

MANGROVE VEGETATION

IN

NORTHERN AUSTRALIA

by

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VOLUME II

APPENDICES

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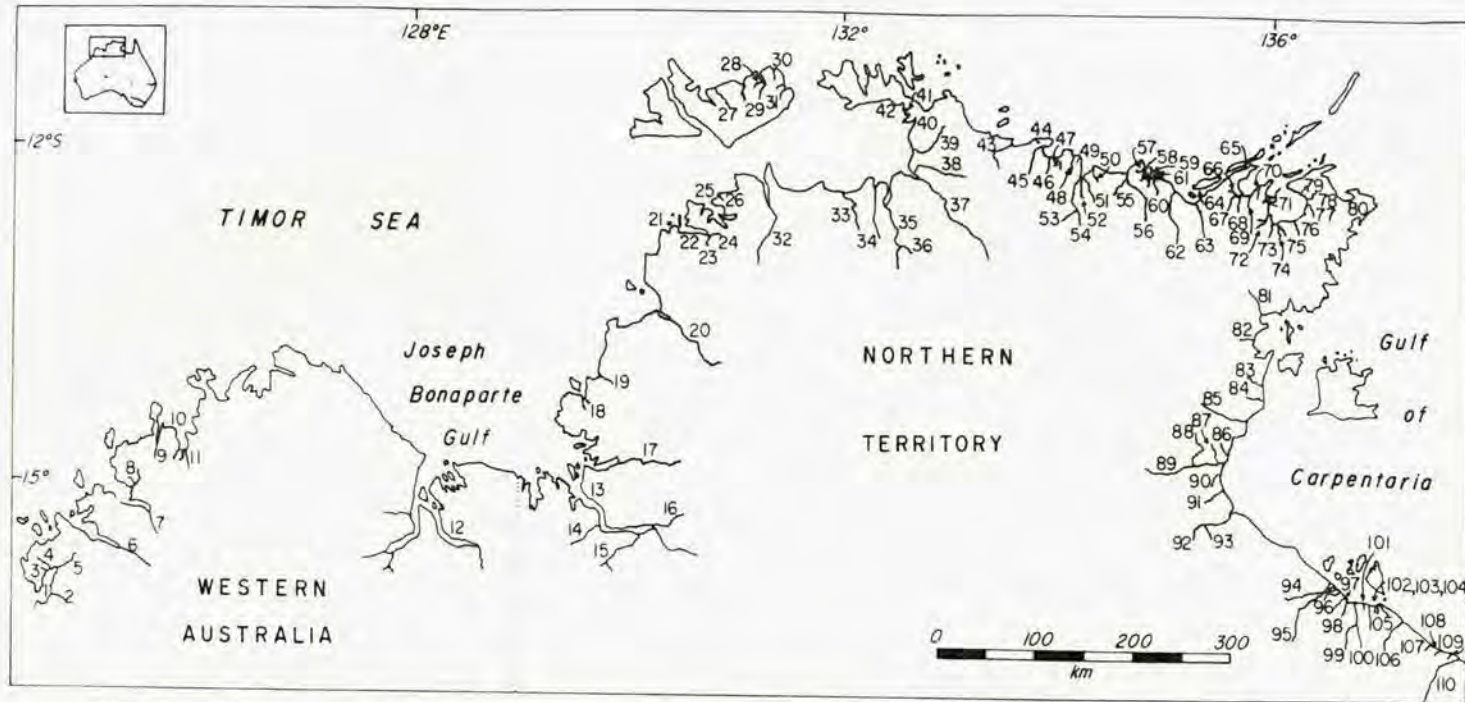
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- 1 GEORGE WATER
- 2 SALE R.
- 3 BARLEE IMPEDIMENT
- 4 GAIRDNER R.
- 5 GLENELG R.
- 6 PRINCE REGENT R.
- 7 ROE R.
- 8 HUNTER R.
- 9 MITCHELL R.
- 10 PORT WARRENDER
- 11 LAWLEY R.
- 12 ORD R.
- 13 VICTORIA R.
- 14 BULLO R.
- 15 BAINES R.
- 16 ANGALARRI R.
- 17 FITZMAURICE R.
- 18 PORT KEATS
- 19 MOYLE R.
- 20 DALY R.
- 21 PORT PATERSON
- 22 BYNOE HARBOUR

- 23 ANNIE R.
- 24 CHARLOTTE R.
- 25 DARWIN HARBOUR
- 26 BUFFALO CK.
- 27 ANDRANANGOO CK.
- 28 BATH CK.
- 29 JOHNSTON R.
- 30 DONGAU CK.
- 31 TINGANOO CK.
- 32 ADELAIDE R.
- 33 WILDMAN R.
- 34 WEST ALLIGATOR R.
- 35 SOUTH ALLIGATOR R.
- 36 NOURLANGIE CK.
- 37 EAST ALLIGATOR R.
- 38 COOPERS CK.
- 39 MURGENELLA CK.
- 40 MINI MINI CK.
- 41 IWALG CK.
- 42 ILAMARYI R.
- 43 KING R.
- 44 ARRLA CK.

- 45 GOOMADEER R.
- 46 WURUGOIJ CK.
- 47 MAJARIE CK.
- 48 NUNGBALGARRIE CK.
- 49 TOMS CK.
- 50 GUDJERARMA CK.
- 51 TOMKINSON R.
- 52 MUNGADOBOLO CK.
- 53 MARAGULIDBAN CK.
- 54 LIVERPOOL R.
- 55 CADELL R.
- 56 BLYTH R.
- 57 NGANDADAUDA CK.
- 58 DJABURA CK.
- 59 DJIGAGILA CK.
- 60 DARBITLA CK.
- 61 BENNETT CK.
- 62 GLYDE R.
- 63 WOOLEN R.
- 64 HUTCHINSON STRAIT
- 65 CADELL STRAIT
- 66 KALARWOI R. (CK. B)

- 67 KALARWOI R.
- 68 BUCKINGHAM R.
- 69 WARAWURUWOI R.
- 70 KURALA R.
- 71 SLIPPERY CK.
- 72 DARWARUNGA R.
- 73 HABGOOD R.
- 74 BARALMINAR R.
- 75 GOBALPA R.
- 76 GOROMURU R.
- 77 CATO R.
- 78 PETER JOHN R.
- 79 BURUNGBIRINUNG R.
- 80 MELVILLE BAY
- 81 KOOLATONG R.
- 82 WALKER R.
- 83 HART R.
- 84 MUNTAK CK.
- 85 ROSE R.
- 86 YIWAPA CK.
- 87 PAINNYLATYA CK.
- 88 PHELP R.

- 89 ROPER R.
- 90 NAYARNPI CK.
- 91 TOWNS R.
- 92 LIMMEN BIGHT R.
- 93 NATHAN R.
- 94 BATTEN CK.
- 95 MCARTHUR R.
- 96 'JOHNSON' R.
- 97 'COULOMB' CK.
- 98 'FARADAY' CK.
- 99 WEARYAN R.
- 100 FOELSCHKE R.
- 101 'BOHR' CK.
- 102 'PLANCK' CK.
- 103 'ARCHIMEDES' CK.
- 104 'GALILEO' CK.
- 105 FAT FELLOWS CK.
- 106 ROBINSON R.
- 107 'EINSTEIN' CK.
- 108 'NEWTON' CK.
- 109 'PAULI' CK.
- 110 CALVERT R.

APPENDIX A1

Mangrove species recorded on tidal waterways of the
survey area - Western Australia; Northern Territory:



<u>FAMILY</u>	<u>SPECIES</u>
ACANTHACEAE	<i>Acanthus ilicifolius</i>
AVICENNIACEAE	<i>Avicennia marina</i>
	<i>Avicennia officinalis</i>
BOMBACACEAE	<i>Camptostemon schultzei</i>
COMBRETACEAE	<i>Lumnitzera littorea</i>
	<i>Lumnitzera racemosa</i>
EUPHORBIACEAE	<i>Excoecaria agallocha</i>
MELIACEAE	<i>Xylocarpus granatum</i>
	<i>Xylocarpus australasicus</i>
MYRSINACEAE	<i>Aegiceras corniculatum</i>
MYRTACEAE	<i>Osbornia octodonta</i>
PLUMBAGINACEAE	<i>Aegialitis annulata</i>
RHIZOPHORACEAE	<i>Bruguiera exaristata</i>
	<i>Bruguiera gymnorhiza</i>
	<i>Bruguiera parviflora</i>
	<i>Bruguiera sexangula</i>
	<i>Ceriops decandra</i>
	<i>Ceriops tagal</i>
	var. <i>australis</i>
	<i>Ceriops tagal</i>
	<i>Rhizophora apiculata</i>
	<i>Rhizophora stylosa</i>
RUBIACEAE	<i>Scyphiphora hydrophyllacea</i>
SONNERATIACEAE	<i>Sonneratia alba</i>
	<i>Sonneratia caseolaris</i>

GLENELG RIVER
Lat. 15°40'S Long. 124°45'E

GAIRDNER RIVER
Lat. 15°40'S Long. 124°45'E

BARLEE IMPEDIMENT
Lat. 15°47'S Long. 124°43'E

SALE RIVER
Lat. 15°57'S Long. 124°33'E

GEORGE WATER
Lat. 15°52'S Long. 124°34'E

X		X		X		X		X	
X		X		X		X		X	
X		X				X		X	
X		X				X		X	
X		X				X		X	
X		X				X		X	
X		X				X		X	
X		X				X			
X		X				X		X	
X		X		X		X		X	
X		X		X		X		X	

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS IN THE NORTH-WEST KIMBERLEYS, WESTERN AUSTRALIA.



FAMILY	SPECIES
ACANTHACEAE	<i>Acanthus ilicifolius</i>
AVICENNIACEAE	<i>Avicennia marina</i> <i>Avicennia officinalis</i>
BOMBACACEAE	<i>Camptostemon schultzei</i>
COMBRETACEAE	<i>Lumnitzera littorea</i> <i>Lumnitzera racemosa</i>
EUPHORBIACEAE	<i>Excoecaria agallocha</i>
MELIACEAE	<i>Xylocarpus granatum</i> <i>Xylocarpus australasicus</i>
MYRSINACEAE	<i>Aegiceras corniculatum</i>
MYRTACEAE	<i>Osbornia octodonta</i>
PLUMBAGINACEAE	<i>Aegialitis annulata</i>
RHIZOPHORACEAE	<i>Bruguiera exaristata</i> <i>Bruguiera gymnorhiza</i> <i>Bruguiera parviflora</i> <i>Bruguiera sexangula</i> <i>Ceriops decandra</i> <i>Ceriops tagal</i> <i>var. australis</i> <i>Ceriops tagal</i> <i>Rhizophora apiculata</i> <i>Rhizophora stylosa</i> <i>Scyphiphora hydrophyllacea</i>
RUBIACEAE	
SONNERATIACEAE	<i>Sonneratia alba</i> <i>Sonneratia caseolaris</i>

PRINCE REGENT RIVER
Lat. 15°27'S Long. 125°03'E

ROE RIVER
Lat. 15°08'S Long. 125°22'E

HUNTER RIVER
Lat. 15°07'S Long. 125°21'E

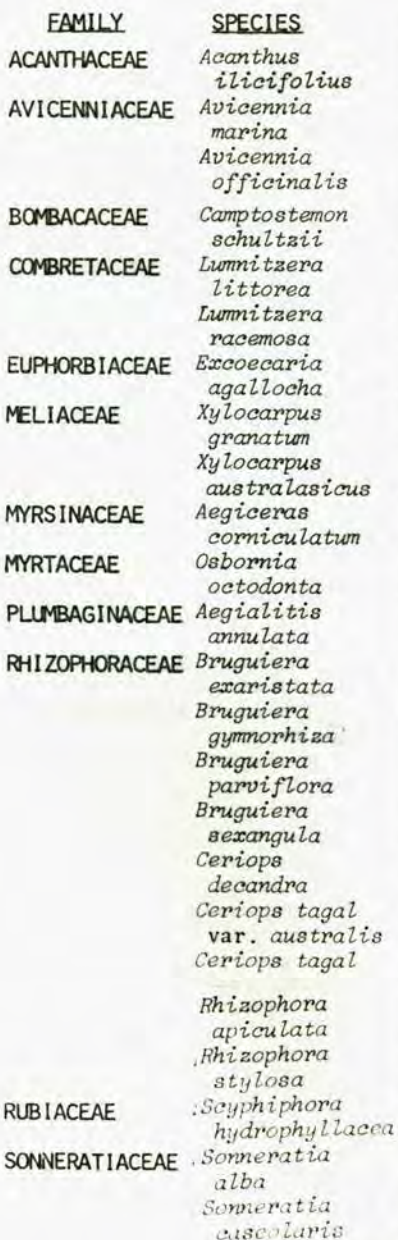
MITCHELL RIVER
Lat. 14°30'S Long. 125°42'E

PORT WARRENDER
Lat. 14°38'S Long. 125°50'E

LAWLEY RIVER
Lat. 14°38'S Long. 125°55'E

X		X		X		X		X		X	
X		X		X		X		X		X	
X		X		X		X		X		X	
X		X		X		X		X		X	
X		X		X		X		X		X	
X		X		X		X		X		X	
X		X		X		X		X		X	
X		X		X		X		X		X	
X		X		X		X		X		X	
X		X		X		X		X		X	

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS IN THE NORTH-WEST KIMBERLEYS, WESTERN AUSTRALIA.

[illegible]

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS ENTERING
JOSEPH BONAPARTE GULF, WEST COAST OF THE NORTHERN
TERRITORY AND WESTERN AUSTRALIA.



FAMILY	SPECIES
ACANTHACEAE	<i>Acanthus ilicifolius</i>
AVICENNIACEAE	<i>Avicennia marina</i> <i>Avicennia officinalis</i>
BOMBACACEAE	<i>Camptostemon schultzei</i>
COMBRETACEAE	<i>Lumnitzera littorea</i> <i>Lumnitzera racemosa</i>
EUPHORBIACEAE	<i>Excoecaria agallocha</i>
MELIACEAE	<i>Xylocarpus granatum</i> <i>Xylocarpus australasicus</i>
MYRSINACEAE	<i>Aegiceras corniculatum</i>
MYRTACEAE	<i>Osbornia octodonta</i>
PLUMBAGINACEAE	<i>Aegialitis annulata</i>
RHIZOPHORACEAE	<i>Bruguiera exaristata</i> <i>Bruguiera gymnorhiza</i> <i>Bruguiera parviflora</i> <i>Bruguiera sexangula</i> <i>Ceriops decandra</i> <i>Ceriops tagal</i> var. <i>australis</i> <i>Ceriops tagal</i> <i>Rhizophora apiculata</i> <i>Rhizophora stylosa</i>
RUBIACEAE	<i>Scyphiphora hydrophyllacea</i>
SONNERATIACEAE	<i>Sonneratia alba</i> <i>Sonneratia caseolaris</i>

PORT KEATS Lat. 14° 05' S Long. 129° 33' E	MOYLE RIVER Lat. 13° 55' S Long. 129° 44' E	DALY RIVER Lat. 13° 19' S Long. 130° 14' E	PORT PATERSON Lat. 12° 34' S Long. 130° 31' E	BYNOE HARBOUR Lat. 12° 30' S Long. 130° 31' E	ANNIE RIVER Lat. 12° 43' S Long. 130° 42' E	CHARLOTTE RIVER Lat. 12° 43' S Long. 130° 42' E	DARWIN HARBOUR Lat. 12° 25' S Long. 130° 48' E	BUFFALO CREEK Lat. 12° 20' S Long. 130° 57' E
		X					X	
X	X	X	X	X	X	X	X	X
								X
X	X	X	X	X	X	X	X	X
X		X	X	X			X	X
	X	X	X	X		X	X	X
X		X	X	X		X	X	X
X		X	X	X	X	X	X	X
X			X	X		X	X	X
X			X	X	X	X	X	X
		X	X	X			X	X
							X	X
X			X	X	X	X	X	X
				X			X	
X	X		X	X		X	X	X
X	X		X	X	X	X	X	X
				X		X	X	
X			X	X	X	X	X	X

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS IN THE DARWIN AREA, NORTHERN TERRITORY.



FAMILY	SPECIES	ANDRANGOO CREEK Lat. 11°21'S Long. 130°51'E	JOHNSTON RIVER Lat. 11°18'S Long. 131°10'E	BATH CREEK Lat. 11°18'S Long. 131°10'E	DONGAU CREEK Lat. 11°18'S Long. 131°21'E	TINGANOO CREEK Lat. 11°23'S Long. 131°28'E
ACANTHACEAE	<i>Acanthus ilicifolius</i>	X		X		
AVICENNIACEAE	<i>Avicennia marina</i>	X	X	X	X	X
	<i>Avicennia officinalis</i>					
BOMBACACEAE	<i>Camptostemon schultzei</i>					
COMBRETACEAE	<i>Lumnitzera littorea</i>		X	X		
	<i>Lumnitzera racemosa</i>	X	X	X	X	X
EUPHORBIACEAE	<i>Excoecaria agallocha</i>	X	X	X	X	X
MELIACEAE	<i>Xylocarpus granatum</i>	X				
	<i>Xylocarpus australasicus</i>	X	X	X	X	X
MYRSINACEAE	<i>Aegiceras corniculatum</i>	X	X	X	X	X
MYRTACEAE	<i>Osbornia octodonta</i>	X	X	X	X	X
PLUMBAGINACEAE	<i>Aegialitis annulata</i>	X	X	X	X	X
RHIZOPHORACEAE	<i>Bruguiera exaristata</i>	X	X	X	X	X
	<i>Bruguiera gymnorhiza</i>	X	X	X	X	X
	<i>Bruguiera parviflora</i>	X	X	X	X	X
	<i>Bruguiera sexangula</i>					
	<i>Ceriops decandra</i>	X	X	X	X	X
	<i>Ceriops tagal</i> var. <i>australis</i>	X	X	X	X	X
	<i>Ceriops tagal</i>					X
	<i>Rhizophora apiculata</i>	X	X	X	X	X
	<i>Rhizophora stylosa</i>	X	X	X	X	X
RUBIACEAE	<i>Scyphiphora hydrophyllacea</i>	X	X	X	X	
SONNERATIACEAE	<i>Sonneratia alba</i>	X	X		X	X
	<i>Sonneratia caseolaris</i>	X				

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS ACROSS
THE NORTH COAST OF MELVILLE ISLAND, NORTHERN TERRITORY.



FAMILY	SPECIES
ACANTHACEAE	<i>Acanthus ilicifolius</i>
AVICENNIACEAE	<i>Avicennia marina</i> <i>Avicennia officinalis</i>
BOMBACACEAE	<i>Camptostemon schultzei</i>
COMBRETACEAE	<i>Lumnitzera littorea</i> <i>Lumnitzera racemosa</i>
EUPHORBIACEAE	<i>Excoecaria agallocha</i>
MELIACEAE	<i>Xylocarpus granatum</i> <i>Xylocarpus australasicus</i>
MYRSINACEAE	<i>Aegiceras corniculatum</i>
MYRTACEAE	<i>Osbornia octodonta</i>
PLUMBAGINACEAE	<i>Aegialitis annulata</i>
RHIZOPHORACEAE	<i>Bruguiera exaristata</i> <i>Bruguiera gymnorhiza</i> <i>Bruguiera parviflora</i> <i>Bruguiera sexangula</i> <i>Ceriops decandra</i> <i>Ceriops tagal</i> var. <i>australis</i> <i>Ceriops tagal</i> <i>Rhizophora apiculata</i> <i>Rhizophora stylosa</i>
RUBIACEAE	<i>Scyphiphora hydrophyllacea</i>
SONNERATIACEAE	<i>Sonneratia alba</i> <i>Sonneratia caseolaris</i>

ADELAIDE RIVER Lat. 12°13'S Long. 131°13'E	WILDMAN RIVER Lat. 12°18'S Long. 132°04'E	WEST ALLIGATOR RIVER Lat. 12°13'S Long. 132°17'E	SOUTH ALLIGATOR RIVER Lat. 12°11'S Long. 132°23'E	NOURLANGIE CREEK Lat. 12°23'S Long. 132°30'E	EAST ALLIGATOR RIVER Lat. 12°05'S Long. 132°36'E	COOPERS CREEK Lat. 12°08'S Long. 132°41'E	MURGENELLA CREEK Lat. 11°53'S Long. 132°39'E	MINI MINI CREEK Lat. 11°44'S Long. 132°37'E	IWALG CREEK Lat. 11°38'S Long. 132°34'E	ILAWARYI RIVER Lat. 11°29'S Long. 132°29'E
X	X	X			X	X	X			
X	X	X	X	X	X	X	X		X	X
X	X	X	X		X	X	X			
X	X	X	X		X	X	X		X	
X	X	X		X	X	X	X		X	X
X	X	X	X	X	X	X	X		X	X
X	X	X	X		X	X	X		X	X
X	X	X	X	X	X	X	X		X	X
X			X		X		X		X	X
X	X	X	X	X	X	X	X		X	X
X	X	X	X		X	X			X	X
X		X								
X	X	X					X		X	X
X	X	X								
X	X	X	X	X	X	X	X		X	X
X	X	X	X		X	X	X		X	X
X	X	X	X		X	X	X		X	X
	X	X	X	X	X	X	X			

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS IN VAN DIEMEN GULF, NORTHERN TERRITORY.



FAMILY	SPECIES	KING RIVER Lat. 11°50'S Long. 133°32'E	ARRLA CREEK Lat. 11°44'S Long. 133°48'E	GOOMADEER RIVER Lat. 11°50'S Long. 133°49'E	WURUGOIJ CREEK Lat. 11°54'S Long. 133°52'E	MAJARIE CREEK Lat. 11°55'S Long. 133°55'E	NUNGBALGARRIE CREEK Lat. 11°55'S Long. 134°04'E
ACANTHACEAE	<i>Acanthus ilicifolius</i>	X		X		X	X
AVICENNIACEAE	<i>Avicennia marina</i>	X	X	X	X	X	X
	<i>Avicennia officinalis</i>						
BOMBACACEAE	<i>Camptostemon schultzei</i>	X	X	X	X	X	X
COMBRETACEAE	<i>Lumnitzera littorea</i>						
	<i>Lumnitzera racemosa</i>	X	X	X			X
EUPHORBIACEAE	<i>Excoecaria agallocha</i>	X	X	X	X	X	X
MELIACEAE	<i>Xylocarpus granatum</i>						
	<i>Xylocarpus australasicus</i>	X	X	X	X	X	X
MYRSINACEAE	<i>Aegiceras corniculatum</i>	X	X	X	X	X	X
MYRTACEAE	<i>Osbornia octodonta</i>	X	X	X	X	X	X
PLUMBAGINACEAE	<i>Aegiceras annulata</i>	X	X	X	X	X	X
RHIZOPHORACEAE	<i>Bruguiera exaristata</i>	X	X	X	X	X	X
	<i>Bruguiera gymnorhiza</i>	X		X			X
	<i>Bruguiera parviflora</i>	X	X	X	X	X	X
	<i>Bruguiera sexangula</i>						
	<i>Ceriops decandra</i>	X	X	X	X	X	X
	<i>Ceriops tagal</i>	X	X	X	X	X	X
	<i>Ceriops tagal</i> var. <i>australis</i>			X			
	<i>Ceriops tagal</i>						
	<i>Rhizophora apiculata</i>	X					X
	<i>Rhizophora stylosa</i>	X	X	X	X	X	X
RUBIACEAE	<i>Sapindus</i>	X			X		
SONNERATIACEAE	<i>Sonneratia alba</i>	X	X	X	X	X	X
	<i>Sonneratia caseolaris</i>						

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS AROUND JUNCTION BAY, ARNHEM LAND, NORTHERN TERRITORY.



