIONS IN VASCULAR PATTERNS	41
a. Increase and decrease in sympodium number	41
b. Adventitious vascular tissue	45
c. Parenchyma in vascular bundles	48
3. PRIMARY VASCULAR SYSTEMS IN GENERA OF CUPRESSACEAE	49
a. <i>Widdringtonia</i>	49
b. <i>Tetraclinis</i>	50
c. <i>Diselma</i>	51
d. <i>Callitris</i>	51
e. <i>Actinostrobus</i>	52
f. <i>Libocedrus</i>	53
g. <i>Papuacedrus</i>	54
h. <i>Austrocedrus</i>	54
i. <i>Cupressus</i>	55
j. <i>Chamaecyparis</i>	55
k. <i>Thuja</i>	55
l. <i>Thujopsis</i>	56
m. <i>Calocedrus</i>	56
n. <i>Juniperus</i>	56
o. <i>Metasequoia</i>	57

TABLE OF CONTENTS (cont.)

	<u>Page No.</u>
4. DISCUSSION	57
CHAPTER IV EVOLUTION IN THE CUPRESSACEAE	66
1. INTRODUCTION	66
2. THE FEMALE CONE	67
3. THE MALE CONE AND REPRODUCTIVE BIOLOGY	70
4. VEGETATIVE MORPHOLOGY	74
5. PHYTOCHEMISTRY	77
6. GEOGRAPHY	78
7. DISCUSSION	80
a. Tribe Cupresseae	82
b. Tribe Thujopsidaeae	85
c. Tribe Junipereae	85
d. Tribe Callitreae	85
e. Tribe Austrolibocedreae	86
f. Tribe Tetraclineae	87
CHAPTER V CONCLUSIONS AND FUTURE WORK	90
APPENDIX I A selection of vascular diagrams prepared in this study	92
REFERENCES	102

LIST OF ILLUSTRATIONS

		<u>Page No.</u>
FIGURE I	Series of transverse sections through the first five nodes of <i>Callitris preissii</i>	24
FIGURE II	Stages in the construction of a vascular diagram for <i>Callitris preissii</i>	26
FIGURE III	Vascular patterns in the Cupressaceae	33
FIGURE IV	Types of division and fusion of sympodia in Cupressaceae	36
FIGURE V	Possible origins of type (e) pattern	40
FIGURE VI	Aberrations in vascular patterns - change in sympodial number	44
FIGURE VII	Aberrations in vascular patterns - adventitious vascular tissue and parenchyma in vascular bundles	47
FIGURE VIII	Diagram showing possible evolutionary relationships between genera of the Cupressaceae	84

LIST OF TABLES

	<u>Page No.</u>
TABLE I      Distribution, number of species and taxonomic treatment followed of the genera of Cupressaceae	14
TABLE II     Data on the primary vascular system of 66 shoots examined in this study	15
TABLE III    Details of the five vascular patterns	42
TABLE IV     Distribution of vascular patterns in genera of Cupressaceae	59

SUMMARY

The architecture of the primary vascular system has been investigated in 26 species from 14 genera of the family Cupressaceae, and five patterns, referred to as (a), (b), (c), (d) and (e), have been described. Of these (a), (b) and (d) have been described previously for the Cupressaceae (Namboodiri and Beck, 1968), but (c) and (e) are described for the first time. Type (e) represents a possible evolutionary step between two previously known patterns, (a) and (d). Pattern (d) occurs widely in the subfamily Cupressoideae but is absent from all but one species of the subfamily Callitroideae, thus providing further evidence in support of the theory of long independent evolution of the two subfamilies. Pattern (c) is confined to *Callitris* and *Actinostrobus*, indicating a probable close relationship between these two genera. Investigation of the other two members of the tribe Callitreae could help clarify the composition of this tribe. The other three patterns are distributed widely among the genera of Cupressaceae and thus in general the architecture of the primary vascular system is not a useful generic character in this family. Other studies on the evolution of the Cupressaceae have been reviewed, so that the evolution of vascular patterns could be considered in conjunction with other evidence to provide a more complete picture of evolution within the family.

## DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma and, to the best of my knowledge, contains no material previously published or written by any other person, except where due reference is made in the text.

Anne Pillman

### ACKNOWLEDGEMENTS

I wish to thank the following people who have assisted with this study: Dr. D.C. Christophel for suggesting the topic and his assistance as my supervisor, Dr. J. Jessop and Dr. E.M. Wollaston, my co-supervisors during Dr. Christophel's absence in the latter half of 1977, for their encouragement and helpful criticism of the manuscript, Mr. B. Rowlands for technical assistance with the preparation of serial sections and Mr. D. Blackburn for help with photography.