FAMILY	SPECIES	TOMS CREEK Lat. 12°00'S Long. 134°10'E	GUDJERAMA CREEK Lat. 12°03'S Long. 134°15'E	LIVERPOOL RIVER Lat. 12°03'S Long. 134°15'E	TOMKINSON RIVER Lat. 12°08'S Long. 134°12'E	MUNGARDOBOLO CREEK Lat. 12°08'S Long. 134°12'E	MARAGULIDBAN CREEK Lat. 12°10'S Long. 134°08'E
ACANTHACEAE	<i>Acanthus ilicifolius</i>	X	X	X	X	X	X
AVICENNIACEAE	<i>Avicennia marina</i>	X	X	X	X	X	X
	<i>Avicennia officinalis</i>			X	X	X	
BOMBACACEAE	<i>Camptostemon schultzei</i>	X	X	X	X	X	X
COMBRETACEAE	<i>Lumnitzera littorea</i>			X			
	<i>Lumnitzera racemosa</i>	X	X	X	X	X	X
EUPHORBIACEAE	<i>Excoecaria agallocha</i>	X	X	X	X	X	X
MELIACEAE	<i>Xylocarpus granatum</i>						
	<i>Xylocarpus australasicus</i>	X	X	X	X	X	X
MYRSINACEAE	<i>Aegiceras corniculatum</i>	X	X	X	X	X	X
MYRTACEAE	<i>Osbornia octodonta</i>	X	X	X	X	X	
PLUMBAGINACEAE	<i>Aegialitis annulata</i>	X	X	X	X	X	X
RHIZOPHORACEAE	<i>Bruguiera exaristata</i>	X	X	X	X	X	X
	<i>Bruguiera gymnorhiza</i>		X	X	X	X	X
	<i>Bruguiera parviflora</i>	X	X	X	X	X	X
	<i>Bruguiera sexangula</i>						
	<i>Ceriops decandra</i>	X	X	X	X	X	X
	<i>Ceriops tagal</i> var. <i>australis</i>	X	X	X	X	X	X
	<i>Ceriops tagal</i>			X			
	<i>Rhizophora apiculata</i>			X			
	<i>Rhizophora stylosa</i>	X	X	X	X	X	X
RUBIACEAE	<i>Scyphiphora hydrophyllacea</i>	X		X			
SONNERATIACEAE	<i>Sonneratia alba</i>	X	X	X	X	X	
	<i>Sonneratia caseolaris</i>						

MANGROVE SPECIES RECORDED (X) ON THE LIVERPOOL/TOMKINSON RIVER SYSTEM, ARNHAM LAND, NORTHERN TERRITORY.



FAMILY	SPECIES	BLYTH RIVER Lat. 12°02'S Long. 134°35'E	CADELL RIVER Lat. 12°10'S Long. 134°35'E	NGANDADA CREEK Lat. 11°59'S Long. 134°46'E	DJABURA CREEK Lat. 12°02'S Long. 134°48'E	DJIGAGILA CREEK Lat. 12°08'S Long. 134°51'E	DARBITLA CREEK Lat. 12°09'S Long. 134°54'E
ACANTHACEAE	<i>Acanthus ilicifolius</i>	X	X	X		X	X
AVICENNIACEAE	<i>Avicennia marina</i>	X	X	X	X	X	X
	<i>Avicennia officinalis</i>	X	X		X	X	X
BOMBACACEAE	<i>Camptostemon schultzei</i>	X	X	X	X	X	X
COMBRETACEAE	<i>Lumnitzera littorea</i>						
	<i>Lumnitzera racemosa</i>	X	X	X	X	X	X
EUPHORBIACEAE	<i>Excoecaria agallocha</i>	X	X	X	X	X	X
MELIACEAE	<i>Xylocarpus granatum</i>						
	<i>Xylocarpus australasicus</i>	X	X	X	X	X	X
MYRSINACEAE	<i>Aegiceras corniculatum</i>	X	X	X	X	X	X
MYRTACEAE	<i>Osbornia octodonta</i>	X		X	X	X	X
PLUMBAGINACEAE	<i>Aegialitis annulata</i>	X	X	X	X	X	X
RHIZOPHORACEAE	<i>Bruguiera exaristata</i>	X	X	X	X	X	X
	<i>Bruguiera gymnorhiza</i>	X	X				X
	<i>Bruguiera parviflora</i>	X	X	X	X	X	X
	<i>Bruguiera sexangula</i>						
	<i>Ceriops decandra</i>	X	X	X	X	X	X
	<i>Ceriops tagal</i> var. <i>australis</i>	X	X	X	X	X	X
	<i>Ceriops tagal</i>			X			
	<i>Rhinophora apiculata</i>						X
	<i>Rhinophora stylacea</i>	X	X	X	X	X	X
RUBIACEAE	<i>Rhinophora stylacea</i>						
SONNERATIACEAE	<i>Sonneratia alba</i>	X	X	X	X	X	X
	<i>Sonneratia alba</i>						

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS OF BOUCAUT AND CASTLEREAGH BAYS, ARNHEM LAND, NORTHERN TERRITORY.



GLYDE RIVER Lat. 12°16'S Long. 135°03'E		WOOLEN RIVER Lat. 12°14'S Long. 135°09'E		HUTCHINSON STRAIT Lat. 12°12'S Long. 135°10'E		CADELL STRAIT Lat. 12°02'S Long. 135°32'E	
X		X		X		X	
X		X		X		X	
X							
X		X		X		X	
		X		X			
X				X		X	
X		X		X		X	
X		X		X		X	
X		X		X		X	
X		X		X		X	
X		X		X		X	
X		X		X		X	
X		X		X		X	
X		X		X		X	
X		X		X		X	
		X					
X		X		X		X	
		X					
X		X		X		X	

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS, IN
CASTLEREAGH BAY, ARNHEM LAND, NORTHERN TERRITORY.



FAMILY	SPECIES	BUCKINGHAM RIVER Lat. 12°16'S Long. 135°44'E	KALAWOI RIVER Lat. 12°19'S Long. 135°42'E	KALAWOI CREEK B Lat. 12°19'S Long. 135°40'E	WARAWURUWOI RIVER Lat. 12°15'S Long. 135°46'E	KURALA RIVER Lat. 12°09'S Long. 135°54'E	SLIPPERY CREEK Lat. 12°17'S Long. 135°57'E
ACANTHACEAE	<i>Acanthus ilicifolius</i>	X	X	X	X		X
AVICENNIACEAE	<i>Avicennia marina</i>	X	X	X	X	X	X
	<i>Avicennia officinalis</i>						
BOMBACEAE	<i>Camptostemon schultzei</i>	X	X	X	X	X	X
COMBRETACEAE	<i>Lumnitzera littorea</i>						
	<i>Lumnitzera racemosa</i>	X	X	X	X		X
EUPHORBIACEAE	<i>Excoecaria agallocha</i>	X	X	X	X	X	X
MELIACEAE	<i>Xylocarpus granatum</i>						
	<i>Xylocarpus australasicus</i>	X	X	X	X	X	X
MYRSINACEAE	<i>Aegiceras corniculatum</i>	X	X	X	X	X	X
MYRTACEAE	<i>Osbornia octodonta</i>	X		X	X	X	X
PLUMBAGINACEAE	<i>Aegialitis annulata</i>	X	X	X	X	X	X
RHIZOPHORACEAE	<i>Bruguiera exaristata</i>	X	X	X	X	X	X
	<i>Bruguiera gymnorhiza</i>	X				X	
	<i>Bruguiera parviflora</i>	X		X	X	X	X
	<i>Bruguiera sexangula</i>						
	<i>Ceriops decandra</i>	X	X	X	X	X	X
	<i>Ceriops tagal</i>	X	X	X	X	X	X
	<i>Ceriops tagal</i> var. <i>australis</i>						X
	<i>Rhizophora apiculata</i>						
	<i>Rhizophora stylosa</i>	X	X	X	X	X	X
RUBIACEAE	<i>Scyphiphora hydrophyllacea</i>						
SONNERATIACEAE	<i>Sonneratia alba</i>	X	X	X	X	X	X
	<i>Sonneratia ascolaris</i>						

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS OF
BUCKINGHAM BAY, ARNHEM LAND, NORTHERN TERRITORY.



FAMILY	SPECIES	DARWARUNGA RIVER Lat. 12°23'S Long. 135°59'E	HABGOOD RIVER Lat. 12°27'S Long. 136°00'E	BARALMINAR RIVER Lat. 12°29'S Long. 136°01'E	GOBALPA RIVER Lat. 12°29'S Long. 136°02'E	GOROMURU RIVER Lat. 12°28'S Long. 136°13'E	CATO RIVER Lat. 12°16'S Long. 136°21'E	PETER JOHN RIVER Lat. 12°15'S Long. 136°21'E	BURLINGBIRNING RIVER Lat. 12°13'S Long. 136°19'E
ACANTHACEAE	<i>Acanthus ilicifolius</i>	X	X	X	X	X	X	X	X
AVICENNIACEAE	<i>Avicennia marina</i>	X	X	X	X	X	X	X	X
	<i>Avicennia officinalis</i>								
BOMBACACEAE	<i>Camptostemon schultzei</i>	X	X	X	X	X	X	X	X
COMBRETACEAE	<i>Lumnitzera littorea</i>	X			X				
	<i>Lumnitzera racemosa</i>	X	X	X		X	X	X	X
EUPHORBIACEAE	<i>Excoecaria agallocha</i>	X	X	X	X	X	X	X	X
MELIACEAE	<i>Xylocarpus granatum</i>								
	<i>Xylocarpus australasicus</i>	X	X	X	X	X	X	X	X
MYRSINACEAE	<i>Aegiceras corniculatum</i>	X	X	X	X	X	X	X	X
MYRTACEAE	<i>Osbornia octodonta</i>	X		X	X		X	X	
PLUMBAGINACEAE	<i>Aegialitis annulata</i>	X	X	X	X	X	X		X
RHIZOPHORACEAE	<i>Bruguiera exaristata</i>	X	X	X	X	X	X	X	X
	<i>Bruguiera gymnorhiza</i>	X	X	X		X	X		
	<i>Bruguiera parviflora</i>	X	X	X	X	X	X	X	X
	<i>Bruguiera sexangula</i>						X	X	
	<i>Ceriops decandra</i>	X	X	X	X	X	X	X	X
	<i>Ceriops tagal</i>	X	X	X	X	X	X	X	X
	<i>var. australis</i>	X	X	X	X	X			
	<i>Ceriops tagal</i>								
	<i>Rhizophora apiculata</i>		X				X	X	
	<i>Rhizophora stylosa</i>	X	X	X	X	X	X	X	X
RUBIACEAE	<i>Scyphiphora hydrophyllacea</i>	X		X	X			X	X
SONNERATIACEAE	<i>Sonneratia alba</i>	X	X	X	X	X	X	X	X
	<i>Sonneratia caseolaris</i>		X			X	X	X	

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS OF
ARNHEM BAY, ARNHEN LAND, NORTHERN TERRITORY.



FAMILY	SPECIES	MELVILLE BAY Lat. 12°15'S Long. 136°40'E	KOOLATONG RIVER Lat. 13°16'S Long. 135°56'E	WALKER RIVER Lat. 13°55'S Long. 135°50'E	HART RIVER Lat. 14°05'S Long. 135°53'E	MUNTAK CREEK Lat. 14°09'S Long. 135°53'E	ROSE RIVER Lat. 14°17'S Long. 135°44'E	YIWAPA CREEK Lat. 14°44'S Long. 135°24'E	ROPER RIVER Lat. 14°45'S Long. 135°24'E	PAINYILATYA CREEK Lat. 14°45'S Long. 135°23'E	PHLEP RIVER Lat. 14°41'S Long. 135°12'E
ACANTHACEAE	<i>Acanthus ilicifolius</i>	X	X	X					X	X	X
AVICENNIACEAE	<i>Avicennia marina</i>	X	X	X	X	X	X	X	X	X	X
	<i>Avicennia officinalis</i>										
BOMBACACEAE	<i>Camptostemon schultzei</i>	X									
COMBRETACEAE	<i>Lumnitzera littorea</i>	X					X				
	<i>Lumnitzera racemosa</i>	X	X	X	X	X		X	X	X	X
EUPHORBIACEAE	<i>Excoecaria agallocha</i>	X	X	X	X	X	X	X	X	X	X
MELIACEAE	<i>Xylocarpus granatum</i>	X									
	<i>Xylocarpus australasicus</i>	X	X	X	X	X	X	X	X		X
MYRSINACEAE	<i>Aegiceras corniculatum</i>	X	X	X				X	X	X	X
MYRTACEAE	<i>Osbornia octodonta</i>	X	X	X	X	X	X	X	X		
PLUMBAGINACEAE	<i>Aegialitis annulata</i>	X	X	X	X	X		X	X	X	X
RHIZOPHORACEAE	<i>Bruguiera exaristata</i>	X	X	X	X	X			X	X	X
	<i>Bruguiera gymnorhiza</i>	X	X	X		X	X		X		X
	<i>Bruguiera parviflora</i>	X	X	X					X	X	
	<i>Bruguiera sexangula</i>										
	<i>Ceriops decandra</i>	X									
	<i>Ceriops tagal</i> var. <i>australis</i>	X	X	X	X	X		X	X	X	X
	<i>Ceriops tagal</i>										
	<i>Rhizophora apiculata</i>	X									
	<i>Rhizophora stylosa</i>	X	X	X	X	X	X	X	X	X	X
RUBIACEAE	<i>Scyphiphora hydrophyllacea</i>	X		X	X	X	X				
SONNERATIACEAE	<i>Sonneratia alba</i>	X									
	<i>Sonneratia caseolaris</i>										

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS ENTERING THE SOUTHERN PORTION OF THE GULF OF CARPENTARIA, NORTHERN TERRITORY.



FAMILY	SPECIES
ACANTHACEAE	<i>Acanthus ilicifolius</i>
AVICENNIACEAE	<i>Avicennia marina</i> <i>Avicennia officinalis</i>
BOMBACACEAE	<i>Camptostemon schultzei</i>
COMBRETACEAE	<i>Lumnitzera littorea</i> <i>Lumnitzera racemosa</i>
EUPHORBIACEAE	<i>Excoecaria agallocha</i>
MELIACEAE	<i>Xylocarpus granatum</i> <i>Xylocarpus australasicus</i>
MYRSINACEAE	<i>Aegiceras corniculatum</i>
MYRTACEAE	<i>Osbornia octodonta</i>
PLUMBAGINACEAE	<i>Aegialitis annulata</i>
RHIZOPHORACEAE	<i>Bruguiera exaristata</i> <i>Bruguiera gymnorhiza</i> <i>Bruguiera parviflora</i> <i>Bruguiera sexangula</i> <i>Ceriops decandra</i> <i>Ceriops tagal</i> var. <i>australis</i> <i>Ceriops tagal</i> <i>Rhizophora apiculata</i> <i>Rhizophora stylosa</i>
RUBIACEAE	<i>Scyphiphora hydrophyllacea</i>
SONNERATIACEAE	<i>Sonneratia alba</i> <i>Sonneratia caseolaris</i>

NAYARNPI CREEK Lat. 14°49'S Long. 135°24'E	TOWNS RIVER Lat. 14°55'S Long. 135°26'E	LIMMEN BIGHT RIVER Lat. 15°06'S Long. 135°42'E	NATHAN RIVER Lat. 15°14'S Long. 135°31'E	BATTEN CREEK Lat. 15°53'S Long. 136°31'E	MCARTHUR RIVER Lat. 15°49'S Long. 136°41'E	'JOHNSON' RIVER Lat. 15°55'S Long. 136°41'E	'COULOMB' CREEK Lat. 15°54'S Long. 136°47'E	'FARADAY' CREEK Lat. 15°54'S Long. 136°48'E	WEARYAN RIVER Lat. 15°55'S Long. 136°52'E	FOELSCH RIVER Lat. 16°03'S Long. 136°48'E
					X					
X	X	X	X	X	X	X	X	X	X	X
		X								
	X	X	X	X	X		X		X	X
X	X	X	X	X	X	X	X	X	X	X
		X	X		X	X			X	
X	X	X	X	X	X	X	X	X	X	X
X	X	X			X	X	X	X	X	
		X			X	X	X		X	
		X								
X	X	X			X	X	X	X	X	
X	X	X	X	X	X	X	X	X	X	X

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS ALONG THE SOUTH WEST COAST OF THE GULF OF CARPENTARIA, NORTHERN TERRITORY.



FAMILY	SPECIES
ACANTHACEAE	<i>Acanthus ilicifolius</i>
AVICENNIACEAE	<i>Avicennia marina</i> <i>Avicennia officinalis</i>
BOMBACACEAE	<i>Camptostemon schultzei</i>
COMBRETACEAE	<i>Lumnitzera littorea</i> <i>Lumnitzera racemosa</i>
EUPHORBIACEAE	<i>Excoecaria agallocha</i>
MELIACEAE	<i>Xylocarpus granatum</i> <i>Xylocarpus australasicus</i>
MYRSINACEAE	<i>Aegiceras corniculatum</i>
MYRTACEAE	<i>Osbornia octodonta</i>
PLUMBAGINACEAE	<i>Aegialitis annulata</i>
RHIZOPHORACEAE	<i>Bruguiera exaristata</i> <i>Bruguiera gymnorhiza</i> <i>Bruguiera parviflora</i> <i>Bruguiera sexangula</i> <i>Ceriops decandra</i> <i>Ceriops tagal</i> <i>var. australis</i> <i>Ceriops tagal</i> <i>Rhizophora apiculata</i> <i>Rhizophora stylosa</i>
RUBIACEAE	<i>Scephyphora hydrophyllacea</i>
SONNERATIACEAE	<i>Sonneratia alba</i> <i>Sonneratia caseolaris</i>

'BOHR' CREEK Lat. 15°56'S Long. 136°55'E	'PLANCK' CREEK Lat. 15°56'S Long. 136°55'E	'ARCHIMEDES' CREEK Lat. 15°53'S Long. 136°58'E	'GALILEO' CREEK Lat. 15°53'S Long. 137°00'E	FAT FELLOWS CREEK Lat. 15°53'S Long. 137°00'E	ROBINSON RIVER Lat. 16°02'S Long. 137°15'E	'EINSTEIN' CREEK Lat. 16°10'S Long. 137°32'E	'NEWTON' CREEK Lat. 16°10'S Long. 137°35'E	'PAULI' CREEK Lat. 16°12'S Long. 137°38'E	CALVERT RIVER Lat. 16°16'S Long. 137°45'E
X	X	X	X	X	X	X	X	X	X
X					X			X	
X	X		X	X	X	X	X	X	X
					X				X
X	X		X	X	X	X	X		X
X	X	X	X	X	X	X	X	X	X
X	X			X	X	X	X	X	
X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X

MANGROVE SPECIES RECORDED (X) ON TIDAL WATERWAYS ENTERING THE SOUTHERN PORTION OF THE GULF OF CARPENTARIA, NORTHERN TERRITORY.

APPENDIX 1

Student Newman-Keuls' multiple range tests on means ($\log_e$ transformed data) of girths of *Avicennia marina*, *Camptostemon schultzei* and *Rhizophora stylosa* at stations within the Liverpool-Tomkinson Rivers System, N.T.

Student Newman-Keuls' multiple range tests were carried out as described in Zar (1974). Tables used were from Rohlf and Sokal (1969).

In the conclusions mean values of stations underlined by a common line are not significantly different at $p < 0.05$.

Avicennia marina: Liverpool River

To test H_0 : $\mu_{\text{Stn } 2} = \mu_{\text{Stn } 3} = \mu_{\text{Stn } 4} = \mu_{\text{Stn } 5} = \mu_{\text{Stn } 6}$

Ranks of sample means

			$\bar{X}$ loge cm
1	(Station 3)	=	3.2542
2	(" 4)	=	3.3193
3	(" 2)	=	3.3444
4	(" 5)	=	3.7715
5	(" 6)	=	3.9120

Standard error (from nested Anova) = 0.07293

Conclusions:

<u>Stn 3</u>	<u>Stn 4</u>	<u>Stn 2</u>	<u>Stn 5</u>	<u>Stn 6</u>
--------------	--------------	--------------	--------------	--------------

Camptostemon schultzei: Liverpool River

To test H_0 : $\mu_{\text{Stn } 2} = \mu_{\text{Stn } 3} = \mu_{\text{Stn } 4} = \mu_{\text{Stn } 5} = \mu_{\text{Stn } 6}$

Ranks of sample means

			$\bar{X}$ loge cm
1	(Station 2)	=	3.02814
2	(" 3)	=	3.03694
3	(" 4)	=	3.4222
4	(" 6)	=	3.5829
5	(" 5)	=	3.61616

Standard error (from nested Anova) = 0.05914

Conclusions:

<u>Stn 2</u>	<u>Stn 3</u>	<u>Stn 4</u>	<u>Stn 5</u>	<u>Stn 6</u>
--------------	--------------	--------------	--------------	--------------

Rhizophora stylosa: Liverpool River

To test $H_0: \mu_{\text{Stn } 1} = \mu_{\text{Stn } 2} = \mu_{\text{Stn } 3} = \mu_{\text{Stn } 4}$

Ranks of sample means

			$\bar{X}$ loge cm
1	(Station 2)	=	3.0754
2	(" 3)	=	3.0770
3	(" 1)	=	3.2110
4	(" 4)	=	3.4229

Standard error (from nested Anova) = 0.0558

Conclusions:

<u>Stn 1</u>	<u>Stn 2</u>	<u>Stn 3</u>	<u>Stn 4</u>
--------------	--------------	--------------	--------------

Avicennia marina: Tomkinson River

To test $H_0: \mu_{\text{Stn } 1} = \mu_{\text{Stn } 2} = \mu_{\text{Stn } 3} = \mu_{\text{Stn } 4} = \mu_{\text{Stn } 5} = \mu_{\text{Stn } 6}$

Ranks of sample means

			$\bar{X}$ loge cm
1	(Station 2)	=	2.7274
2	(" 3)	=	2.9660
3	(" 1)	=	3.1427
4	(" 4)	=	3.1442
5	(" 5)	=	3.5685
6	(" 6)	=	3.8431

Standard error (from nested Anova) = 0.0701

Conclusions:

<u>Stn 2</u>	<u>Stn 3</u>	<u>Stn 1</u>	<u>Stn 4</u>	<u>Stn 5</u>	<u>Stn 6</u>
--------------	--------------	--------------	--------------	--------------	--------------

Camptostemon schultzei: Tomkinson River

To test $H_0: \mu_{\text{Stn 1}} = \mu_{\text{Stn 2}} = \mu_{\text{Stn 3}} = \mu_{\text{Stn 4}} = \mu_{\text{Stn 5}}$

Ranks of sample means

			$\bar{X} \text{ loge cm}$
1	(Station 2)	=	2.5607
2	(" 1)	=	2.6182
3	(" 3)	=	3.0365
4	(" 4)	=	3.2512
5	(" 5)	=	3.3650

Standard error (from nested Anova) = 0.0680

Conclusions:

Stn 2 Stn 1 Stn 3 Stn 4 Stn 5

Rhizophora stylosa: Tomkinson River

To test $H_0: \mu_{\text{Stn 1}} = \mu_{\text{Stn 2}} = \mu_{\text{Stn 3}} = \mu_{\text{Stn 4}}$

Ranks of sample means

			$\bar{X} \text{ loge cm}$
1	(Station 2)	=	2.4654
2	(" 1)	=	2.7486
3	(" 3)	=	2.9158
4	(" 4)	=	3.3131

Standard error (from nested Anova) = 0.0774

Conclusions:

Stn 2 Stn 1 Stn 3 Stn 4

Avicennia marina: Mungardobolo Creek

To test $H_0: \mu_{\text{Stn 1}} = \mu_{\text{Stn 2}} = \mu_{\text{Stn 3}} = \mu_{\text{Stn 4}} = \mu_{\text{Stn 5}} = \mu_{\text{Stn 6}}$

Ranks of sample means

			$\bar{X}$ loge cm
1	(Station 6)	=	2.4947
2	(" 5)	=	2.9175
3	(" 1)	=	2.9763
4	(" 2)	=	3.0116
5	(" 4)	=	3.0750
6	(" 3)	=	3.3358

Standard error (from nested Anova) = 0.1183

Conclusions:

Stn 6 Stn 5 Stn 1 Stn 2 Stn 4 Stn 3

Camptostemon schultzei: Mungardobolo Creek

To test $H_0: \mu_{\text{Stn 1}} = \mu_{\text{Stn 2}} = \mu_{\text{Stn 3}} = \mu_{\text{Stn 4}}$

Ranks of sample means

			$\bar{X}$ loge cm
1	(Station 2)	=	2.5904
2	(" 1)	=	2.6011
3	(" 3)	=	2.6883
4	(" 4)	=	2.7892

Standard error (from nested Anova) = 0.0500

Conclusions:

Stn 2 Stn 1 Stn 3 Stn 4

Rhizophora stylosa: Mungardobolo Creek

To test $H_0: \mu_{\text{Stn 1}} = \mu_{\text{Stn 2}} = \mu_{\text{Stn 3}} = \mu_{\text{Stn 4}}$

Ranks of sample means

			$\bar{X}$ loge cm
1	(Station 4)	=	2.5030
2	(" 2)	=	2.6546
3	(" 1)	=	2.6584
4	(" 3)	=	2.8170

Standard error (from nested Anova) = 0.0618

Conclusions:

<u>Stn 4</u>	<u>Stn 2</u>	<u>Stn 1</u>	Stn 3
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APPENDIX 2

Location of quadrats and stations used for girth,
basal area and density studies on the Liverpool-Tomkinson Rivers
System, N.T.

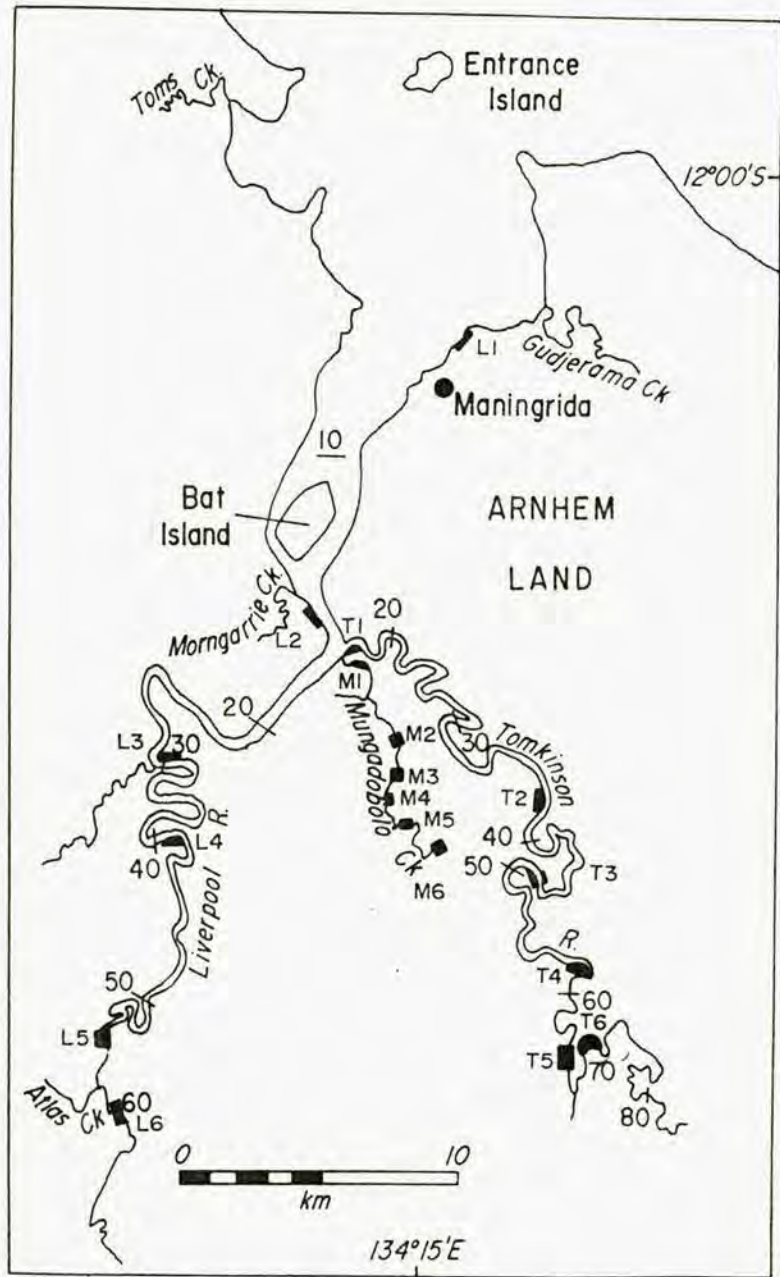


Figure A2.1

Location of stations used for girth, basal area and density studies of three mangrove species, etc., on the Liverpool-Tomkinson Rivers System.

LIVERPOOL RIVER, N.T.

Station Number	Station Length	Peak Dry Season High Tide Salinity (1979) ‰	Peak Dry Season Soil Salinity (1979) ‰	Random Starting Points of Quadrats (in metres)
1				Q ₁ = 90 Q ₂ = 180
3 - 4 km	1 km	35	40	Q ₃ = 240 Q ₄ = 560 Q ₅ = 850
2				Q ₁ = 0 Q ₂ = 120
15-16 km	1 km	35	40	Q ₃ = 220 Q ₄ = 460 Q ₅ = 810
3				Q ₁ = 60 Q ₂ = 220
30-31 km	1 km	35	44	Q ₃ = 570 Q ₄ = 980 Q ₅ = 730
4				Q ₁ = 50 Q ₂ = 370
41-42 km	1 km	30	40	Q ₃ = 810 Q ₄ = 520 Q ₅ = 680
5				Q ₁ = 80 Q ₂ = 190
55-56 km	1 km	18	25	Q ₃ = 370 Q ₄ = 560 Q ₅ = 640
6				Q ₁ = 90 Q ₂ = 230
59-60 km	1 km	9	10	Q ₃ = 360 Q ₄ = 170 Q ₅ = 990

TABLE A 2.1

Quadrat and Station information for the Liverpool River

TOMKINSON RIVER, N.T.

Station Number	Station Length	Peak Dry Season High Tide Salinity (1979) ‰	Peak Dry Season Soil Salinity (1979) ‰	Random Starting Points of Quadrats (in metres)
1				Q ₁ = 40
17.5 - 18.5 km	1 km	35	48	Q ₂ = 220
				Q ₃ = 390
				Q ₄ = 520
				Q ₅ = 800
2				Q ₁ = 130
38-39 km	1 km	35	50	Q ₂ = 190
				Q ₃ = 480
				Q ₄ = 680
				Q ₅ = 800
3				Q ₁ = 440
47.5 - 48.5 km	1 km	25	28	Q ₂ = 640
				Q ₃ = 840
				Q ₄ = 960
				Q ₅ = 990
4				Q ₁ = 360
56-57 km	1 km	20	27	Q ₂ = 730
				Q ₃ = 190
				Q ₄ = 810
				Q ₅ = 910
5				Q ₁ = 110
65-66 km	1 km	15	24	Q ₂ = 240
				Q ₃ = 330
				Q ₄ = 600
				Q ₅ = 690
6				Q ₁ = 100
68-69 km	1 km	14	15	Q ₂ = 190
				Q ₃ = 550
				Q ₄ = 840
				Q ₅ = 920

TABLE A 2.2

Quadrat and Station information for the Tomkinson River.

MUNGARDOBOLO CREEK, N.T.

Station Number	Station Length	Peak Dry Season High Tide Salinity (1979) ‰	Peak Dry Season Soil Salinity (1979) ‰	Random Starting Points of Quadrats (in metres*)
1				Q ₁ = 220 Q ₂ = 420
17.5 - 18.5 km	1 km	35	52	Q ₃ = 530 Q ₄ = 740 Q ₅ = 980
2				Q ₁ = 65 Q ₂ = 165
22 - 22.5 km	0.5 km	37	60	Q ₃ = 225 Q ₄ = 320 Q ₅ = 480
3				Q ₁ = 50 Q ₂ = 160
23 - 23.5 km	0.5 km	40	45	Q ₃ = 340 Q ₄ = 415 Q ₅ = 485
4				Q ₁ = 140 Q ₂ = 275
24 - 24.5 km	0.5 km	41	48	Q ₃ = 495 Q ₄ = 50 Q ₅ = 85
5				Q ₁ = 20 Q ₂ = 110
25 - 25.5 km	0.5 km	44	50	Q ₃ = 195 Q ₄ = 225 Q ₅ = 400
6				Q ₁ = 50 Q ₂ = 95
26 - 26.5 km	0.5 km	52	73	Q ₃ = 275 Q ₄ = 420 Q ₅ = 460

TABLE A 2.3

Quadrat and Station information for Mungardobolo Creek

* The length of Station 1 was set at 1 km, and that of each of the other stations at 500 m.

LIVERPOOL RIVER, N.T.

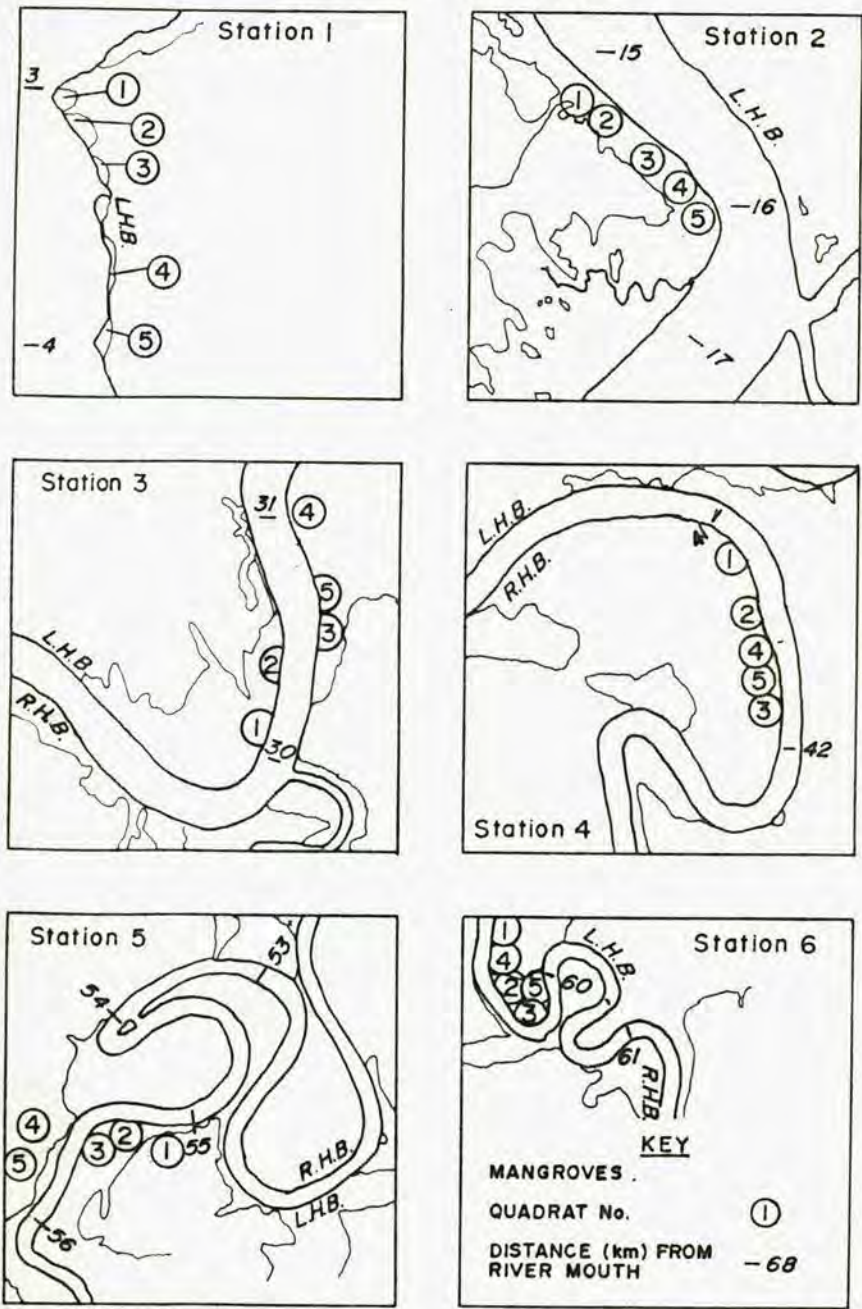


Figure A 2.2

Specific location of quadrats within stations on the Liverpool River, N.T.

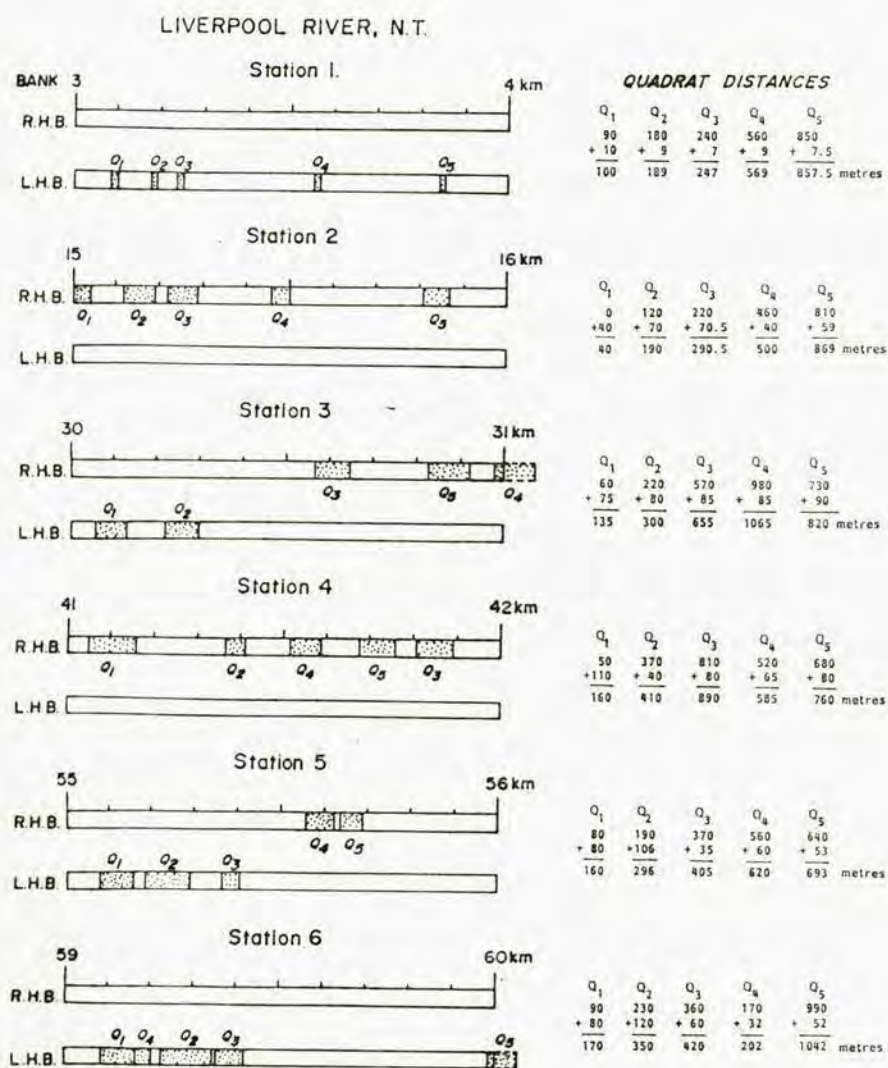


Figure A 2.3

Schematic presentation of quadrats within stations on the Liverpool River and the start and end points of each randomly chosen quadrat (in metres).

TOMKINSON RIVER, N.T.

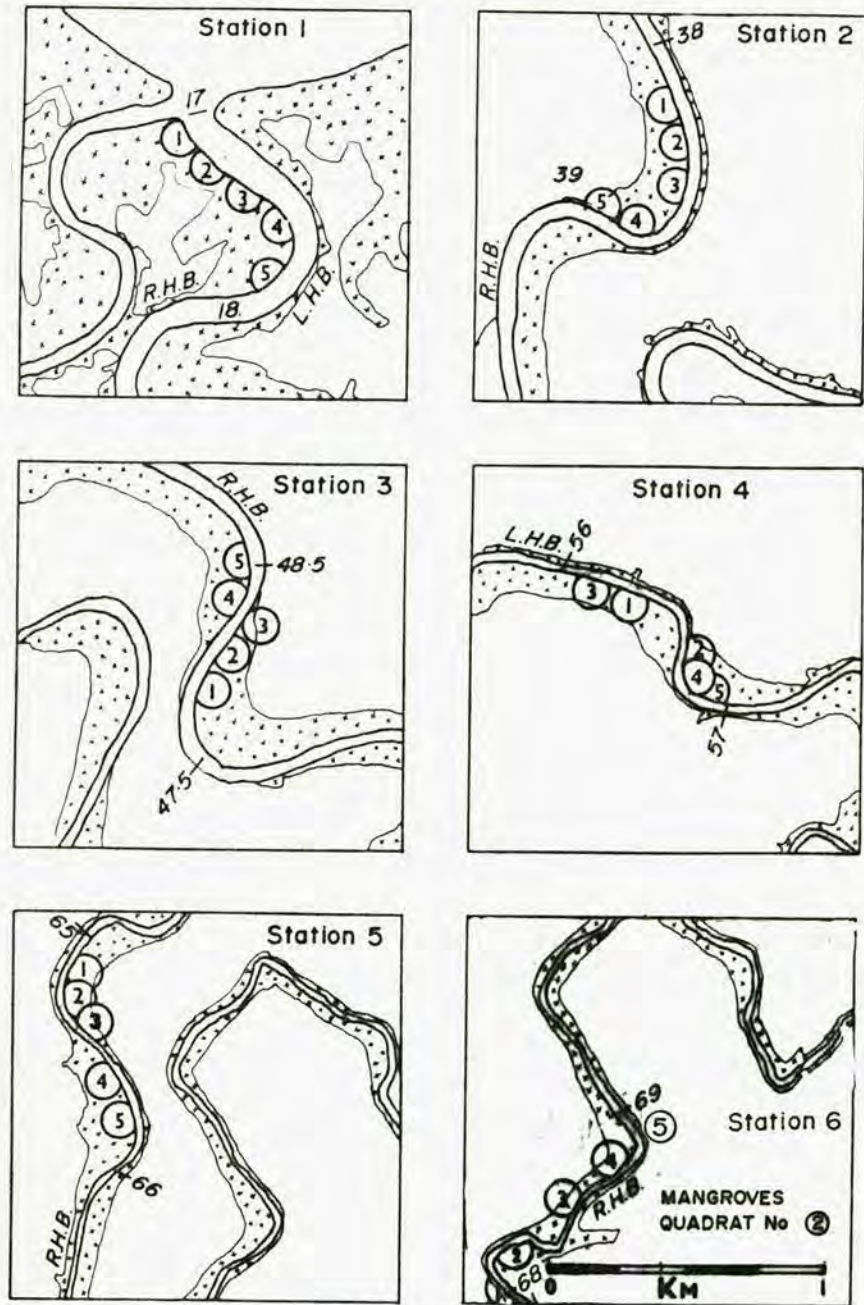


Figure A 2.4 Specific location of quadrats within stations on the Tomkinson River, N.T.

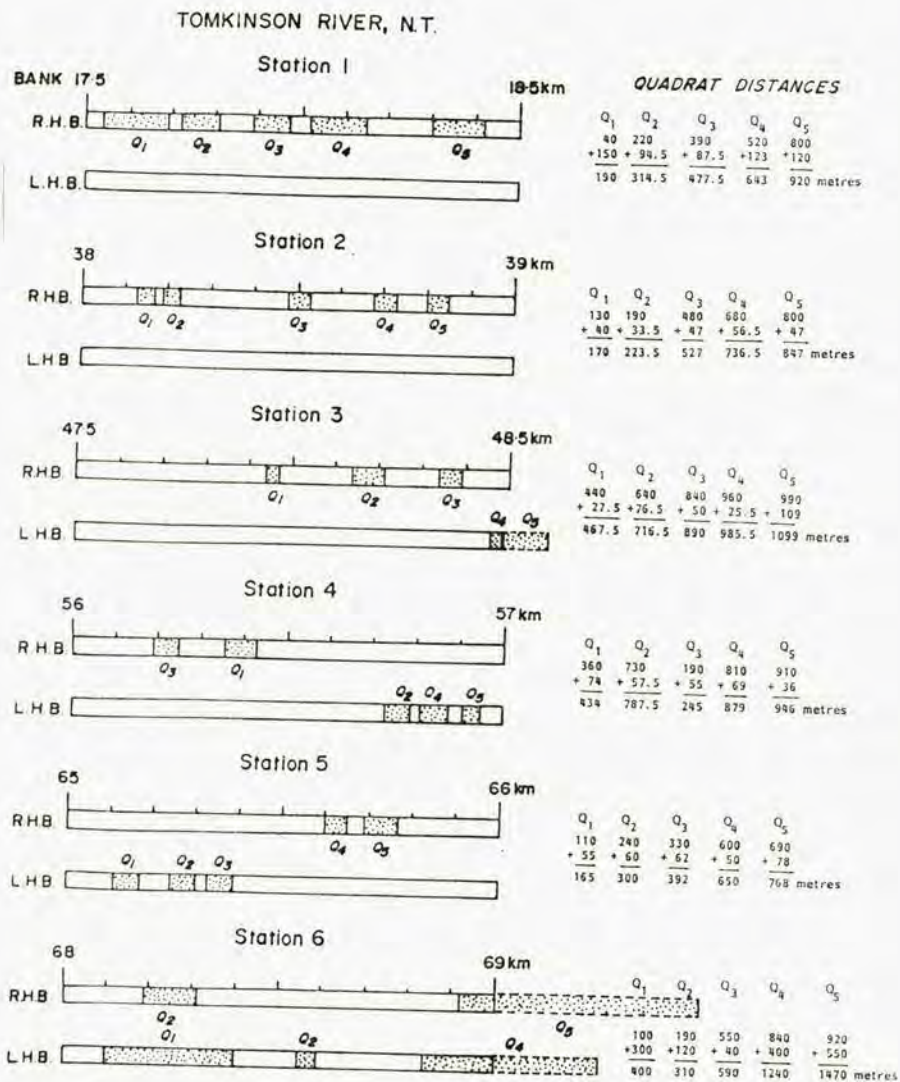


Figure A 2.5

Schematic presentation of quadrats within stations on the Tomkinson River and the start and end points of each randomly chosen quadrat (in metres).

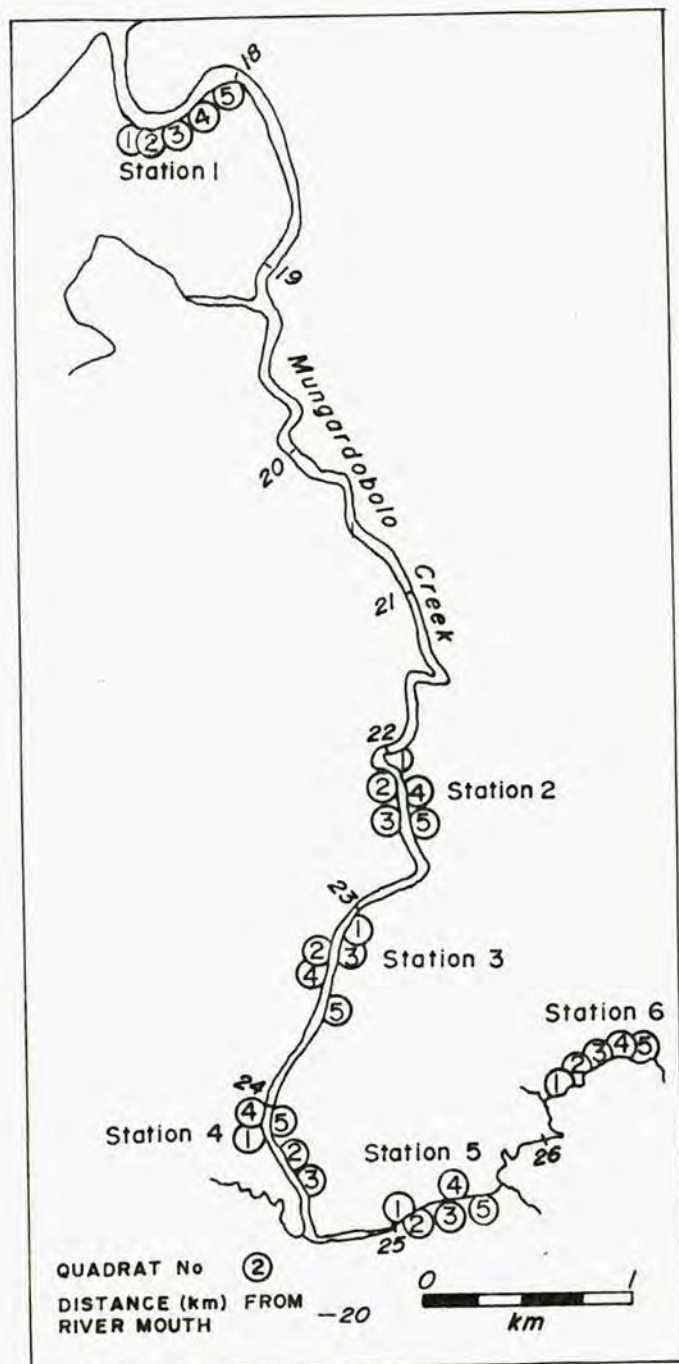
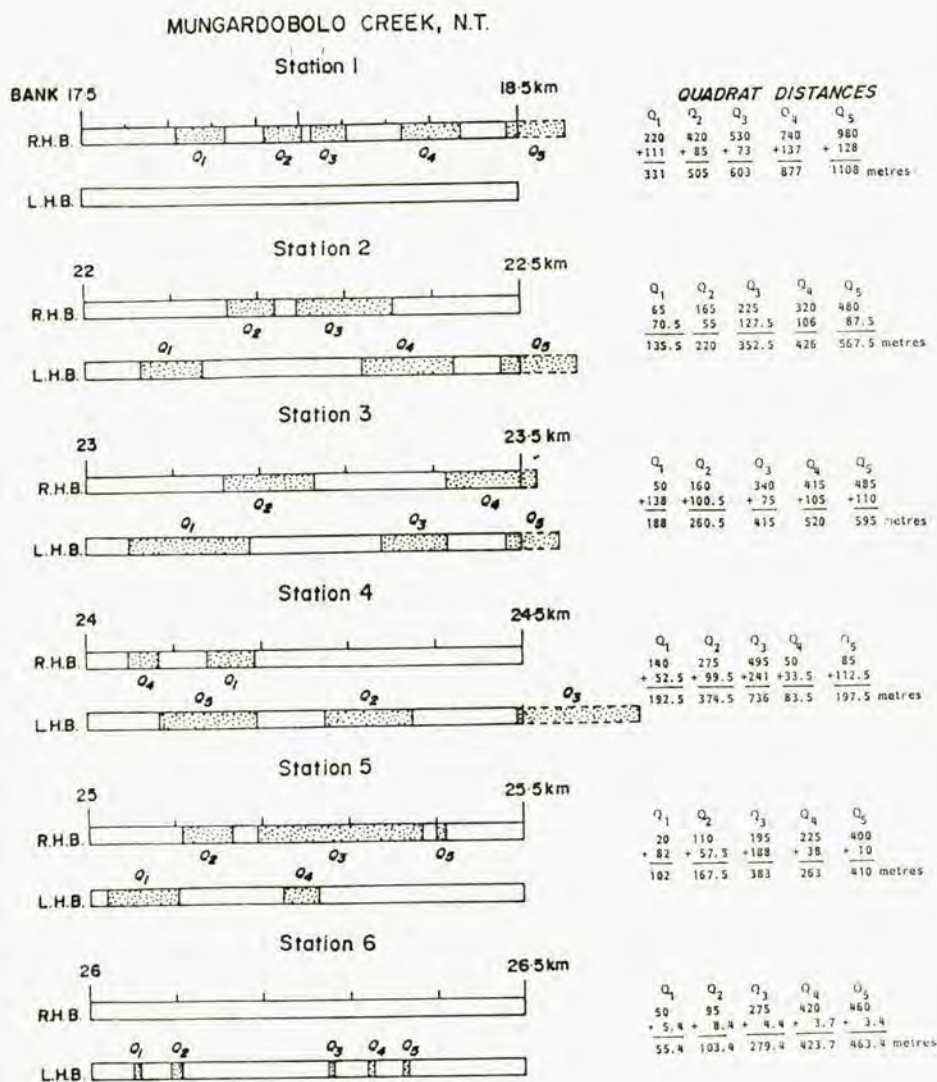


Figure A 2.6

Specific locations of quadrats within stations on Mungardobolo Creek, N.T.


Station 3
23.5 km
23

R.H.B.

L.H.B.

Q ₁	Q ₂	Q ₃	Q ₄	Q ₅
50	160	340	415	485
+128	+100.5	+75	+105	+110
178	260.5	415	520	595

metres

Station 4
24.5 km
24

R.H.B.

L.H.B.

Q ₁	Q ₂	Q ₃	Q ₄	Q ₅
140	275	495	50	85
+52.5	+99.5	+241	+33.5	+112.5
192.5	374.5	736	83.5	197.5

metres

Station 5
25.5 km
25

R.H.B.

L.H.B.

Q ₁	Q ₂	Q ₃	Q ₄	Q ₅
20	110	195	225	400
+82	+57.5	+188	+38	+10
102	167.5	383	263	410

metres

Station 6
26.5 km
26

R.H.B.

L.H.B.

Q ₁	Q ₂	Q ₃	Q ₄	Q ₅
50	95	275	420	460
+5.4	+8.4	+4.4	+3.7	+3.4
55.4	103.4	279.4	423.7	463.4

metres

Figure A 2.7

Schematic presentation of quadrats within stations on Mungardobolo Creek and the start and end points of each randomly chosen quadrat (in metres).

APPENDIX 3

Densities of *Avicennia marina*, *Camptostemon schultzei*
and *Rhizophora stylosa* at sites on the Liverpool-Tomkinson
Rivers System, N.T.

For trees/shrubs of a species at "all inclusive heights" the densities of the first 10 trees/shrubs at each of the five randomly chosen quadrats in a station were summed providing an overall density based on the first 50 trees/shrubs encountered at a station.

For trees "at canopy height" refers to the summed densities of the first 10 trees encountered within each of the five randomly chosen quadrats (50 trees within each station) that attained the canopy height of the forest.

Densities were converted to trees/hectare.

TABLE A 3.1

Densities of *Avicennia marina* at sites on the Liverpool-Tomkinson Rivers System.

Station	Density: at "All Inclusive Heights"	Density: at "Forest Canopy Height"
Liverpool 2	50 trees/shrubs in 3730 m ² 1 / 74.6 m ² 134.0/ hectare	50 trees in 5070 m ² 1 / 101.4 m ² 98.6/ hectare
Liverpool 3	50 trees/shrubs in 5300 m ² 1 / 106 m ² 94.3/ hectare	50 trees in 5840 m ² 1 / 116.8 m ² 85.6/ hectare
Liverpool 4	50 trees/shrubs in 5060 m ² 1 / 101.2 m ² 98.8/ hectare	50 trees in 6400 m ² 1 / 128 m ² 78.12/ hectare
Liverpool 5	50 trees/shrubs in 5760 m ² 1 / 115.2 m ² 86.8/ hectare	50 trees in 6680 m ² 1 / 133.6 m ² 74.8/ hectare
Liverpool 6	50 tree/shrubs in 5960 m ² 1 / 119.2 m ² 83.8/ hectare	50 trees in 6680 m ² 1 / 133.6 m ² 74.8/ hectare
Tomkinson 1	50 trees/shrubs in 10296 m ² 1 / 205.9 m ² 48.5/ hectare	50 trees in 11250 m ² 1 / 225 m ² 44.4/ hectare
Tomkinson 2	50 trees/shrubs in 3142 m ² 1 / 62.84 m ² 159.1/ hectare	50 trees in 4480 m ² 1 / 89.6 m ² 111.6/ hectare
Tomkinson 3	50 trees/shrubs in 3690 m ² 1 / 73.8 m ² 135.5/ hectare	50 trees in 5450 m ² 1 / 109 m ² 91.7/ hectare
Tomkinson 4	50 trees/shrubs in 2110 m ² 1 / 42.2 m ² 236.9/ hectare	50 trees in 3980 m ² 1 / 76.6 m ² 130.5/ hectare
Tomkinson 5	50 trees/shrubs in 4270 m ² 1 / 85.4 m ² 117.0/ hectare	50 trees in 5310 m ² 1 / 106.2 m ² 94.1/ hectare
Tomkinson 6	50 trees/shrubs in 19300 m ² 1 / 386 m ² 25.9/ hectare	50 trees in 28200 m ² 1 / 564 m ² 17.7/ hectare
Mungardobolo 1	50 trees/shrubs in 7860 m ² 1 / 157.2 m ² 63.6/ hectare	50 trees in 8546 m ² 1 / 170.9 m ² 58.5/ hectare
Mungardobolo 2	50 trees/shrubs in 3850 m ² 1 / 77 m ² 129.8/ hectare	50 trees in 7980 m ² 1 / 159.6 m ² 62.6/ hectare
Mungardobolo 3	50 trees/shrubs in 6360 m ² 1 / 127.2 m ² 78.6/ hectare	50 trees in 8970 m ² 1 / 179.4 m ² 55.7/ hectare
Mungardobolo 4	50 trees/shrubs in 2330 m ² 1 / 46.6 m ² 214.5/ hectare	50 trees in 2790 m ² 1 / 55.8 m ² 179.2/ hectare
Mungardobolo 5	50 trees/shrubs in 760 m ² 1 / 15.2 m ² 657.8/ hectare	50 trees in 1542 m ² 1 / 30.8 m ² 324.2/ hectare
Mungardobolo 6	50 trees/shrubs in 159.7 m ² 1 / 3.1 m ² 3,129.8/ hectare	50 trees in 414.7 m ² 1 / 8.2 m ² 1,205.6/ hectare

TABLE A 3.2

Densities of *Camptostemon schultzei* at sites on the Liverpool-Tomkinson Rivers System.

Station	Density: at "All Inclusive Heights"	Density: at "Forest Canopy Height"
Liverpool 2	50 trees/shrubs in 3010 m ² 1 / 60.2 m ² 166.1/ hectare	50 trees in 4010 m ² 1 / 80.2 m ² 124.6/ hectare
Liverpool 3	50 trees/shrubs in 3520 m ² 1 / 70.4 m ² 142 / hectare	50 trees in 6100 m ² 1 / 122 m ² 81.9/ hectare
Liverpool 4	50 trees/shrubs in 2040 m ² 1 / 40.8 m ² 245 / hectare	50 trees in 2650 m ² 1 / 53 m ² 188.6/ hectare
Liverpool 5	50 trees/shrubs in 1200 m ² 1 / 24 m ² 416.6/ hectare	50 trees in 1850 m ² 1 / 37 m ² 270.2/ hectare
Liverpool 6	50 trees/shrubs in 1240 m ² 1 / 24.8 m ² 403.2/ hectare	50 trees in 5360 m ² 1 / 107.2 m ² 93.2/ hectare
Tomkinson 1	50 trees/shrubs in 4020 m ² 1 / 80.4 m ² 124.3/ hectare	50 trees in 6160 m ² 1 / 123.2 m ² 81.1/ hectare
Tomkinson 2	50 trees/shrubs in 532 m ² 1 / 10.6 m ² 939.8/ hectare	50 trees in 1644 m ² 1 / 32.8 m ² 304.1/ hectare
Tomkinson 3	50 trees/shrubs in 1144 m ² 1 / 22.8 m ² 437.1/ hectare	50 trees in 2030 m ² 1 / 40.6 m ² 246.3/ hectare
Tomkinson 4	50 trees/shrubs in 1008 m ² 1 / 20.2 m ² 496.0/ hectare	50 trees in 4010 m ² 1 / 80.2 m ² 124.7/ hectare
Tomkinson 5	50 trees/shrubs in 4760 m ² 1 / 95.2 m ² 105.0/ hectare	50 trees in 5640 m ² 1 / 112.8 m ² 88.6/ hectare
Mungardobolo 1	50 trees/shrubs in 2636 m ² 1 / 52.7 m ² 189.7/ hectare	50 trees in 5330 m ² 1 / 106.6 m ² 93.8/ hectare
Mungardobolo 2	50 trees/shrubs in 4000 m ² 1 / 80 m ² 125 / hectare	50 trees in 7144 m ² 1 / 142.8 m ² 70.0/ hectare
Mungardobolo 3	50 trees/shrubs in 5290 m ² 1 / 105.8 m ² 94.5/ hectare	50 trees in 8580 m ² 1 / 171.6 m ² 58.3/ hectare
Mungardobolo 4	50 trees/shrubs in 5264 m ² 1 / 105.3 m ² 95.0/ hectare	50 trees in 7310 m ² 1 / 146.2 m ² 68.4/ hectare
Mungardobolo 5	30 trees/shrubs in 1784 m ² 1 / 59.4 m ² 168.2/ hectare	30 trees in 3066 m ² 1 / 102.2 m ² 97.8/ hectare

TABLE A 3.3

Densities of *Rhizophora stylosa* at sites on the Liverpool-Tomkinson Rivers System.

Station	Density: at "All Inclusive Heights"	Density: at "Forest Canopy Height"
Liverpool 1	50 trees/shrubs in 520 m ² 1 / 10.4 m ² 961.5/ hectare	50 trees in 850 m ² 1 / 17 m ² 588.2/ hectare
Liverpool 2	50 trees/shrubs in 2190 m ² 1 / 43.8 m ² 228.3/ hectare	50 trees in 2430 m ² 1 / 48.6 m ² 205.7/ hectare
Liverpool 3	50 trees/shrubs in 3680 m ² 1 / 73.6 m ² 135.8/ hectare	50 trees in 5520 m ² 1 / 110.4 m ² 90.5/ hectare
Liverpool 4	50 trees/shrubs in 3250 m ² 1 / 65 m ² 153.8/ hectare	50 trees in 3720 m ² 1 / 74.4 m ² 134.4/ hectare
Tomkinson 1	50 trees/shrubs in 2370 m ² 1 / 47.4 m ² 210.9/ hectare	50 trees in 2722 m ² 1 / 54.44 m ² 183.6/ hectare
Tomkinson 2	50 trees/shrubs in 778 m ² 1 / 15.5 m ² 642.6/ hectare	50 trees in 926 m ² 1 / 18.5 m ² 539.9/ hectare
Tomkinson 3	50 trees/shrubs in 780 m ² 1 / 15.6 m ² 641.0/ hectare	50 trees in 1600 m ² 1 / 32 m ² 312.5/ hectare
Tomkinson 4	50 trees/shrubs in 4320 m ² 1 / 86.4 m ² 115.7/ hectare	50 trees in 4850 m ² 1 / 97 m ² 103.0/ hectare
Mungardobolo 1	50 trees/shrubs in 796 m ² 1 / 15.9 m ² 628.1/ hectare	50 trees in 1170 m ² 1 / 23.4 m ² 427.3/ hectare
Mungardobolo 2	50 trees/shrubs in 2186 m ² 1 / 43.72 m ² 228.7/ hectare	50 trees in 2970 m ² 1 / 59.4 m ² 168.3/ hectare
Mungardobolo 3	50 trees/shrubs in 4260 m ² 1 / 85.2 m ² 117.3/ hectare	50 trees in 4810 m ² 1 / 96.2 m ² 103.9/ hectare
Mungardobolo 4	50 trees/shrubs in 4640 m ² 1 / 92.8 m ² 107.7/ hectare	50 trees in 8130 m ² 1 / 162.8 m ² 61.4/ hectare
Mungardobolo 5	30 trees/shrubs in 5136 m ² 1 / 171.2 m ² 58.4/ hectare	30 trees in 6224 m ² 1 / 207.4 m ² 48.2/ hectare

TABLE A 3.4

* Densities for *Avicennia marina* at sites on the Liverpool-Tomkinson Rivers System influenced by seawater salinities 35-37‰ towards the end of the dry season.

Station	Density: trees-shrubs/hectare at "All Inclusive Heights"	Density: trees-shrubs/hectare at "Forest Canopy Height"
Tomkinson 1 (30% of year under seawater salinities)	48	44
Tomkinson 2 (11% of year under seawater salinities)	159	111
Mungardobolo 1 (30% of year under seawater salinities)	63	58
Mungardobolo 2 (18% of year under seawater salinities)	129	62
Liverpool 2 (36% of year under seawater salinities)	134	98
Liverpool 3 (12% of year under seawater salinities)	94	85

* Number of individuals per hectare

TABLE A 3.5

* Densities for *Avicennia marina* at sites on the Liverpool-Tomkinson Rivers System influenced by fresh-brackish waters throughout the year.

Station	Density: trees-shrubs/hectare at "All Inclusive Heights"	Density: trees-shrubs/hectare at "Forest Canopy Height"
Tomkinson 5 (53% of year under freshwater, 10% of year under 25-30‰)	117	94
Tomkinson 6 (60% of year under freshwater, 6% of year under 20-25‰)	25	17
Liverpool 5 (60% of year fresh water inundation, 6% of year 10-15‰)	86	74
Liverpool 6 (74% of year fresh water inundation, 9% of year 5-10 ‰)	83	74

* Number of individuals per hectare.

TABLE A 3.6

* Densities of *Camptostemon schultzei* at sites on the Liverpool-Tomkinson Rivers System influenced by seawater salinities (35-38‰) towards the end of the dry season.

<u>Station</u>	Density: trees-shrubs/hectare at <u>"All Inclusive Heights"</u>	Density: trees/hectare at <u>"Forest Canopy Height"</u>
Tomkinson 1	124	81
Tomkinson 2	939	304
Mongardobolo 1	189	93
Mungardobolo 2	125	69
Liverpool 2	166	124
Liverpool 3	142	81

* Number of individuals per hectare

TABLE A 3.7

* Densities of *Camptostemon schultzei* at sites on the Liverpool-Tomkinson Rivers System influenced by fresh and brackish waters throughout the year.

<u>Station</u>	Density: trees-shrubs/hectare at <u>"All Inclusive Heights"</u>	Density: trees/hectare at <u>"Forest Canopy Height"</u>
Liverpool 5	416	270
Liverpool 6	403	93
Tomkinson 5	105	88

* Number of individuals per hectare

TABLE A 3.8

*Densities of *Rhizophora stylosa* at sites on the Liverpool-Tomkinson Rivers System influenced by seawater salinities (35‰ for 75% of the year).

<u>Station</u>	Density: trees-shrubs/hectare at <u>"All Inclusive Heights"</u>	Density: trees/hectare at <u>"Forest Canopy Height"</u>
Liverpool 1	961	588

*Densities of *Rhizophora stylosa* at sites influenced by seawater salinities for between 30-40% of the year.

Liverpool 2	228	205
Tomkinson 1	210	183
Mungardobolo 1	628	427

*Densities of *Rhizophora stylosa* at sites influenced by freshwater inundation for 40-50% of the year and brackish waters for the remainder of the year.

Liverpool 4	154	134
Tomkinson 3	641	312
Tomkinson 4	116	103

* Number of individuals per hectare.

APPENDIX 4

Bole basal areas ($\text{m}^2/\text{hectare}$) of *Avicennia marina*,
Camptostemon schultzei and *Rhizophora stylosa* at quadrats within
stations on the Liverpool-Tomkinson Rivers System, N.T.

TABLE A 4.1

Bole basal areas ($\text{m}^2/\text{hectare}$) of *Avicennia marina* at quadrats within stations on the Liverpool and Tomkinson Rivers and Mungardobolo Creek, N.T.

Station	Quadrat	Liverpool R.	Tomkinson R.	Mungardobolo Ck.
1	1		2.18	1.99
	2		7.44	2.42
	3		2.85	8.84
	4		1.26	2.29
	5		1.36	3.90
2	1	12.49	2.44	2.20
	2	6.64	2.33	3.01
	3	6.22	2.08	5.21
	4	7.53	2.25	1.62
	5	5.15	3.14	4.48
3	1	5.70	24.01	1.61
	2	4.74	2.07	5.02
	3	12.78	2.16	11.16
	4	6.33	7.65	3.23
	5	2.37	2.44	9.14
4	1	4.77	3.63	9.60
	2	7.50	11.53	11.44
	3	4.27	8.04	14.46
	4	6.17	8.57	15.70
	5	6.24	14.22	8.53
5	1	17.49	25.53	10.47
	2	8.32	10.24	20.13
	3	29.00	16.41	51.10
	4	12.85	26.29	12.25
	5	13.35	9.26	31.14
6	1	24.70	4.09	6.46
	2	5.49	12.08	19.12
	3	22.67	30.79	33.89
	4	45.90	2.49	17.44
	5	36.17	2.07	14.74

TABLE A 4.2

Bole basal areas ($\text{m}^2/\text{hectare}$) of *Camptostemon schultzei* at quadrats within stations on the Liverpool and Tomkinson Rivers and Mungardobolo Creek, N.T.

Station	Quadrat	Liverpool R.	Tomkinson R.	Mungardobolo Ck.
1	1		1.65	8.77
	2		0.99	0.84
	3		2.92	1.10
	4		0.57	1.49
	5		7.21	2.40
2	1	4.66	7.39	0.76
	2	4.26	5.02	4.25
	3	3.69	3.50	0.86
	4	7.95	4.09	1.38
	5	7.29	4.40	0.92
3	1	6.13	24.34	1.67
	2	2.80	18.70	0.87
	3	2.47	6.37	1.50
	4	2.06	6.62	1.01
	5	5.02	8.68	1.08
4	1	22.62	7.81	2.40
	2	19.35	5.72	2.70
	3	12.92	14.73	1.31
	4	10.61	7.42	2.58
	5	189.29	5.91	1.06
5	1	10.67	9.42	4.37
	2	47.27	6.00	1.21
	3	58.02	5.18	1.47
	4	91.84	7.10	
	5	41.51	10.70	
6	1	12.40		
	2	4.77		
	3	18.14		
	4	19.59		
	5	22.88		

TABLE A 4.3

Bole basal areas ($\text{m}^2/\text{hectare}$) of *Rhizophora stylosa* at quadrats within stations on the Liverpool and Tomkinson Rivers and Mungardobolo Creek, N.T.

Station	Quadrat	Liverpool R.	Tomkinson R.	Mungardobolo Ck.
1	1	30.55	11.39	7.61
	2	23.54	1.12	11.11
	3	34.29	18.46	4.00
	4	27.71	7.66	11.08
	5	36.48	10.37	10.80
2	1	3.80	5.57	5.79
	2	15.11	14.16	6.44
	3	17.45	15.06	1.52
	4	9.37	10.78	2.06
	5	6.72	4.96	3.54
3	1	6.27	8.58	5.69
	2	3.61	20.21	2.55
	3	3.19	5.61	4.97
	4	1.59	10.69	3.80
	5	8.46	21.83	1.44
4	1	5.22	5.35	1.51
	2	65.46	9.85	1.02
	3	36.04	7.70	0.22
	4	10.47	8.89	6.90
	5	21.02	12.99	5.44
5	1			1.21
	2			1.79
	3			0.29
	4			
	5			
6	1			
	2			
	3			
	4			
	5			

APPENDIX 5

Analysis of variance of linear and parabolic regression of girths ($\log_e$ data) of *Avicennia marina*, *Camptostemon schultzei* and *Rhizophora stylosa* on peak dry season soil and water salinities on waterways on the Liverpool-Tomkinson Rivers System, Northern Territory.

For *Avicennia marina* on the Liverpool River the best fit ($\log_e$) linear and second degree polynomial regressions were

$$y = 4.268 - 0.022x$$

and $y = 3.986 + 0.006x - 0.0005x^2$

where $y = \log_e$ tree girth and x is the peak dry season interstitial soil salinity. The second degree polynomial however did not provide a significantly better fit than the linear regression ($p = 0.05$), indicating that throughout the range of soil salinities under which *Avicennia marina* grows on the Liverpool River the relationship between $\log_e$ girth of trees that have attained the canopy height and peak dry season interstitial soil salinities was linear.

Source	s.s.	d.f.	m.s.	F.
Regression on x (soil salinity)	1.97	1	1.97	72.00**
Regression on x and x^2 (soil salinity and (soil salinity) ²)	2.05	2	1.02	40.50**
Deviations from linear regression	0.63	23	0.03	
Deviations from parabolic regression	0.56	22	0.03	
Curvilinearity	0.07	1	0.07	2.93 N.S.

** Significant at 0.05 level

N.S. Not significant at 0.05 level

TABLE A 5.1

Analysis of variance of linear and parabolic regression (Snedecor and Cochran, 1967) of girth of *Avicennia marina* on peak dry season interstitial soil salinities on the Liverpool River, Northern Territory.

For *Avicennia marina* on the Tomkinson River, the best fit ($\log_e$) linear and second degree polynomial regressions were

$$y = 4.217 - 0.038x$$

and $y = 6.340 - 0.231x + 0.0039x^2$

where $y = \log_e$ tree girth and x is the peak dry season high tide water salinity.

The second degree polynomial was a significantly better fit than the linear regression, indicating that throughout the range of water salinities under which *Avicennia marina* grows on the Tomkinson River that the relationship between $\log_e$ girth of trees that have attained the canopy height and water salinity was curvilinear.

Source	s.s.	d.f.	m.s.	F.
Regression of x (water salinity)	3.16	1	3.16	42.07**
Regression on x and x^2 (water salinity + (water salinity) ²)	4.06	2	2.03	45.71**
Deviations from linear regression	2.10	28	0.07	
Deviations from parabolic regression	1.20	27	0.04	
Curvilinearity	0.90	1	0.90	20.32**

** Significant at 0.05 level.

TABLE A 5.2

Analysis of variance of linear and parabolic regression (Snedecor and Cochran, 1967) of girth of *Avicennia marina* on peak dry season high tide water salinities on the Tomkinson River, Northern Territory.

For *Avicennia marina* on Mungardobolo Creek the best fit ($\log_e$) linear and second degree polynomial regressions were

$$y = 4.465 - 0.008x$$

and $y = 3.492 + 0.008x - 0.0003x^2$

where $y = \log_e$ tree girth and x is the peak dry season interstitial soil salinity.

The second degree polynomial did not provide a better fit than the linear regression indicating that throughout the range of soil salinities under which *Avicennia marina* grows on Mungardobolo Creek that the relationship between $\log_e$ girth of trees that have attained the forest canopy height and peak dry season interstitial soil salinity was linear.

Source	s.s.	d.f.	m.s.	F.
Regression on x (soil)	1.77	1	1.77	21.13**
Regression on x and x^2	1.78	2	0.89	10.32**
Deviations from linear regression	2.34	28	0.08	
Deviations from parabolic regression	2.33	27	0.09	
Curvilinearity	0.01	1	0.01	0.15 N.S.

** Significant at 0.05 level

N.S. Not significant at 0.05 level.

TABLE A 5.3

Analysis of variance of linear and parabolic regression (Snedecor and Cochran, 1967) of girth of *Avicennia marina* on peak dry season interstitial soil salinities on Mungardobolo Creek, Northern Territory.

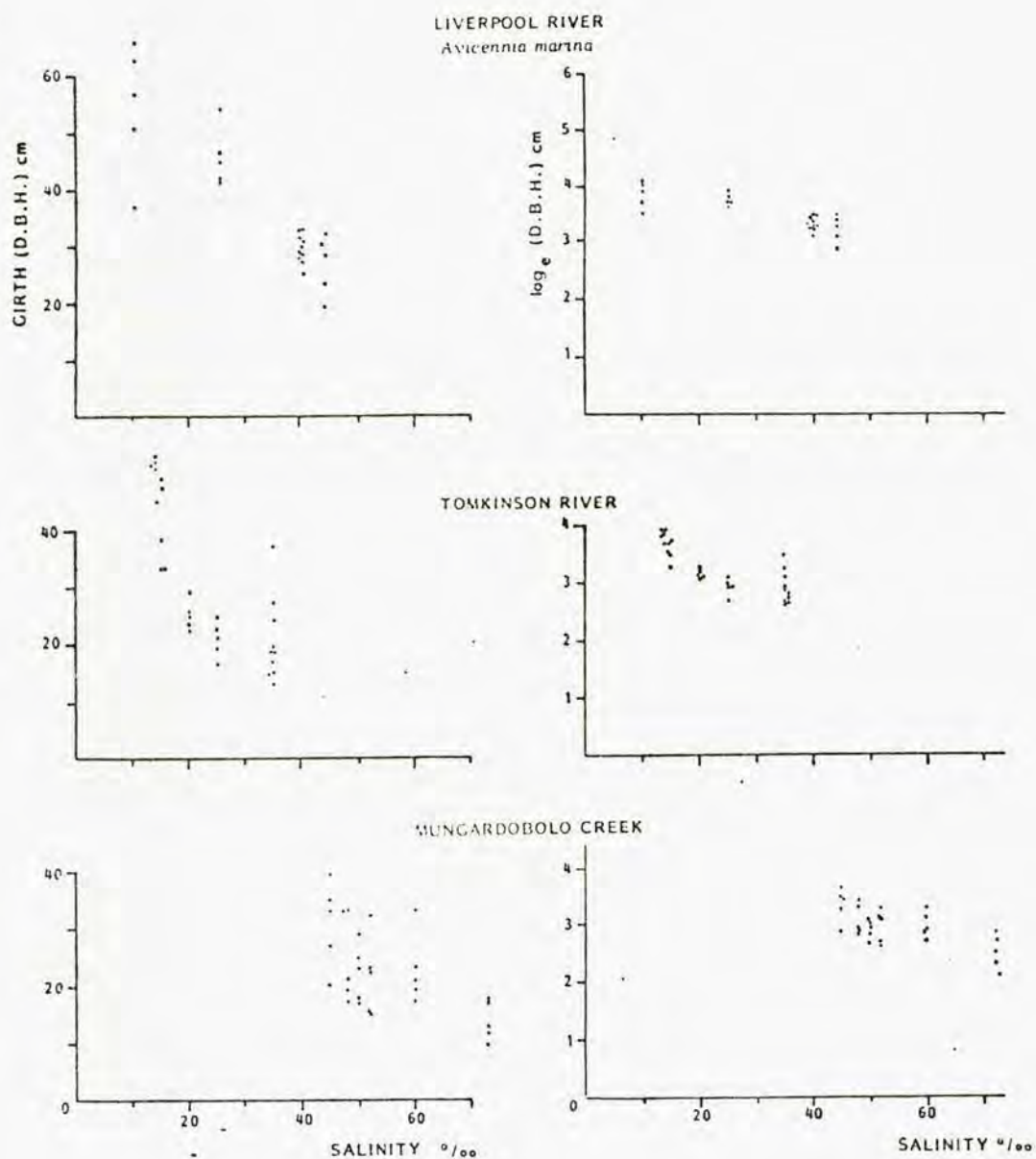


FIG. A 5.1

Relationships between original girth data and regressed $\log_e$ girth data for canopy trees of *Avicennia marina* against peak dry season interstitial soil salinity (‰) on the Liverpool River and Mungardobolo Creek and peak dry season high tide water salinity on the Tomkinson River, Northern Territory.

For *Camptostemon schultzei* on the Liverpool River, the best fit ($\log_e$) linear and second degree polynomial regressions were

$$y = 3.945 - 0.022x$$

$$\text{and } y = 3.194 + 0.063x - 0.0019x^2$$

where $y = \log_e$ tree girth and x is the peak dry season high tide water salinity.

The second degree polynomial was a significantly better fit than the linear regression indicating that throughout the range of water salinities under which *Camptostemon schultzei* grows on the Liverpool River that the relationship between $\log_e$ girth of trees that have attained the forest canopy height, and water salinity was curvilinear.

Source	s.s.	d.f.	m.s.	F.
Regression on x (water salinity)	1.32	1	1.32	40.59**
Regression on x and x^2 (water salinity and (water salinity) ²)	1.68	2	0.84	47.68**
Deviations from linear regression	0.75	23	0.03	
Deviations from parabolic regression	0.39	22	0.02	
Curvilinearity	0.36	1	0.36	20.39**

** Significant at 0.05 level.

TABLE A 5.4

Analysis of variance of linear and parabolic regression of girth of *Camptostemon schultzei* on peak dry season high tide water salinities on the Liverpool River, Northern Territory (Snedecor and Cochran, 1967).

For *Camptostemon schultzei* on the Tomkinson River the best fit ($\log_e$) linear and second degree polynomial regressions were

$$y = 4.087 - 0.042x$$

$$\text{and } y = 3.591 + 0.0009x - 0.0008x^2$$

where $y = \log_e$ tree girth and x is the peak dry season high tide water salinity.

The second degree polynomial was not a significantly better fit than the linear regression, indicating that throughout the range of water salinities under which *Camptostemon schultzei* grows on the Tomkinson River the relationship between $\log_e$ girth of trees that have attained the canopy height and peak dry season high tide water salinity was linear.

Source	s.s.	d.f.	m.s.	F.
Regression on x (water salinity)	2.75	1	2.75	117.23**
Regression on x and x^2 (water salinity + (water salinity) ²)	2.78	2	1.39	59.83**
Deviations from linear regression	0.54	23	0.02	
Deviations from parabolic regression	0.52	22	0.02	
Curvilinearity	0.03	1	0.03	1.24 N.S.

** Significant at 0.05 level

N.S. Not significant at 0.05 level.

TABLE A 5.5

Analysis of variance of linear and parabolic regression of girth of *Camptostemon schultzei* on peak dry season high tide water salinities on the Tomkinson River, Northern Territory (Snedecor and Cochran, 1967).

For *Camptostemon schultzei* on Mungardobolo Creek the best fit ($\log_e$) linear and second degree polynomial regression were

$$y = 1.571 + 0.03x$$

$$\text{and } y = 16.623 - 0.765x + 0.0104x^2$$

where $y = \log_e$ tree girth and x is the peak dry season high tide water salinity.

The second degree polynomial was not a significantly better fit than the linear regression indicating that throughout the range of water salinities under which *Camptostemon schultzei* grows on Mungardobolo Creek, the relationship between $\log_e$ girth of trees that have attained the forest canopy height and water salinity was linear.

Source	s.s.	d.f.	m.s.	F.
Regression on x (water salinity)	0.10	1	0.10	8.29**
Regression on x and x^2 (water salinity and (water salinity) ²)	0.12	2	0.06	5.58**
Deviations from linear regression	0.22	18	0.01	
Deviations from parabolic regression	0.19	17	0.01	
Curvilinearity	0.03	1	0.03	2.28 N.S.

** Significant at 0.05 level

N.S. Not significant at 0.05 level.

TABLE A 5.6

Analysis of variance of linear and parabolic regression of girth of *Camptostemon schultzei* on peak dry season high tide water salinities on Mungardobolo Creek, Northern Territory (Snedecor and Cochran, 1967).

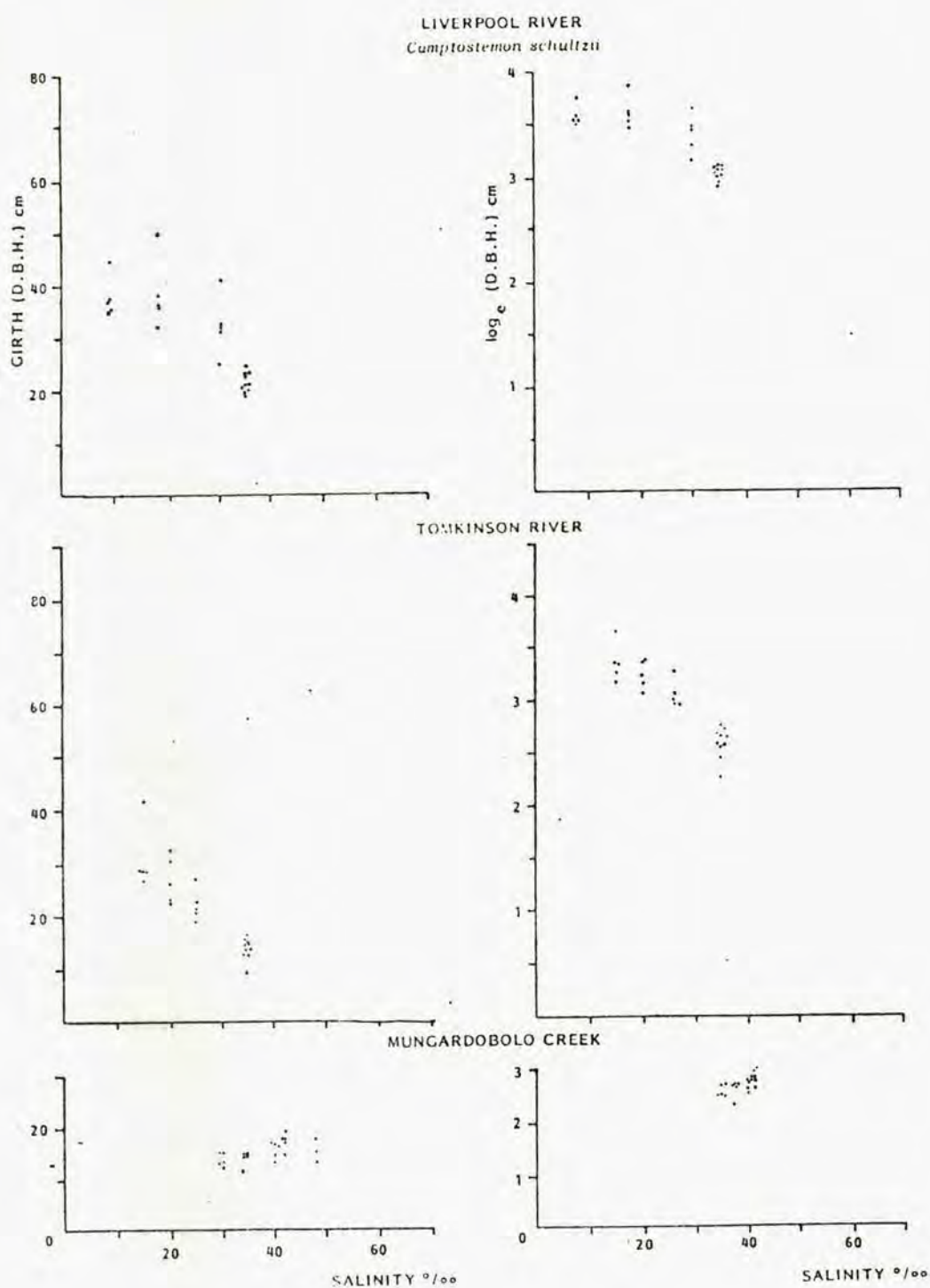


FIG. A 5.2

Relationships between original girth data and regressed $\log_e$ girth data for canopy trees of *Campostemon schultzei* against peak dry season high tide water salinities on the Liverpool and Tomkinson Rivers and Mungardobolo Creek, Northern Territory.

For *Rhizophora stylosa* on the Tomkinson River, the best fit ($\log_e$) linear and second degree polynomial regressions were

$$y = 4.219 - 0.0452x$$

$$\text{and } y = 6.580 - 0.2231x + 0.0032x^2$$

where $y = \log_e$ tree girth and x is the peak dry season high tide water salinity.

The second degree polynomial was not a significantly better fit than the linear regression indicating that throughout the range of water salinities under which *Rhizophora stylosa* grows on the Tomkinson River the relationship between $\log_e$ girth of trees that have attained the forest canopy height and peak dry season high tide water salinity was linear.

Source	s.s.	d.f.	m.s.	F.
Regression on x (water salinity)	1.73	1	1.73	41.44**
Regression on x and x^2 (water salinity + (water salinity) ²)	1.81	2	0.90	23.10**
Deviations from linear regression	0.75	18	0.04	
Deviations from parabolic regression	0.67	17	0.04	
Curvilinearity	0.08	1	0.08	2.13 N.S.

** Significant at 0.05 level

N.S. Not significant at 0.05 level.

TABLE A 5.7

Analysis of variance of linear and parabolic regression (Snedecor and Cochran, 1967) of girth of *Rhizophora stylosa* on peak dry season high tide water salinities on the Tomkinson River, Northern Territory.

For *Rhizophora stylosa* on Mungardobolo Creek the best fit ($\log_e$) linear and second degree polynomial regressions were

$$y = 3.033 - 0.0065x$$

and $y = 10.291 - 0.285x + 0.0026x^2$

where $y = \log_e$ tree girth and x is the peak dry season interstitial soil salinity.

The second degree polynomial was not a significantly better fit than the linear regression, indicating that throughout the range of soil salinities under which *Rhizophora stylosa* establishes on Mungardobolo Creek the relationship between $\log_e$ girth of trees that have attained forest canopy height and peak dry season interstitial soil salinities was linear.

Source	s.s.	d.f.	m.s.	F.
Regression on x (soil salinity)	0.03	1	0.03	0.91 N.S.
Regression on x and x^2 (soil salinity and (soil salinity) ²)	0.11	2	0.05	1.98 N.S.
Deviations from linear regression	0.53	18	0.03	
Deviations from parabolic regression	0.45	17	0.03	
Curvilinearity	0.08	1	0.08	2.95 N.S.

N.S. Not significant at 0.05 level.

TABLE A 5.8

Analysis of variance of linear and parabolic regression (Snedecor and Cochran, 1967) of girth of *Rhizophora stylosa* on peak dry season soil salinities on Mungardobolo Creek, Northern Territory.

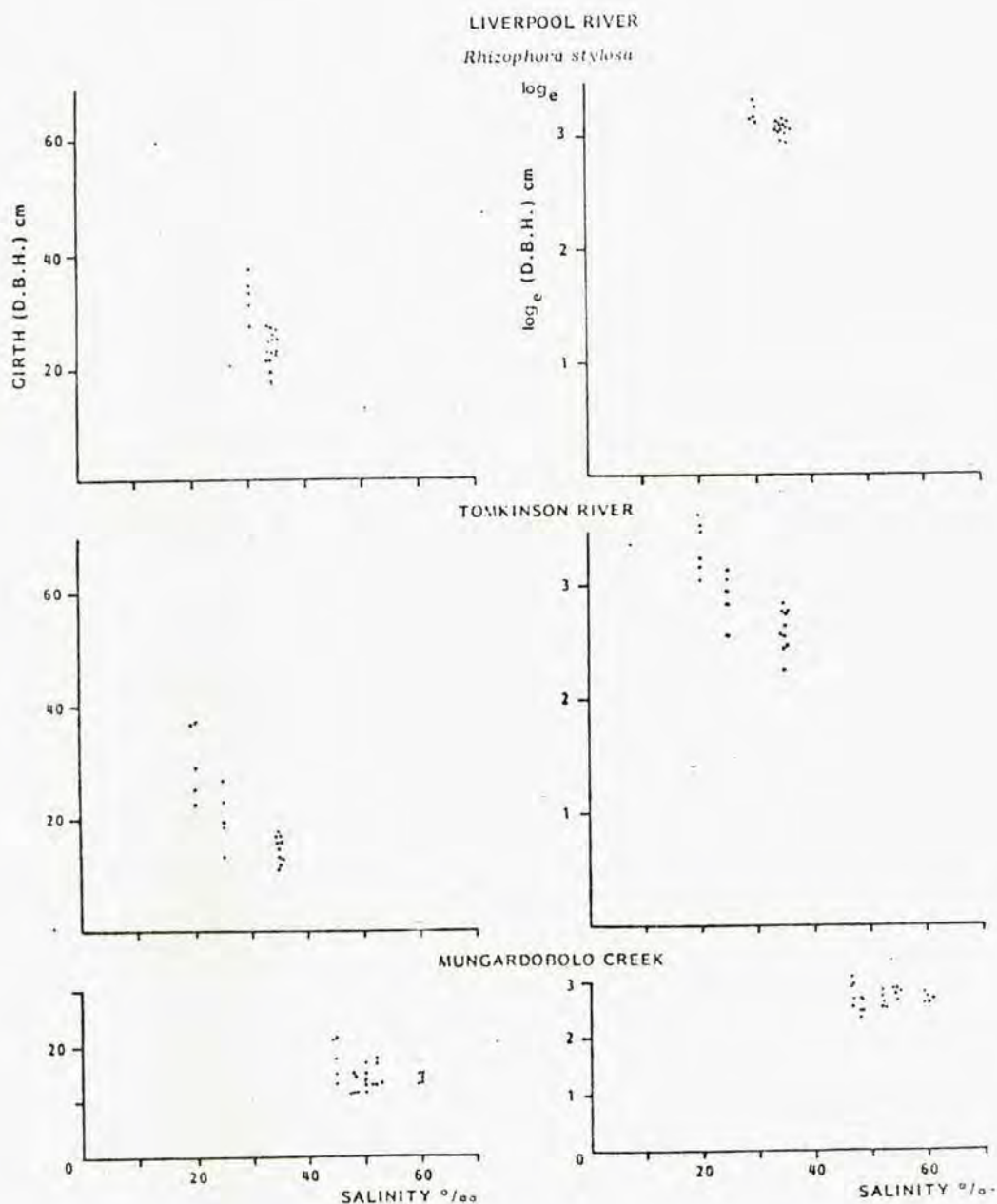


FIG. A 5.3

Relationships between original girth data and regressed $\log_e$ girth data for canopy trees of *Rhizophora stylosa* against peak dry season high tide water salinities on the Liverpool and Tomkinson Rivers and peak dry season interstitial soil salinities on Mungardobolo Creek, Northern Territory.

Station	Peak Dry Season Salinity ‰			Mean Girths / Quadrat (cm)				
	Soil	Water						
Liverpool	2	40	35	27.13	30.35	33.60	28.50	26.78
	3	44	35	32.51	28.99	30.89	19.55	22.70
	4	40	30	24.36	27.35	28.63	31.08	33.24
	5	25	18	54.99	45.23	47.77	41.76	41.83
	6	10	9	66.28	37.54	56.74	50.78	63.59
Tomkinson	1	48	35	27.16	24.01	37.68	18.97	19.49
	2	50	35	15.53	13.90	14.93	17.06	18.52
	3	28	25	24.68	19.68	16.25	21.15	22.90
	4	27	20	25.47	23.23	29.78	22.29	25.13
	5	24	15	49.27	33.60	47.07	33.94	38.38
	6	15	14	51.04	53.48	52.36	46.60	51.71
Mungardobolo	1	52	35	22.99	14.96	15.03	25.56	32.07
	2	60	37	16.85	19.70	33.19	20.18	23.85
	3	45	40	20.01	33.85	39.23	26.73	34.93
	4	48	41	33.01	19.10	33.95	21.49	16.90
	5	50	44	16.60	17.18	23.40	28.52	24.88
	6	73	52	16.24	17.57	12.09	10.90	8.18

TABLE A.5.9

Mean girths of canopy trees of *Avicennia marina* for quadrats within stations on the Liverpool and Tomkinson Rivers and Mungardobolo Creek, Northern Territory. Salinities are 1979 readings.

Station		Peak Dry Season Salinity ‰		Mean Girths / Quadrat (cm)				
		Soil	Water					
Liverpool	2	40	35	18.53	23.21	24.19	22.13	19.13
	3	44	35	21.03	23.39	20.85	20.82	20.83
	4	40	30	30.66	25.83	40.98	32.21	33.73
	5	25	18	32.87	38.60	36.54	50.54	36.55
	6	10	9	36.22	37.31	44.58	35.55	35.80
Tomkinson	1	48	35	15.87	14.81	14.96	12.17	13.26
	2	50	35	13.75	14.43	9.84	13.38	16.02
	3	28	25	27.95	22.37	19.66	21.08	20.24
	4	27	20	23.93	26.81	32.09	30.41	22.25
	5	24	15	28.98	26.12	28.35	28.68	42.62
Mungardobolo	1	52	35	13.70	12.84	13.79	14.67	15.10
	2	60	37	11.00	15.04	15.40	14.11	14.05
	3	45	40	12.74	14.31	16.25	16.23	16.78
	4	48	41	17.28	16.61	19.28	14.29	17.32

TABLE A 5.10

Mean girths of canopy trees of *Camptostemon schultzei* for quadrats within stations on the Liverpool and Tomkinson Rivers and Mungardobolo Creek, Northern Territory. Salinities are 1979 readings.

<u>Station</u>	Peak Dry Season Salinity ‰		<u>Mean Girths / Quadrat (cm)</u>					
	Soil	Water						
Liverpool	1	40	35	27.45	22.98	24.49	24.97	25.95
	2	40	35	19.02	26.98	22.75	21.30	22.06
	3	44	35	26.14	24.22	21.95	17.49	22.30
	4	40	30	34.07	33.63	30.04	27.32	37.94
	5							
Tomkinson	1	48	35	16.15	16.28	14.53	17.93	15.47
	2	50	35	13.10	11.67	10.93	15.05	12.65
	3	28	25	23.35	19.87	13.55	18.30	26.14
	4	27	20	22.53	36.65	28.58	36.64	25.99
Mungardobolo	1	52	35	13.10	13.94	13.35	17.50	16.88
	2	60	37	13.81	15.17	13.88	14.51	15.34
	3	45	40	15.65	13.70	21.15	21.50	17.99
	4	48	41	11.77	15.01	11.55	11.98	14.21
	5							

TABLE A 5.11

Mean girths of canopy trees of *Rhizophora stylosa* for quadrats within stations on the Liverpool and Tomkinson Rivers and Mungardobolo Creek, Northern Territory. Salinities are 1979 readings.

APPENDIX 6

Daily plateau measurements of stem xylem pressure potentials of *Avicennia marina*, *Camptostemon schultzei* and *Rhizophora stylosa* during the late wet and late dry seasons (1977) on the Liverpool-Tomkinson Rivers System, N.T.

TABLE A611

Daily plateau measurements of stem xylem pressure potentials of *Avicennia marina* at sites on the Liverpool-Tomkinson Rivers System, N.T.

Locality	Tree No.	Late Wet Season (May 77)		Late Dry Season (Oct 77)	
		High Tide Water Salinity Measurmts. 1145-1430 hrs		High Tide Water Salinity Measurmts. 1300-1600 hrs	
Tomkinson River 17 km	1	-2.6 MPa	0 ‰	-4.5 MPa	34 ‰
	2	-2.4		-5.2	
	3	-3.3		-4.0	
	4	-3.4		-4.5	
	5	-3.7		-4.7	
Tomkinson River 56 km	1	-2.5	0 ‰	-3.6	16 ‰
	2	-3.6		-3.6	
	3	-2.8		-3.5	
	4	-3.0		-3.5	
	5	-3.2		-4.1	
Tomkinson River 68.5 km	1	-3.4	0 ‰	-3.4	8 ‰
	2	-3.1		-3.7	
	3	-2.4		-3.2	
	4	-3.3		-3.5	
	5	-3.3		-3.9	
Liverpool River 60 km	1			-3.6	2 ‰
	2			-3.4	
	3			-3.4	
	4			-2.6	
	5			-3.0	
Mungardobolo Ck 25 km	1	-2.3	0 ‰	-4.9	34 ‰
	2	-2.8		-5.0	
	3	-2.5		-5.0	
	4	-2.9		-5.8	
	5	-3.2		-5.0	
Mungardobolo Ck 26 km	1	-2.6	0 ‰	-5.7	40 ‰
	2	-2.7		-5.6	
	3	-3.0		-6.2	
	4	-2.6		-6.0	
	5	-2.6		-5.2	

TABLE A 6.2

Daily plateau measurements of stem xylem pressure potentials of *Camptostemon schultzei* at sites on the Liverpool-Tomkinson Rivers System, N.T.

Locality	Tree No.	Late Wet Season (May 77)		Late Dry Season (Oct 77)	
		High Tide Water Salinity Measurmts. 1145-1430 hrs		High Tide Water Salinity Measurmts. 1300-1600 hrs	
Tomkinson River 17 km	1	-2.7 MPa	0 ‰	-4.6 MPa	34 ‰
	2	-2.4		-4.3	
	3	-2.7		-3.9	
	4	-2.5		-4.2	
	5	-2.5		-4.0	
Tomkinson River 56 km	1	-2.2	0 ‰	-2.2	16 ‰
	2	-2.8		-2.6	
	3	-2.7		-2.9	
	4	-2.5		-2.5	
	5	-2.6		-2.9	
Tomkinson River 68.5 km	1	-2.8	0 ‰	-3.2	8 ‰
	2	-2.8			
	3	-2.8			
	4	-2.7			
	5	-2.8			
Liverpool River 60 km	1			-3.3	2 ‰
	2			-2.5	
	3			-2.3	
	4			-2.3	
	5			-2.1	
Mungardobolo Ck 25 km	1	-2.2	0 ‰	-4.4	34 ‰
	2	-2.3		-4.1	
	3	-2.3		-4.9	
	4	-2.1		-4.2	
	5	-2.1		-4.1	
Mungardobolo Ck 26 km	1	-2.0	0 ‰	-4.7	40 ‰
	2	-2.0		-4.8	

TABLE A 6.3

Daily plateau measurements of stem xylem pressure potentials of *Rhizophora stylosa* at sites on the Liverpool-Tomkinson Rivers System, N.T.

Locality	Tree No.	Late Wet Season (May 77)		Late Dry Season (Oct 77)	
		High Tide Water Salinity Measurmts. 1145-1430 hrs		High Tide Water Salinity Measurmts. 1300-1600 hrs	
Tomkinson River 17 km	1	-3.3 MPa	0 ‰	-4.3 MPa	34 ‰
	2	-3.0		-4.6	
	3	-3.0		-4.7	
	4	-2.9		-4.4	
	5	-3.3		-4.9	
Tomkinson River 56 km	1	-3.3	0 ‰	-3.6	16 ‰
	2	-3.5		-3.2	
	3	-3.3		-3.4	
	4	-3.1		-3.3	
	5	-3.3		-3.3	
Mungardobolo Ck 25 km	1	-3.5	0 ‰	-4.7	34 ‰
	2	-3.1		-4.9	
	3	-3.5		-5.0	
	4	-3.3		-5.0	
	5	-3.4		-5.1	

APPENDIX 7

Girth measurements and height estimates of
Avicennia marina, *Camptostemon schultzii* and *Rhizophora*
stylosa at quadrats within stations on the Liverpool and
Tomkinson Rivers and Mungardobolo Creek, Northern Territory.

1. *Acanthus ilicifolius*
2. *Avicennia marina*
3. *Avicennia officinalis*
4. *Camptostemon schultzei*
5. *Lumnitzera racemosa*
6. *Excoecaria agallocha*
7. *Xylocarpus australasicus*
8. *Aegiceras corniculatum*
9. *Osbornia octodonta*
10. *Aegialitis annulata*
11. *Bruguiera exaristata*
12. *Bruguiera gymnorhiza*
13. *Bruguiera parviflora*
14. *Ceriops decandra*
15. *Ceriops tagal* var. *australis*
16. *Rhizophora stylosa*
17. *Sonneratia alba*
18. *Derris trifoliata*
19. *Rhizophora apiculata*
20. *Diospros ferrea* var. *humilis*
21. *Acrostichum speciosum*
22. *Flagellaria indica*
23. *Cathormion umbellatum*
24. *Corypha elata*
25. *Clerodendrum inerme*
26. *Melaleuca leucadendron*

TABLE A 7.1

Additional plant species recorded within quadrats on the Liverpool/Tomkinson River System, Northern Territory.

RECORDER Hauser
Wells

LOCATION 4km

BANK L.H.B.

LIVERPOOL RIVER

DATE 2.8.77

STATION L1

OTHER PLANT SPECIES IN QUADRAT

2, 4, 9, 10, 12, 13, 15,
17

QUADRAT 1

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

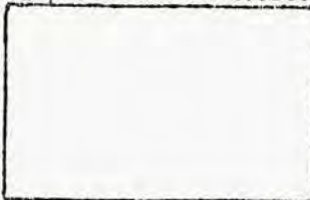
KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'Is' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	24.0	8	*			
2s	25.8	12				
2s	25.7	8	*			
2s	36.8	14				
2s	22.8	14				
2s	26.1	14				
2s	32.4	14				
2s	18.2	9	*			
2s	22.7	14				
2s	27.9	12				
2s	33.2	14				
2s	26.5	15				
2s	20.3	14				

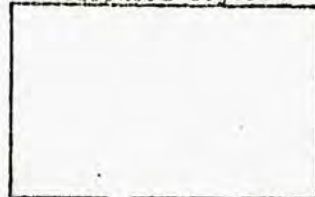
Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A) 5m x 20m

(B)

(B)

(B) 10m x 20m

RECORDER Hauser
Wells

LIVERPOOL RIVER

DATE 2.8.77

LOCATION 4km

STATION L1

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 2

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

2, 4, 9, 10, 12, 13, 15,
17

KEY
's' *Camptostemon schultzei*
'2s' *Rhinophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	24.8	12			
2s	24.5	12			
2s	27.3	12			
2s	24.1	8 *			
2s	22.3	14			
2s	21.7	14 - 15			
2s	13.4	6 *			
2s	27.9	14			
2s	18.4	12			
2s	25.5	14			
2s	18.6	12			
2s	18.8	14			

Avicennia marina

Camptostemon schultzei

Rhinophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A) 6m x 20m

(B)

(B)

(B) 9m x 20m

RECORDER Hauser
Wells

LOCATION 4km

BANK L.H.B.

LIVERPOOL RIVER

DATE 2.8.77

STATION L1

OTHER PLANT SPECIES IN QUADRAT

2, 4, 9, 10, 12, 13, 15,
17

QUADRAT 3

* TREE NOT AT Canopy Heights
FIRST TO TREES OF SPECIES
AT ALL Inclusive Heights
FIRST TO TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	26.8	14			
2s	27.7	14			
2s	27.2	14			
2s	18.6	12			
2s	25.5	14			
2s	18.0	11			
2s	20.8	12			
2s	21.0	12			
2s	29.5	14			
2s	25.5	14			
2s	22.3	14			

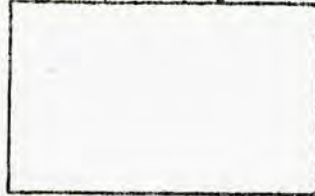
Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



DENSITIES OF THE FIRST TO TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A) 6m x 20m

(B)

(B)

(B) 7m x 20m

RECORDER Hauser
Wells

LOCATION 4km

BANK L.H.B.

LIVERPOOL RIVER

DATE 2.8.77

STATION L1

OTHER PLANT SPECIES IN QUADRAT

2, 4, 9, 10, 12, 13, 15
17

QUADRAT 4

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	13.8	6 *			
2s	24.5	14			
2s	26.8	14			
2s	21.5	14			
2s	27.0	14			
2s	20.8	14			
2s	19.7	14			
2s	11.4	6 *			
2s	24.1	14			
2s	29.5	14 - 15			
2s	30.4	14			
2s	25.4	15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A) 5m x 20m

(B)

(B)

(B) 9m x 20m

RECORDER Hauser
Wells

LIVERPOOL RIVER

DATE 2.8.77

LOCATION

STATION L1

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 5

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhinophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	20.2	14			
2s	22.0	14			
2s	31.3	14			
2s	21.4	14			
2s	23.0	15			
2s	11.8	6 *			
2s	31.0	14 - 15			
2s	15.7	6 *			
2s	17.8	8 *			
2s	20.3	9 *			
2s	32.6	14			
2s	31.8	15			
2s	21.4	15			
2s	24.8	14			

Avicennia marina

Camptostemon schultzei

Rhinophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A) 4m x 20m

(B)

(B)

(B) 7.5m x 20m

RECORDERS Allaway
Myercoough
Wells

LIVERPOOL RIVER

DATE 7.8.77

LOCATION 15 - 16km

STATION L2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 1

6, 7, 11, 13, 14

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

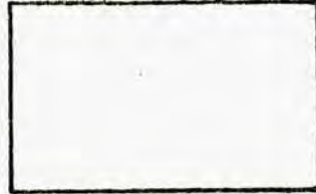
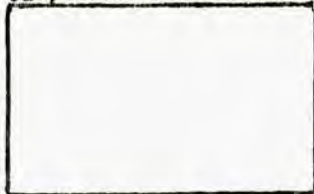
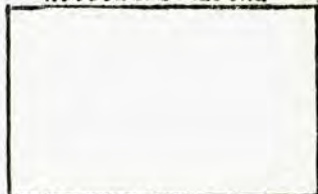
KEY
'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	24.8	15	1e	35.5	15 - 18
1e	30.3	15 - 18	5	25.1	15
5	13.0	14 *	1e	31.3	15
5	10.3	12 *	2s	11.8	15
1e	21.3	15	2s	20.1	15
1e	42.8	15 - 18	1e	28.2	14 - 15
5	17.8	15	1e	33.1	15
1e	20.6	15 - 18	2s	12.2	12 *
	32.8		2s	17.6	14 - 15
5	13.8	15	2s	19.6	15
5	15.3	15	2s	13.1	14 - 15
2s	8.3	14 *	2s	30.2	15
2s	21.3	15	2s	14.8	14 - 15
5	17.8	15			
5	15.8	15			
5	14.7	14 - 15			
1e	29.8	15			
5	23.2	15			
2s	11.9	12 *			
2s	18.8	15			
2s	22.9	15			
5	20.5	15			
1e	23.6	15			
5	24.2	15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 20m x 20m

(A) 35m x 20m

(B) 30m x 20m

(B) 30m x 20m

(B) 40m x 20m

RECORDER Elwell
Wells

LOCATION 15 - 16km

LIVERPOOL RIVER

DATE 7.8.77

STATION L2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 2

7, 11, 13, 14

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	34.8	15 - 17		5	11.7	12 - 14 *
5	16.3	9	*		15.2	
1e	11.2	12	*	5	15.6	14 - 15
	19.4			5	32.5	15 - 18
2s	17.9	14 - 15		5	17.2	15
1e	17.2	12	*	5	14.2	15
1e	18.7	12	*	1e	35.7	15
1e	20.0	14 - 15		1e	30.9	15 - 18
2s	21.8	15		5	22.2	15
2s	22.5	15 - 18		5	36.3	15 - 18
2s	26.2	15 - 18		1e	43.2	15
2s	39.3	18 - 20				
2s	20.9	14 - 15				
2s	36.4	15 - 18				
2s	31.0	18				
5	25.3	15 - 18				
2s	26.0	15 - 18				
2s	27.8	15 - 18				
1e	34.3	15 - 18				
5	19.8	12	*			
5	24.2	14 - 15				
1e	25.9	15 - 18				
1e	27.7	15 - 18				
5	30.6	15 - 18				
5	14.0	15 - 18				
1e	44.9	18 - 20				
1e	38.7	15				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 40m x 20m

(A) 40m x 20m

(A)

(B) 70m x 20m

(B) 55m x 20m

(B) 20m x 20m

RECORDER Elwell
Wells

LOCATION 15 - 16km

LIVERPOOL RIVER

DATE 7.8.77

STATION L2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 3

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
2s	31.2	15	1e	26.3	15
2s	20.6	15	1e	28.5	15
2s	12.8	14 - 15	1e	20.9	14 - 15
2s	13.0	14 - 15	1e	35.6	15
2s	19.6	15	5	15.0	14 *
2s	28.8	15 - 18	5	28.6	15 - 18
2s	28.2	18 - 20	5	44.8	15 - 18
2s	20.3	14 - 15	5	30.0	15 - 18
2s	26.8	15			
5	21.6	15			
5	29.4	15			
2s	26.2	15			
5	15.2	14 *			
1e	8.2	12 *			
1e	39.5	15 - 18			
5	19.2	14 - 15			
5	16.3	15			
5	12.9	15			
5	18.3	15			
1e	30.8	15 - 18			
1e	18.4	12 *			
5	20.8	15			
1e	25.3	14 *			
1e	30.8	15			
1e	32.5	15 - 18			
1e	26.8	15			
1e	14.2	15			
1e	20.8	14 *			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 42.5m x 20m

(A) 55.5m x 20m

(A)

(B) 54.5m x 20m

(B) 70.5m x 20m

(B) 12.5m x 20m

RECORDER Elwell
Wells

LIVERPOOL RIVER

DATE 7.8.77

LOCATION 15 - 16km

STATION L2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 11, 13, 14

QUADRAT 4

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2a' *Rhinophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	18.6	15 - 18	1e	23.4	15 - 18
2s	19.2	15 - 18	1e	27.8	18 - 20
1e	25.3	15	1e	31.6	15 - 18
2s	29.2	15	1e	37.2	14 - 15
5	17.0	15			
2s	21.7	14 - 15			
2s	25.8	15 - 18			
2s	29.5	15 - 18			
2s	11.3	12 *			
5	25.2	14 - 15			
2s	16.7	14 - 15			
5	14.8	12 *			
5	21.8	14			
5	24.2	14 - 15			
5	31.5	15 - 18			
2s	19.8	14 - 15			
5	18.7	14 - 15			
5	21.8	14 - 15			
5	18.2	15			
5	23.4	15			
1e	22.8	15 - 18			
2s	15.8	15			
1e	25.5	14 - 15			
1e	31.9	15 - 18			
1e	27.7	18			
	31.6				
5	19.5	14 - 15			
2s	16.7	14 - 15			

Avicennia marina

Camptostemon schultzei

Rhinophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 15m x 20m

(A) 15m x 20m

(A)

(B) 40m x 20m

(B) 25m x 20m

(B) 20m x 20m

RECORDER Elwell
Wells

LOCATION 15 - 16km

LIVERPOOL RIVER

DATE 7.8.77

STATION L2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 6, 7, 8, 11, 13, 14

QUADRAT 5

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'7' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	22.0	15	2s	17.5	14 - 15
5	16.4	14 - 15	2s	23.2	14 - 15
1e	25.3	15	2s	18.4	15
2s	25.2	15 - 18	1e	22.5	14 - 15
5	21.2	15	1e	31.2	15 - 18
5	18.2	14 - 15	1e	36.2	15 - 18
1e	36.3	15 - 18	1e	{23.3}	15
2s	16.2	12	1e	{28.2}	
5	12.0	12	1e	23.5	15 - 18
5	11.5	11			
5	22.8	15 - 18			
1e	{14.5}	14 - 15			
	{9.7}				
2s	23.2	15			
2s	12.5	12			
1e	20.0	14 - 15			
2s	25.5	15			
5	17.7	15			
2s	15.0	12			
2s	19.4	15			
2s	19.0	15			
2s	16.3	12			
2s	27.2	15 - 18			
5	20.8	15			
5	15.7	14 - 15			
5	19.2	15			
5	17.3	14 - 15			
2s	22.0	15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 20m x 20m

(A) 22m x 20m

(B) 59m x 20m

(B) 20m x 20m

(B) 29m x 20m

RECORDER Burrows
Wells

LOCATION 30km

BANK L.H.B.

LIVERPOOL RIVER

DATE 6.8.77

STATION L3

OTHER PLANT SPECIES IN QUADRAT

1, 7, 13, 14, 18

QUADRAT 1

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	10.8	14 *	2s	32.0	15 - 18
1e	25.5	15	2s	30.9	18 - 20
5	19.8	14 - 15	1e	34.6	18 - 20
5	19.7	15	1e	25.2	14 - 15
2s	17.8	15	1e	26.5	15 - 18
1e	31.4	15	1e	45.3	15 - 20
1e	36.4	18 - 20	5	22.4	15 - 18
5	13.8	18	5	23.7	15 - 18
1e	32.3	15 - 18			
5	16.2	14 - 15			
5	14.1	14 - 15			
5	11.1	14 *			
2s	20.2	14 - 15			
5	12.0	14 *			
5	14.6	14 *			
5	22.6	15			
2s	18.7	14 - 15			
2s	27.8	15			
5	29.8	15			
2s	16.0	14 *			
1e	34.7	18			
2s	20.0	14 - 15			
5	28.2	15			
1e	33.2	15			
2s	28.5	17 - 18			
2s	33.3	18			
2s	32.2	15			
1e	15.6	14 *			

Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 70m x 20m

(A) 10m x 20m

(A) 45m x 20m

(B) 75m x 20m

(B) 30m x 20m

(B) 45m x 20m

RECORDER Burrows
Wells

LIVERPOOL RIVER

DATE 6.8.77

LOCATION 30km

STATION L3

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 3, 7, 13, 14, 18

QUADRAT 2

TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'le' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	22.2	15 - 18	2s	22.5	15 - 18
1e	35.2	15 - 18	2s	22.7	15 - 18
5	23.8	15 - 18	1e	25.0	15 - 18
5	27.1	15 - 18	1e	28.2	15 - 18
5	9.0	11 *	1e	25.0	15 - 18
2s	18.2	14 - 15	2s	18.3	14 *
5	16.7	14 *	2s	19.8	14 - 15
5	16.2	14 *	2s	24.3	15
5	23.5	15 - 18	2s	24.3	15
5	14.5	14 *	2s	23.8	15 - 18
2s	34.6	15 - 18	5	20.8	15
5	13.0	12	1e	33.8	15
2s	28.6	15	1e	34.9	15 - 18
5	20.2	14 - 15	1e	29.7	15 - 18
5	24.0	15 - 18	5	27.0	15 - 18
2s	26.3	15 - 18	5	32.3	15 - 18
1e	{15.8}				
	{15.2}	9 *			
	{12.2}				
1e	9.4	9 *			
1e	22.6	12 *			
1e	35.1	14 - 15 *			
2s	16.3	14 *			
2s	20.4	15 - 18			
2s	24.8	15			
1e	16.5	11 *			
1e	23.7	15 - 18			
1e	19.3	14 - 15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 60m x 20m

(A)

(A) 61m x 20m

(B) 72m x 20m

(B)

80m x 20m

(B) 66m x 20m

RECORDER Burrows
Wells

LIVERPOOL RIVER

DATE 6.8.77

LOCATION 30km

STATION L3

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 3

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	24.7	15 - 18	1e	25.8	15 - 18
2s	21.0	15 - 18	1e	26.7	15
5	15.4	14 *	1e	30.2	18
5	21.7	15	1e	33.5	18
2s	25.7	15	2s	11.6	11 *
2s	27.0	14 - 15	5	18.5	14 - 15
2s	15.4	11 *	5	19.8	14 - 15
5	15.6	11 *	5	18.3	14 *
5	19.7	14 *	5	14.7	12 *
5	15.3	14 *	5	18.7	14 - 15
2s	22.1	14 - 15	5	13.6	14 *
2s	19.3	14 - 15	5	11.2	14 *
2s	9.0	6 *	5	6.3	9 *
5	12.2	14 *	2s	21.8	15
5	12.5	14 *	2s	21.2	14 - 15
1e	28.9	15	5	17.8	14 - 15
1e	35.8	15 - 18	5	16.6	14 - 15
5	16.3	14 *	5	14.5	14 - 15
2s	22.5	15	5	37.8	18
1e	(27.4)		2s	20.7	14
	(17.7)	15 - 18			
	(28.2)				
	(18.0)				
1e	39.3	15 - 18			
1e	22.8	14 *			
1e	31.8	15 - 18			
2s	18.2	14 - 15			
5	18.4	14 - 15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 30m x 20m

(A) 25m x 20m

(A) 33m x 20m

(B) 30m x 20m

(B) 75m x 20m

(B) 60m x 20m

RECORDER Burrows
Wells

LIVERPOOL RIVER

DATE 6.8.77

LOCATION 30km

STATION L3

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 13, 14

QUADRAT 4

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	25.2	15	5	11.3	14 *
5	7.6	9 *	5	16.7	14 *
2s	18.3	14 - 15	2s	15.4	14 *
5	20.5	15	5	21.0	14 - 15
2s	26.8	15	5	18.8	14 - 15
2s	6.3	6 *	2s	15.7	14 - 15
2s	12.3	14 *	5	20.4	15
1e	13.6	14 - 15	2s	13.8	14 - 15
1e	18.3	15	5	25.0	15
1e	15.2	14	2s	15.0	14 - 15
1e	25.2	15	2s	12.5	14 - 15
1e	23.2	15	5	27.0	15
2s	13.5	14 - 15	5	18.0	15
5	13.8	14 *	2s	20.4	15
1e	20.2	14 *			
1e	17.4	14 - 15			
1e	19.3	14 - 15			
1e	{13.3}	14 - 15			
	{15.7}				
2s	7.9	8 *			
5	9.2	9 *			
5	13.8	15			
2s	23.2	14 - 15			
1e	20.4	15			
1e	28.4	15 - 18			
2s	15.7	14 - 15			
5	16.6	14 *			
5	18.5	14 - 15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 20m x 20m

(A) 31m x 20m

(A) 35m x 20m

(B) 25m x 20m

(B) 85m x 20m

(B) 80m x 20m

RECORDER Burrows
Wells

LOCATION 30km

BANK R.H.B.

LIVERPOOL RIVER

DATE 6.8.77

STATION L3

OTHER PLANT SPECIES IN QUADRAT

1, 6, 7, 13

QUADRAT 5

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	36.9	15	5	20.8	14 - 15
2s	23.3	15 - 17	5	20.0	14 - 15
2s	13.3	12 *	1e	13.8	14 - 15
2s	18.2	11 - 12 *	1e	17.8	14 - 15
2s	{18.0}	14 *	1e	25.8	14 - 15
	{14.3}		1e	7.7	14 *
2s	16.0	15	1e	{19.6}	14 - 15
2s	10.6	14 *		{24.0}	
2s	23.3	14 - 15	1e	23.3	14 - 15
5	24.3	15 - 18	1e	25.2	14 - 15
5	17.8	14 - 15	1e	14.8	11 *
5	16.7	14 - 15	1e	26.2	14 - 15
5	17.3	14	1e	29.8	15
2s	22.9	14 - 15	1e	28.5	15
2s	12.8	11 - 12 *	1e	35.3	15 - 18
5	14.2	14 *			
5	16.4	14 - 15			
2s	{23.2}	14 - 15			
	{27.9}				
5	15.2	14 *			
5	28.2	15			
2s	17.4	14 - 15			
2s	26.6	15 - 18			
2s	18.3	14 - 15			
2s	18.3	14 - 15			
5	23.0	17			
5	17.3	15			
5	23.8	14 - 15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A) 85m x 20m

(A) 30m x 20m

(A) 10m x 20m

(B) 90m x 20m

(B) 35m x 20m

(B) 25m x 20m

RECORDER Hauser
Wells

LOCATION 41 - 42km

LIVERPOOL RIVER

DATE 5.8.77

STATION L4

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 11, 13, 14, 18

QUADRAT 1

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	16.8	14 *	2s	11.5	9 *
1e	37.5	18	2s	13.2	9 - 11 *
5	28.2	18	2s	23.2	18
5	39.2	18 - 20	2s	64.0	18
5	52.5	18 - 20	2s	41.0	18 - 20
2s	37.5	15 - 18	2s	63.0	18 - 20
2s	16.5	14 *	2s	31.8	20
5	54.4	15	2s	24.5	18 - 20
2s	12.4	15			
2s	10.8	15			
5	21.7	15			
5	13.3	15			
5	6.8	11 *			
5	12.6	15			
5	24.7	15 - 17			
1e	23.5	18			
5	18.7	15			
5	41.3	15 - 18			
2s	12.5	14 *			
1e	15.7	17 - 18			
1e	30.4	18 - 20			
1e	40.4	20			
2s	32.5	18 - 20			
1e	14.6	18 - 20			
1e	20.0	18 - 20			
1e	16.7	18 - 20			
1e	18.8	15 - 18			
1e	26.0	18 - 20			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 15m x 20m

(A) 95m x 20m

(B) 55m x 20m

(B) 20m x 20m

(B) 110m x 20m

RECORDER Hauser
Wells

LIVERPOOL RIVER

DATE 5.8.77

LOCATION 41 - 42km

STATION L4

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 11, 13, 14, 18

QUADRAT2

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

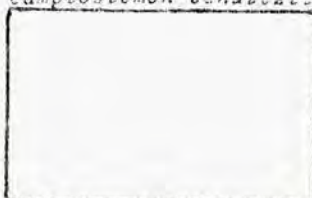
'S' *Camptostemon schultzei*
'2a' *Rhisophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	49.3	20	1e	29.3	14 - 15
5	38.8	18	1e	29.7	19
5	34.2	17 - 18			
2s	31.3	18			
2s	34.6	18			
2s	33.8	18			
2s	28.4	15 - 18			
2s	26.5	18			
2s	31.7	18			
2s	29.6	20			
2s	35.5	18			
2s	35.6	20 - 21			
5	16.7	15			
5	17.4	15			
5	16.8	15			
5	19.4	15			
5	16.3	14 *			
5	28.2	15 - 18			
1e	27.4	15			
1e	30.3	14 - 15			
5	20.5	14 - 15			
1e	19.8	14 - 15			
1e	19.9	14 - 15			
1e	28.3	15			
1e	30.8	15			
5	38.7	15 - 18			
5	27.6	15			
1e	31.2	14 - 15			

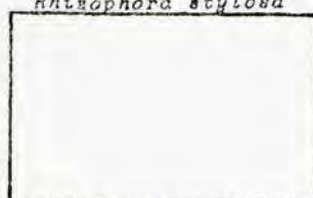
Avicennia marina



Camptostemon schultzei



Rhisophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 25m x 20m

(A) 15m x 20m

(A)

(B) 40m x 20m

(B) 15m x 20m

(B) 7m x 20m

RECORDER Hauser
Wells

LIVERPOOL RIVER

DATE 5.8.77

LOCATION 41 - 42km

STATION L4

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 13, 18

QUADRAT 3

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
Camptostemon schultzei
'2s' Rhizophora stylosa
'1e' Avicennia marina

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	34.7	18	1e	27.5	14 - 15
1e	45.6	20 - 21	1e	23.4	11 - 12 *
2s	17.6	15	1e	6.2	4.5 *
2s	24.7	15 - 18	1e	19.2	9 *
2s	40.3	20	1e	21.3	9 *
2s	25.8	15 - 18	1e	38.4	14 - 15
2s	23.0	15	1e	26.5	15 - 18
1e	23.8	8 *	1e	24.2	15 - 18
1e	27.7	6 *	1e	21.7	14 - 15
5	61.5	20	1e	22.7	15
5	32.4	15 - 18	1e	28.6	15 - 18
2s	51.1	20 - 21	1e	24.6	15 - 18
5	28.5	15 - 18	1e	26.5	15 - 18
2s	43.0	18			
2s	26.1	15 - 18			
1e	11.5	6 *			
2s	7.5	8 *			
2s	28.2	15 - 17			
2s	21.1	15 - 17			
5	22.5	15			
5	6.0	4.5 *			
5	8.9	6 *			
5	44.9	18			
5	43.3	15			
5	17.2	14 *			
5	44.3	20			
5	56.4	20			
5	41.3	20			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A) 60m x 20m

(A) 40m x 20m

(A) 10m x 20m

(B) 80m x 20m

(B) 55m x 20m

(B) 11m x 20m

RECORDER Hauser
Wells

LIVERPOOL RIVER

DATE 5.8.77

LOCATION 41 - 42km

STATION L4

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 4

1, 7, 13, 18

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metros) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metros) Visual Estimate
5	22.8	18	5	42.3	20
5	20.9	14 - 15	5	37.2	18 - 20
5	13.2	14 *	5	35.7	20 - 21
1e	31.8	14 - 15	1e	{23.5}	17 - 18
5	30.2	15 - 18		{27.2}	
2s	27.5	18 - 20	1e	22.3	14 - 15
1e	31.8	14 - 15	1e	16.6	9 *
2s	30.6	18 - 20	1e	24.5	14
5	36.8	8 *	1e	{43.2}	18 - 20
5	26.5	14 - 15		{25.9}	
5	10.8	3 *	1e	20.2	17 - 18
1e	35.7	14 - 15	1e	43.7	18
2s	17.0	14 - 15			
2s	{27.7}	15 - 17			
	{22.7}				
5	32.6	15 - 18			
2s	32.3	18 - 20			
2s	29.8	15 - 18			
2s	30.8	18 - 20			
2s	42.0	18 - 20			
2s	16.2	15			
5	10.9	14 *			
5	19.2	14 *			
2s	14.8	14 *			
2s	21.8	15			
1e	41.0	14 - 15			
5	37.6	18 - 20			
5	36.3	18			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 45m x 20m

(A) 30m x 20m

(A) 28m x 20m

(B) 65m x 20m

(B) 40m x 20m

(B) 30m x 20m

RECORDER Hauser
Wells

LIVERPOOL RIVER

DATE 5.8.77

LOCATION 41 - 42km

STATION L4

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 13, 18

QUADRAT 5

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'le' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	44.2	18	2s	46.0	15 - 18
5	48.9	18	2s	47.6	15
5	41.3	18 - 20	2s	23.2	14 - 15
5	17.5	14 *	1e	26.4	18 - 20
5	22.2	14 - 15	1e	29.5	18 - 20
5	28.3	15	1e	60.0	20 - 21
5	26.2	15 - 17	1e	45.7	20 - 21
5	30.2	15 - 17		57.7	
5	16.4	11 - 12 *	1e	{39.4}	
5	6.6	4.5 *		{29.2}	
5	36.8	15		{23.6}	20 - 21
5	29.5	18		{44.0}	
5	29.7	18	1e	35.3	15 - 18
2s	21.7	9 *	1e	13.8	6 *
2s	22.5	14 *	1e	20.3	15 - 18
1e	36.2	15	1e	20.4	15 - 18
1e	{15.3}				
	{22.7}	11 - 12 *			
	{15.2}				
2s	45.3	20			
2s	45.7	20 - 21			
2s	{24.2}	18 - 20			
	{41.2}				
1e	18.5	15 - 18			
2s	30.7	18 - 20			
2s	34.2	15 - 18			
2s	39.0	20 - 21			
2s	34.8	21			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 68m x 20m

(A) 2m x 20m

(A) 22.5m x 20m

(B) 80m x 20m

(B) 2.5m x 20m

(B) 28m x 20m

RECORDER Hauser
Wells

LIVERPOOL RIVER

DATE 3.8.77

LOCATION 55 - 56km

STATION L5

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 1

1, 7, 8, 14, 18, 20, 22

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	30.7	15 - 17			
1e	20.3	15			
5	44.0	12 *			
5	22.5	12 *			
5	57.3	18			
5	25.0	12 *			
5	34.8	12 *			
5	39.0	17 - 18			
5	18.0	15 - 18			
5	{33.2}	15			
	{26.5}				
1e	{17.0}	15			
	{21.8}				
5	{14.7}	15 - 18			
	{30.4}				
5	51.2	18			
1e	90.3	18 - 20			
5	26.0	15 - 18			
5	27.8	15 - 17			
1e	89.0	20 - 21			
5	26.4	15 - 18			
1e	69.0	21			
1e	51.0	20			
1e	58.0	20 - 21			
1e	30.6	20			
1e	65.0	21 - 23			
1e	25.7	15 - 18			
1e	51.0	18 - 20			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 80m x 20m

(A) 30m x 20m

(A)

(B) 80m x 20m

(B) 45m x 20m

(B)

RECORDER Hauser
Wells

LOCATION 55 - 56km

LIVERPOOL RIVER

DATE 3.8.77

STATION L5

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 14, 18, 20

QUADRAT 2

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	43.0	18 - 20			
5	58.0	15 - 17			
1e	48.2	20			
1e	18.0	15 - 17			
1e	15.1	11 *			
5	{33.0}	15 - 17			
	{26.0}				
1e	30.2	17 - 18			
5	39.6	18			
5	37.4	20			
5	32.1	17 - 18			
5	32.8	18			
5	22.6	14 *			
5	{14.4}	12 - 14 *			
	{19.7}				
5	35.0	18			
5	46.4	18			
5	37.2	15			
1e	38.1	20 - 21			
1e	55.3	20 - 21			
1e	19.4	6 *			
1e	47.6	20			
1e	58.2	20			
1e	{26.7}	20			
	{48.0}				
1e	{24.4}	18			
	{74.5}				
1e	70.0	20 - 21			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 85m x 20m

(A) 12m x 20m

(A)

(B) 106m x 20m

(B) 13m x 20m

(B)

RECORDERS Hauser
Wells
LOCATION 55 - 56km

LIVERPOOL RIVER

DATE 3.8.77

STATION L5

SANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT
1, 7, 8, 11, 25

QUADRAT 3

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	17.3	14 *			
5	15.2	14 *			
5	35.2	18			
5	24.4	15			
5	35.9	18			
5	6.8	6 *			
5	18.2	15			
5	6.5	3.5 *			
5	25.3	18			
1e	13.5	14 *			
1e	41.6	15			
5	51.0	20 - 21			
5	38.7	18 - 20			
5	40.6	18 - 20			
1e	35.3	18			
1e	67.0	20			
1e	40.8	20			
5	60.6	20 - 21			
5	35.5	20 - 21			
1e	40.8	20			
1e	37.9	20 - 21			
1e	32.8	15			
1e	92.6	20 - 21			
1e	41.8	20			
1e	47.1	18 - 20			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 35m x 20m

(A) 5m x 20m

(A)

(B) 35m x 20m

(B) 10m x 20m

(B)

RECORDERS Hauser
Wells

LOCATION 55 - 56km

LIVERPOOL RIVER

DATE 3.8.77

STATION L5

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

8, 14, 20

QUADRAT 4

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	35.6	15	1e	31.6	14 - 15
5	69.0	15 - 17			
5	51.0	15 - 17			
5	61.0	18			
5	58.0	18 - 20			
5	16.2	14 *			
5	23.5	14 *			
5	56.4	20			
5	13.5	11 *			
5	32.0	14 - 15			
5	55.5	20			
5	35.8	15 - 17			
5	51.1	18 - 20			
1e	{17.6}	6 *			
	{17.3}				
1e	24.6	15 - 17			
1e	11.4	9 *			
1e	23.2	11 *			
1e	64.0	20 - 21			
1e	29.2	17 - 18			
1e	38.3	18 - 20			
1e	70.5	21 - 23			
1e	{46.2}	20 - 21			
	{58.8}				
1e	42.7	15 - 18			
1e	31.2	20 - 21			
1e	{29.3}	15			
	{36.8}				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 50m x 20m

(A) 10m x 20m

(A)

(B) 60m x 20m

(B) 11.5m x 20m

(B)

RECORDERS Hauser
Wells

LOCATION 55 - 56km

BANK R.H.B.

LIVERPOOL RIVER

DATE 3.8.77

STATION L5

OTHER PLANT SPECIES IN QUADRAT

8, 14, 16, 18

QUADRAT 5

TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

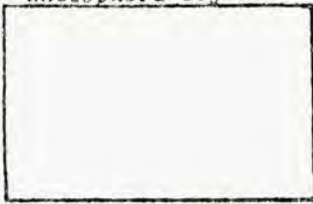
'5' *Camptostemon schultzei*
'2e' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	41.1	20	1e	{43.2}	20
5	23.0	15		{23.1}	
5	12.0	8 *	1e	39.8	15
5	36.3	15 - 17	1e	50.3	20
5	19.0	14 - 15 *			
1e	{26.0}	15			
	{24.7}				
5	15.0	14 *			
5	8.4	9 *			
5	6.4	11 *			
5	5.4	8 - 9 *			
5	4.6	4.5 - 6 *			
5	44.6	18 - 20			
1e	15.2	3.5 *			
1e	47.2	20 - 21			
5	45.3	18 - 20			
1e	48.4	20 - 21			
1e	{45.2}				
	{14.9}	18 - 20			
	{21.8}				
5	31.5	15 - 18			
5	35.8	15 - 18			
5	33.5	17 - 18			
5	38.2	18			
5	36.2	20			
1e	43.5	18 - 20			
1e	43.2	18			
1e	46.6	15 - 18			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 38m x 20m

(A) 3m x 20m

(A)

(B) 53m x 20m

(B) 13m x 20m

(B)

RECORDERS Hauser
Wells

LIVERPOOL RIVER

DATE 3.8.77

LOCATION 60km

STATION L6

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 18, 20, 21

QUADRAT 1

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'Is' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	16.3	14	1e	(56.8)	18 - 20
5	10.2	8 *		{29.1}	
5	34.3	18		{28.2}	
5	22.7	17	1e	65.2	18
5	28.7	17			
5	33.6	17 - 18			
5	12.8	8 *			
5	22.2	11 *			
5	26.1	17			
5	36.5	15 - 17			
1e	14.4	9 *			
5	45.0	18			
1e	133.0	18			
5	40.0	14 - 15			
5	79.0	18 - 20			
1e	58.8	18 - 20			
1e	57.8	18 - 20			
1e	42.8	15 - 17			
1e	85.0	18			
1e	39.8	18 - 20			
1e	{29.6}	18 - 20			
	{58.3}				
	{79.2}				
1e	31.3	11 *			
1e	{99.0}	20			
	{37.4}				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 65m x 20m

(A) 30m x 20m

(A)

(B) 80m x 20m

(B) 50m x 20m

(B)

RECORDERS Hauser
Wells
LOCATION 60km

LIVERPOOL RIVER

DATE 3.8.77

STATION L6

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 2

1, 8, 18, 20

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	50.4	17 - 18	5	28.7	17
5	{45.3}	15 - 17	5	31.5	15
	{35.7}		5	39.6	15 - 17
1e	30.0	12 *	5	36.0	17
1e	25.8	14 - 15	5	46.0	17 - 18
1e	47.0	17 - 18			
5	7.6	9 *			
5	13.7	12 *			
5	5.6	4.5 *			
5	9.0	8 *			
5	7.4	9 *			
5	10.3	6 *			
5	17.7	9 - 11 *			
5	13.5	14 *			
1e	36.2	14 - 15			
1e	{56.0}	15 - 18			
	{16.2}				
1e	47.3	18			
1e	22.8	9 *			
1e	{31.9}	18			
	{13.2}				
1e	39.3	18 - 20			
1e	33.2	18			
1e	26.3	15			
1e	61.7	20 - 21			
5	46.5	17			
5	28.2	15			
5	25.8	15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 100m x 20m

(A) 8m x 20m

(A)

(B) 110m x 20m

(B) 120m x 20m

(B)

RECORDERS Hauser
Wells

LOCATION 60km

BANK L.H.B.

LIVERPOOL RIVER

DATE 3.8.77

STATION L6

OTHER PLANT SPECIES IN QUADRAT

1, 8, 18, 20, 22

QUADRAT 3

TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	27.0	12 *	1e	30.9	14 - 15
5	45.3	17	1e	{41.4}	18
5	17.8	8 *		{49.5}	
5	14.2	8 *	1e	55.2	20
5	9.8	3 *			
5	{11.3}	8 *			
	{9.6}				
5	17.4	12 *			
5	16.0	12 *			
5	13.1	11 *			
5	13.0	11 - 12 *			
5	30.6	14 - 15			
5	51.6	18			
5	32.8	14 - 15			
1e	78.0	20 - 21			
5	{51.5}	18			
	{22.5}				
5	45.0	18			
5	54.5	18			
1e	81.0	18 - 20			
1e	55.0	20			
5	57.3	15			
5	35.7	15			
1e	59.8	20			
5	56.0	17 - 18			
1e	73.0	20			
1e	49.4	18 - 20			
1e	44.2	20			

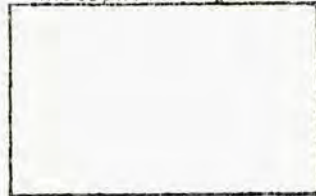
Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

2m x 20m

(A)

(B)

60m x 20m

(B)

45m x 20m

(B)

RECORDERS: Hauser
Wells

LOCATION 60km

BANK L.H.B.

LIVERPOOL RIVER

DATE 3.8.77

STATION L6

OTHER PLANT SPECIES IN QUADRAT

7, 8, 9, 22, 26

QUADRAT 4

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	34.0	15	1e	57.0	18-20
5	64.0	15-18	5	{42.8 9.6}	15-17
5	19.8	8 *	1e	49.0	18-20
5	11.5	4.5 *	5	29.6	14-15
1e	149.0	15	5	27.8	14-15
5	{14.0 16.2 7.0 11.8 26.2}	9-11 *	1e	34.5	18-20
5	32.0	14-15	5	47.8	15
5	{34.7 16.8}	14-15	1e	{29.8 12.6 12.8}	11 *
5	23.2	11 *	1e	44.2	20
5	14.2	4 *	5	40.2	15

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Height (B) At the Canopy Height

(A)

(A)

(A)

(B)

(B)

(B)

LOCATION 60km

LIVERPOOL RIVER

DATE 3.8.77

STATION L6

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 4

- TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

[illegible]

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 28m x 20m

(A) 7m x 20m

A1

В) 32m x 20m

(B) 28m x 20m

(B)

RECORDERS Hauser
Wells

LIVERPOOL RIVER

DATE 3.8.77

LOCATION 60km

STATION L6

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 5

7, 8, 18, 20, 22, 25,
26

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

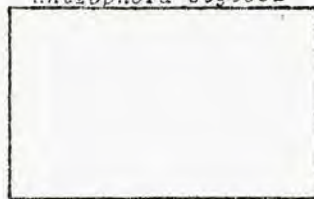
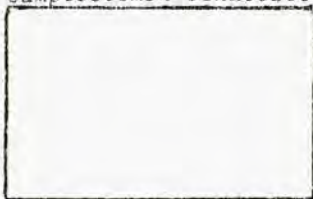
KEY
'S' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	122.0	17 - 18	1e	{ 30.4 72.0 11.3 8.3 }	15
5	33.2	17			
5	8.5	8 *			
5	5.8	3.5 *			
5	13.7	11 *	1e	32.5	11 *
5	19.2	14 - 15	1e	{ 30.7 26.3 }	15 - 17
5	11.5	12 - 14 *			
5	8.6	8 *	1e	48.3	20 - 21
5	10.2	8 *	1e	47.8	15 - 18
5	65.0	20 - 21			
5	17.5	14 - 15 *			
5	36.2	15			
5	25.8	18			
5	49.3	20 - 21			
5	23.8	14 - 15			
5	29.6	15			
5	29.5	17 - 18			
5	46.4	18 - 20			
1e	66.0	18 - 20			
1e	67.3	18 - 20			
1e	72.5	15 - 18			
1e	95.0	20 - 21			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 45m x 20m

(A) 15m x 20m

(A)

(B) 52m x 20m

(B) 25m x 20m

(B)

RECORDERS Allaway
Myerscough
Wells

TOMKINSON RIVER

DATE 6.2.77

LOCATION 17km

STATION T1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 1

6, 11, 13, 14

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

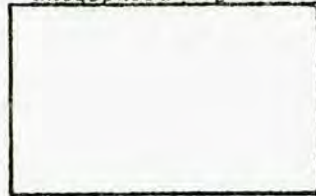
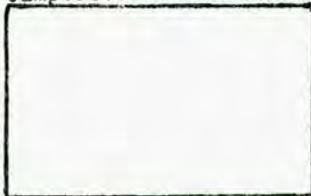
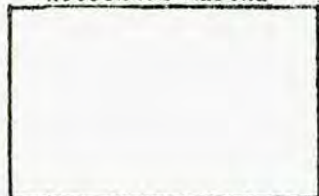
KEY
'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	34.8	14	5	9.5	9 *
5	21.4	14	5	13.0	12
2s	17.0	14	1e	14.8	12 - 14
2s	11.2	12	1e	12.4	12
2s	10.5	12	1e	{20.1}	14
2s	13.2	14		{18.4}	
2s	6.0	6 *	1e	{14.1}	1
2s	16.2	12 - 14		{16.2}	14
2s	15.5	12 - 14		{87.6}	
2s	12.3	12 - 14	1e	{48.7}	12 - 14
2s	7.6	9 *		{29.3}	
2s	7.5	9 - 9	1e	{43.3}	12
2s	17.3	14		{26.3}	
5	13.3	12 - 14	5	16.2	13
2s	8.6	11 *	1e	{23.1}	12
2s	13.5	14		{13.5}	
5	8.3	9 *	1e	{14.6}	12
5	5.4	4 - 5 *		{43.9}	
5	16.4	14	1e	{44.4}	12
5	10.3	12 - 14		{8.2}	
5	23.1	14	5	14.3	12
5	15.4	14			
5	15.3	14			
5	8.7	8 *			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A)

(B) 150m x 20m

(B) 63m x 20m

(B) 10.5m x 20m

RECORDERS Allaway
Myerscough
Kells

TOMKINSON RIVER

DATE 6.2.77

LOCATION 17km

STATION T1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 2

11, 13, 14, 15

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'1s' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	
1e	29.3	12		1e	35.4	14	
1e	{ 9.3 }	11	*	5	11.4	11	*
	{ 9.6 }			5	17.5	12	
1e	42.6	12		5	6.6	11	*
1e	28.8	12		5	20.4	12	
2s	3.8	6	*	1e	48.0	8	*
2s	2.9	3	*	2s	10.6	9	*
2s	3.6	4.5	*	2s	9.8	11	*
2s	2.0	3.0	*	2s	15.0	12	
2s	3.2	4.5	*	5	15.5	12	
2s	3.9	4.5	*	1e	35.7	14	
2s	2.1	3.0	*	1e	21.4	12	
2s	1.9	3	*	1e	64.5	14	
2s	5.2	8		2s	14.0	12	
2s	4.3	5	*	5	10.4	12	
2s	5.1	8	*	5	11.5	12	
2s	9.1	9	*	2s	19.9	14	
2s	7.1	9	*	5	22.4	14	
2s	4.4	5	*	2s	18.5	14	
5	12.3	12		5	8.2	9	*
2s	4.1	3	*	2s	14.7	12 - 14	
5	14.2	12		5	5.0	4	*
5	9.9	12		2s	14.2	12	
1e	41.1	14		2s	15.3	12	

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A)

(B)

(B)

(B)

RECORDERS Allaway
Myercoough
Wells

LOCATION 17km

BANK R.H.B.

TOMKINSON RIVER

DATE 6.2.77

STATION T1

QUADRAT 2

- TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

[illegible]

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A)

(A)

FA

(B) 82m x 20m

(B) 92.5m x 20m

(B) 94.5m x 20m

RECORDERS Allaway
Myercoough
Wells

TOMKINSON RIVER

DATE 8.2.77

LOCATION 17km

STATION T1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 3

6, 8, 10, 13, 15

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2s' *Rhinophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
2s	19.6	12	1e	17.2	14
2s	11.7	12	5	12.9	12
2s	16.6	12	5	12.6	12
2s	9.1	12	5	4.7	4 *
2s	12.0	12	5	16.4	12 - 14
5	21.2	12 - 14	5	11.6	12
2s	11.3	9 *	5	16.0	12 - 14
2s	19.1	12	1e	17.5	12
1e	9.2	9 *	1e	17.3	12
2s	10.5	4.5 *	1e	23.5	12
2s	9.3	10 *	1e	37.6	12
5	17.3	11 - 12	1e	{11.3}	12 - 14
2s	14.8	12		{25.0}	
2s	14.4	11	1e	{9.3}	
2s	15.2	11		{30.8}	12 - 14
2s	12.8	11		{37.7}	
1e	20.0	12	1e	39.2	12 - 14
1e	3.4	4 *	1e	{14.7}	12 - 14
1e	5.5	4.5 *		{33.0}	
5	15.5	12			
5	16.8	11			
5	9.8	9 *			
5	9.3	11			
5	12.2	9 *			

Avicennia marina

Camptostemon schultzei

Rhinophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 45.8m x 20m

(A) 23.5m x 20m

(A) 2.5m x 20m

(B) 87.5m x 20m

(B) 31.5m x 20m

(B) 4.7m x 20m

RECORDERS Allaway
Myrcecoug
Wells

TOMKINSON RIVER

DATE 8.2.77

LOCATION 17km

STATION T1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

3, 7, 8, 10, 13, 15

QUADRAT 4

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'Is' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	{20.2}	14	5	6.4	9 *
	{18.6}		5	6.8	9 *
5	7.4	11	5	6.5	9 *
1e	14.3	12	5	8.8	9 *
1e	8.3	8 *	5	10.4	9 *
1e	6.0	11	5	14.0	12
2s	12.6	11	5	9.9	11 - 12
2s	17.5	12	5	14.5	11 - 12
2s	7.4	8 *	5	9.8	11 - 12
2s	{17.3}		5	19.0	12 - 14
	{22.2}	11 - 12	1e	21.1	11
	{23.6}		5	11.2	11
2s	16.5	11 - 12	5	9.5	11
2s	11.8	11 - 12	5	17.7	14
2s	11.3	9 *	1e	24.6	12 - 14
2s	19.0	12	1e	15.7	12
2s	20.0	11 - 12	1e	20.4	12
2s	{15.2}		1e	25.5	12 - 14
	{20.4}	11 - 12	1e	26.4	12 - 14
	{25.5}		1e	7.0	8 *
2s	21.2	11 - 12	1e	20.0	12 - 14
5	6.3	9 *	1e	15.7	12 - 14
5	8.7	11			
5	6.5	9 *			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 117m x 20m

(A) 12m x 20m

(A) 5.5m x 20m

(B) 123m x 20m

(B) 111m x 20m

(B) 17.0m x 20m

RECORDERS Allaway
Hyercoough
Wells

TOMKINSON RIVER

DATE 8.2.77

LOCATION 17km

STATION T1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 5

1, 6, 7, 13, 15

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	12.7	12	1e	(25.5)	12
2s	20.6	11 - 12		{10.6}	
5	6.7	11	1e	28.7	12
2s	12.0	11 - 12	1e	{14.6}	12 - 14
5	14.2	11 - 12		{26.3}	
2s	11.8	11 - 12	1e	20.8	12 - 14
2s	11.5	11 - 12	1e	21.4	12 - 14
2s	5.2	6 *	1e	{16.9}	12 - 14
5	17.7	12 - 14		{24.6}	
2s	13.6	11 - 12	1e	25.8	12 - 14
2s	9.0	8 *	1e	10.5	12 - 14
2s	16.6	11 - 12	1e	6.7	11 - 12
2s	16.2	11 - 12			
2s	15.6	12 - 14			
5	14.0	12 - 14			
5	12.8	12 - 14			
5	12.9	12 - 14			
5	11.1	12 - 14			
2s	18.2	12			
2s	18.6	12			
5	14.8	12			
5	15.7	12			
1e	(39.3)				
	11.7	12			
	12.8				
	23.5				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A) 5.5m x 20m

(B) 120m x 20m

(B) 10m x 20m

(B) 9.4m x 20m

RECORDERS Allaway
Myercoough
Nells

TOMKINSON RIVER

DATE 15.2.77

LOCATION 38km

STATION T2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 1

1, 7, 8, 13, 14, 18

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhinophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	14.7	14	5	15.7	14 - 15
2s	13.7	14	5	15.4	15
5	11.2	12	5	{10.2}	14
1e	{3.5}	6	5	{11.7}	
	{5.2}		5	20.7	14 - 15
2s	15.5	14	2s	{10.6}	14
2s	10.3	14		{11.1}	
5	7.2	12	2s	11.3	14
1e	{15.2}	14	2s	6.7	11
	{18.7}		2s	{6.8}	11 - 12
1e	15.2	14		{6.3}	
1e	11.3	14	2s	10.7	14
1e	10.2	11	2s	11.0	14
5	7.3	11	2s	16.7	14
5	3.8	6 - 8	2s	15.6	14
5	6.3	8	2s	15.4	14
5	3.8	6	1e	{18.3}	15
5	11.0	14		{14.5}	
5	12.5	14	1e	16.2	14
5	14.3	14	1e	12.6	14
2s	8.2	11	1e	20.7	14
5	{12.2}	14 - 15	1e	{12.2}	14
	{11.3}			{11.0}	
5	10.7	14 - 15	1e	{17.4}	14
				{18.0}	
				{16.7}	

Avicennia marina

Camptostemon schultzei 1e

Rhinophora stylosa 14 - 15

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A) 20.1m x 20m

(A) 3.5m x 20m

(A) 9.4m x 20m

(B) 40m x 20m

(B) 10.5m x 20m

(B) 12.5m x 20m

RECORDERS Allaway
Myerscough
Walls

TOMKINSON RIVER

DATE 15.2.77

LOCATION 38km

STATION T2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 2

1, 7, 8, 13, 14

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	{12.8 9.5}	13	5	7.0	11 - 12 *
2s	{14.8 10.3 28.8}	14	5	14.2	14
2s	14.7	14	1e	13.7	14
5	12.9	14	5	13.6	14
1e	9.8	14	1e	19.5	14
2s	11.9	14	1e	12.7	14 - 15
2s	11.8	14	1e	13.2	14
2s	9.0	14	1e	17.0	14 - 15
2s	10.0	14	1e	{9.4 16.3}	14
2s	8.0	14	1e	13.2	14
5	11.5	14			
2s	9.2	14			
2s	13.2	14			
5	11.3	14			
5	10.3	14			
5	19.5	14			
1e	13.6	14			
1e	13.5	14			
5	14.7	14			
5	19.0	14			
5	17.3	14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A)

(A) 11.5m x 20m

(A) 4.0m x 20m

(B) 33.5m x 20m

(B) 17.0m x 20m

(B) 4.0m x 20m

RECORDERS Allaway
Myerscough
Kelle

TOMKINSON RIVER

DATE 15.2.77

LOCATION 38km

STATION T2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 13, 14

QUADRAT 3

TREE NOT AT Canopy Height
FIRST TO TREES OF SPECIES
AT All Inclusive Heights
FIRST TO TREES OF SPECIES
AT Forest Canopy Height

KEY

's' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	{29.0} {19.8}	14	5	9.4	14
2s	7.0	14	5	13.0	14
2s	{9.7} {6.5}	8 *	5	8.2	14
5	6.4	8 - 9 *	5	9.0	14
2s	8.3	8 *	5	13.2	14
2s	14.4	14	5	7.8	14
2s	9.0	14	5	10.2	14
2s	5.6	14	5	9.4	14
2s	9.1	14	1e	10.4	14
2s	5.0	14	1e	16.7	14 - 15
2s	8.0	14	1e	10.2	14
2s	5.0	12 *	1e	8.3	14
2s	21.9	14	1e	{39.8} {9.2}	15 - 17
2s	16.7	14	1e	{17.9}	
2s	12.6	14	1e	{11.3}	
5	8.7	14	1e	{12.8}	
5	6.9	8 *	1e	10.2	14
5	6.7	12 *	1e	14.3	14
5	4.3	3 - 4 *	1e	14.4	14
5	6.8	4.5 *			
5	6.4	6 *			
5	3.6	6 *			
5	5.3	8 *			
5	8.3	8 *			
1e	22.2	14			
5	9.5	14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST TO TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 4.4m x 20m

(A) 3m x 20m

(B) 47.0m x 20m

(B) 11.2m x 20m

(B) 3.8m x 20m

RECORDERS Allaway
Myercoough
Kells

TOMKINSON RIVER

DATE 15.2.77

LOCATION 38km

STATION T2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 10, 13

QUADRAT 4

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	4.7	8 *	2s	8.1	11 *
1e	{ 6.2 }	8 *	1e	{ 15.0 }	14
	{ 8.3 }			{ 9.8 }	
1e	5.3	6 *	2s	11.8	14
1e	{ 6.0 }	6 *	2s	9.2	14
	{ 5.9 }		5	{ 12.3 }	14
1e	9.2	4.5 *		{ 6.0 }	
2s	{ 10.4 }	14	2s	9.2	14
	{ 9.8 }		2s	14.2	14 - 15
2s	3.8	6 *	5	14.3	14
5	4.3	4.5 *	5	12.8	14
5	8.4	11 *	5	16.0	14
5	10.5	14	1e	13.8	14 - 15
5	6.3	11 *	1e	16.7	14
5	17.4	14	1e	{ 17.8 }	14
5	4.3	3 *		{ 16.2 }	
5	13.6	14	1e	16.0	8 *
5	14.7	14	1e	{ 24.9 }	14 - 15
2s	10.5	14		{ 34.8 }	
2s	7.7	14	1e	16.3	14
5	8.7	14	1e	20.7	14
2s	{ 35.5 }	14	1e	10.2	14
	{ 29.0 }		1e	10.4	14
2s	34.4	14 - 15			
5	16.7	14			
2s	6.0	8 *			
2s	11.2	14			
1e	23.3	14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy height

(A) 31.0m x 20m

(A) 4.2m x 20m

(A) 10.5m x 20m

(B) 56.5m x 20m

(B) 18.0m x 20m

(B) 12m x 20m

RECORDERS Allaway
Hyerbaough
Wells

TOMKINSON RIVER

DATE 15.2.77

LOCATION 38km

STATION T2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

7, 8, 10, 13, 14

QUADRAT 5

* TREE NOT AT Canopy Height
FIRST TO TREES OF SPECIES
AT ALL Inclusive Heights
FIRST TO TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	{11.9}	12 - 14	2s	8.7	14
	{18.5}		2s	10.1	14
1e	{38.0}	14 - 15	2s	19.2	14 - 15
	{18.7}		1e	{21.3}	14 - 15
	{21.2}			{28.4}	
2s	16.8	14		{10.8}	
5	5.4	6 *		{9.5}	
5	3.8	4 *	1e	29.8	14
5	3.5	4 *	2s	9.2	14
5	5.0	4.5 *	1e	6.3	12 *
5	7.6	8 *	1e	17.7	14
5	6.4	8 *	1e	8.5	11 *
5	4.5	3 *	5	{10.9}	14
5	9.5	8 *		{5.2}	
5	4.5	6 *	1e	19.4	15
5	4.7	4.5 *	5	21.7	14 - 15
5	13.2	14	5	13.4	14
5	21.6	14 - 15	1e	11.8	14
2s	13.6	14	5	26.7	15
2s	8.3	14	1e	9.8	14
2s	13.0	14	1e	{13.2}	
2s	8.7	12 - 14		{20.8}	14
5	11.0	14		{13.6}	
5	13.8	14 - 15	1e	22.4	15
5	13.5	14			
2s	4.3	4.5 *			
5	17.2	14			
2s	18.9	14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 25.5m x 20m

(A) 3.0m x 20m

(A) 12m x 20m

(B) 47.0m x 20m

(B) 25.5m x 20m

(B) 14.0m x 20m

RECORDERS Ailaway
Myraconough
Wells

TOMKINSON RIVER

DATE 13.2.77

LOCATION 47.5km

STATION T3

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT
1, 8, 10, 12, 14, 18

QUADRAT 1

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

's' *Camptostemon schultzei*
'sa' *Rhizophora stylosa*
'le' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	10.4	12 - 14	2s	9.9	14
5	3.5	4 *	1e	23.3	15
5	6.8	11 *	1e	16.2	15
5	11.7	11 - 12 *	1e	6.2	8 - 9 *
1e	8.8	12	5	40.5	17 - 18
5	6.6	9 *	5	26.2	17 - 18
5	3.1	4.5 *	5	25.7	15 - 18
1e	14.4	11 - 12	5	34.3	17 - 18
1e	15.7	14	5	26.2	17 - 18
2s	7.3	11 *	1e	35.7	15 - 17
2s	7.1	11 *	2s	23.8	14 - 15
2s	5.8	11 *	2s	28.7	15 - 17
2s	4.5	4.5 - 6 *	2s	{25.8}	
2s	4.7	4.5		{11.8}	15 - 17
2s	{26.5}			{11.3}	
	{15.0}	14	2s	31.2	15
	{14.5}		2s	29.3	18
1e	30.6	14 - 15	2s	35.4	17 - 18
1e	36.0	14 - 15	2s	17.8	14 - 15
5	40.0	14 - 15	2s	22.5	14 - 15
1e	{29.7}	15 - 18			
	{39.0}				
5	36.5	15 - 18			
5	19.5	15 - 18			
1e	{18.6}				
	{38.4}	14 - 15			
	{38.5}				
5	20.2	15 - 17			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 9m x 20m

(A) 9m x 20m

(A) 17.0m x 20m

(B) 11.5m x 20m

(B) 14m x 20m

(B) 27.5m x 20m

RECORDERS Allaway
Myrcoough
Kelle

TOMKINSON RIVER

DATE 13.2.77

LOCATION 47.5km

STATION T3

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 12, 13, 18

QUADRAT 2

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	7.5	11 - 12 *	5	11.5	14 - 15
5	34.2	15 - 18	1e	22.6	15
1e	17.3	11 - 12	1e	20.4	15
2s	{18.0}	14 - 15	5	28.8	17
	{21.6}		5	30.0	17 - 18
2s	13.5	14	1e	26.2	14 - 15
2s	{20.6}	14	1e	16.4	14
	{16.3}		1e	{19.6}	14 - 15
2s	25.4	14 - 15		{7.6}	
1e	5.8	6 *	1e	24.5	17 - 18
5	12.7	14 - 15	1e	15.0	18
5	2.5	3 *	1e	23.8	14 - 15
5	17.5	15	1e	17.0	14 - 15
5	3.4	4 - 4.5 *			
5	7.4	11 - 12 *			
2s	{30.5}	15 - 17			
	{21.9}				
2s	17.3	15			
5	14.0	14			
2s	17.6	14			
2s	20.2	14			
2s	23.9	15 - 18			
2s	21.6	14 - 15			
5	33.8	18 - 19			
5	6.5	6 *			
5	4.8	6 *			
5	24.5	15 - 17			
5	16.7	15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 33.5m x 20m

(A) 9.5m x 20m

(A) 5m x 20m

(B) 76.5m x 20m

(B) 12.0m x 20m

(B) 8m x 20m

RECORDERS Allaway
Myercoough
Wells

TOMKINSON RIVER

DATE 13.2.77

LOCATION 47.5km

STATION T3

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 5, 7, 8, 12, 18

QUADRAT 3

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'le' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	15.8	14	5	17.2	15
5	10.2	11 *	5	21.3	15
5	2.7	3 *	2s	21.0	15
2s	15.2	14 - 15	le	18.2	15
2s	10.8	14	le	16.2	14 - 15
2s	8.3	14	le	18.3	14 - 15
2s	11.8	14	le	16.3	14 - 15
2s	17.5	14	le	5.7	8 *
5	20.5	14 - 15	le	17.6	14 - 15
2s	8.2	14	5	30.6	15 - 17
2s	8.3	12 *	5	23.2	17
le	13.2	14	le	12.2	14
5	23.3	15	le	17.0	14 - 15
2s	9.6	12 *	le	10.5	14 - 15
5	{ 17.7 21.2 19.4 15.8 }	14 - 15			
2s	10.0	12 *			
2s	7.4	11 - 12 *			
le	23.0	14 - 15			
5	16.0	14			
5	12.6	11 *			
5	10.2	14			
5	5.2	9 *			
2s	13.5	14			
2s	11.2	14			
2s	18.0	14 - 15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 36.5m x 20m

(A) 11.7m x 20m

(A) 4.5m x 20m

(B) 50m x 20m

(B) 25.5m x 20m

(B) 14m x 20m

RECORDERS Allaway
Myerscough
Wells

TOMKINSON RIVER

DATE 14.2.77

LOCATION 47.5km

STATION T3

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 13, 18

QUADRAT 4

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	30.0	15	5	13.8	15
2s	11.0	12 *	5	6.3	9 *
2s	16.4	14 - 15	2s	13.7	15
2s	15.5	14 - 15	5	26.3	15
2s	15.5	14 - 15	5	13.6	15
2s	{24.8}	15 - 17	5	12.6	14 - 15
	{16.4}		5	{19.2}	15
1e	26.3	14		{22.6}	
1e	17.7	14	1e	13.8	15 - 17
5	9.3	11 *	5	16.7	15
5	8.8	11 *	5	23.5	17
5	3.8	4 *	1e	28.7	15
5	8.1	11 *			
1e	23.4	14 - 15			
1e	19.8	14 - 15			
1e	8.8	14			
1e	16.6	14 - 15			
2s	15.8	14 - 15			
2s	7.2	11 - 12 *			
2s	12.4	14			
2s	23.9	15			
2s	10.8	14			
2s	38.8	17			
5	37.7	15 - 17			
1e	33.9	15 - 17			
5	15.7	15 - 17			
5	5.3	6 *			
1e	22.5	15 - 17			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 25m x 20m

(A) 9.0m x 20m

(B) 25.5m x 20m

(B) 30m x 20m

(B) 14.5m x 20m

RECORDERS Allaway
Hyercoough
Nalls

TOMKINSON RIVER

DATE 13.2.77

LOCATION 47.5km

STATION T3

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 5

1, 5, 7, 8, 13, 18

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	
2s	9.8	11	*	5	22.3	15	
5	19.7	15		5	14.7	14 - 15	
5	7.4	6	*	5	24.5	15 - 17	
5	3.8	6	*	5	19.0	15	
5	8.6	9	*	5	29.3	15	
5	7.4	8	*	5	18.9	15	
5	6.0	6	*	5	10.8	14 - 15	
5	9.8	8	*	1e	11.8	15	
5	6.2	6	*	1e	54.6	15 - 18	
5	6.8	8	*	1e	21.3	11	*
5	9.2	9	*	1e	15.7	15	
2s	6.3	11	*	1e	7.8	11	*
2s	9.8	11	*	1e	26.3	15	
1e	29.7	15 - 17		1e	28.3	15	
5	28.4	15 - 17		1e	12.6	15	
2s	16.0	15		1e	21.5	15	
2s	13.8	15					
2s	14.6	15					
2s	14.2	15					
2s	17.3	15					
2s	14.8	15					
2s	39.3	18 - 20					
2s	34.4	18 - 20					
2s	55.0	18 - 20					
2s	42.0	18 - 20					
1e	17.2	14 - 15					
1e	11.3	14 - 15					
5	14.8	15					

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 80m x 20m

(A) 2m x 20m

(A) 3.5m x 20m

(B) 109m x 20m

(B) 20m x 20m

(B) 16.0m x 20m

RECORDERS Allaway
Myerscough
Kelle

TOMKINSON RIVER

DATE 11.2.77

LOCATION 56km

STATION T4

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 18, 19, 20

QUADRAT 1

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	23.2	14 - 15	5	21.3	15
2s	44.0	18 - 20	2s	15.5	15 - 17
5	23.9	3.0 *	2s	14.8	15 - 17
5	23.0	14 - 15	2s	8.8	12 *
5	24.3	14 - 15	2s	19.2	14 - 15
2s	19.4	14 - 15	5	26.4	15 - 18
2s	27.5	broken off	1e	36.0	15 - 18
5	24.2	broken off	1e	19.0	15 - 18
5	29.0	15 - 17	5	24.3	15 - 18
5	8.2	11 *	2s	20.2	15 - 18
2s	21.4	broken off	1e	28.4	14 - 15
1e	13.5	11 *	1e	29.3	12 - 15
1e	21.2	14 - 15	1e	31.7	14 - 15
2s	10.3	9 - 11 *	1e	14.2	14 - 15
5	11.0	11 *	2s	14.2	14 - 15
5	9.7	11 - 12 *	2s	29.4	17
5	6.6	4 *	1e	24.2	14 - 15
5	4.8	4.5 *	1e	7.6	6 - 8 *
5	15.2	14 - 15	1e	24.8	14 - 15
2s	14.3	14 - 15	1e	25.9	15
5	23.2	15			
1e	13.3	8 - 9 *			
5	{42.8}	17 - 18			
	{16.0}				
2s	15.2	broken off			
5	30.2	broken off			
2s	34.3	18			
2s	10.7	broken off			

Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 46.0m x 20m

(A) 9.5m x 20m

(A) 31.5m x 20m

(B) 74.0m x 20m

(B) 29.5m x 20m

(B) 44m x 20m

RECORDERS Allaway
Myerscough
Kells

TOMKINSON RIVER

DATE 11.2.77

LOCATION 56km

STATION T4

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

7, 8, 12, 18

QUADRAT 2

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	32.2	14 - 15	1e	{10.7} {27.5}	14 - 15
1e	11.3	14	2s	25.0	15
1e	30.5	14 - 15	5	30.1	15
1e	{10.2} {8.2} {7.3} {3.6}	8 - 9 *	2s	34.6	15 - 18
1e	19.5	14	5	24.9	14
5	9.5	8 *	2s	36.3	18 - 20
5	9.2	8 *	2s	14.6	12 *
5	10.6	6 *	2s	23.8	21 *
5	8.8	6 *	5	14.0	12
5	6.2	4.5 *	5	31.5	15
5	5.7	6 - 8 *	5	40.6	15 - 17
5	6.2	6 *	5	21.8	15
1e	24.0	14	2s	49.7	18
5	19.3	15	5	23.5	14 - 15
2s	39.8	15 - 18	2s	47.3	18 - 21
1e	13.2	14	2s	20.6	15
1e	13.7	6 - 8 *	2s	42.2	18 - 21
1e	30.0	15 - 18	2s	47.2	18 - 21
1e	13.7	8 *			
5	35.4	15			
1e	27.8	14 - 15			
5	26.2	15 - 17			
5	54.6	broken trunk			
5	14.8	14			
1e	24.7	14 - 15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 14m x 20m

(A) 12.4m x 20m

(A) 55.5m x 20m

(B) 20m x 20m

(B) 53m x 20m

(B) 57.5m x 20m

RECORDERS Allaway
Hjercoough
Wells

TOMKINSON RIVER

DATE 11.2.77

LOCATION 56km

STATION T4

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 3

1, 8, 12, 18

* TREE NOT AT Canopy Heights
FIRST IO TREES OF SPECIES
AT All Inclusive Heights
FIRST IO TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	25.6	14	1e	16.7	14
2s	10.0	8 *	1e	{32.4}	14
5	7.3	4 *		{37.4}	
5	9.2	6 *	5	17.2	15 - 17
5	8.6	8 *	2s	10.2	8 *
5	6.8	6 *	2s	16.2	14
5	8.5	11 *	5	27.8	15 - 17
5	15.0	11 *	2s	39.5	18
5	9.3	broken off	5	38.8	15 - 18
5	10.2	11 *	2s	{26.7}	14 - 15
5	10.0	11 *		{39.2}	
5	16.0	14	2s	8.5	8 - 9 *
5	41.1	15 - 17	2s	4.0	broken
5	27.0	15 - 17	2s	15.3	11 *
5	35.2	15 - 17	2s	34.5	18
1e	50.4	15 - 18	1e	63.7	21
2s	16.7	14 - 15	2s	21.5	15
1e	9.9	8 *	2s	{25.6}	14 - 15
1e	3.8	4 *		{18.7}	
1e	13.1	14 - 15	2s	22.7	15
1e	7.3	8 *	2s	24.0	14 - 15
1e	8.0	9 *	1e	33.2	15 - 18
1e	17.4	14 - 15	1e	24.7	15 - 17
2s	55.7	18			
5	17.7	15 - 17			
5	52.1	15 - 17			
5	48.0	15 - 17			
1e	18.3	14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST IO TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 16.0m x 20m

(A) 7.5m x 20m

(A) 36.5m x 20m

(B) 55m x 20m

(B) 31.5m x 20m

(B) 48.5m x 20m

RECORDERS Allaway
Hyslopough
Wells

TOMKINSON RIVER

DATE 11.2.77

LOCATION 56km

STATION T4

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 4

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	29.3	14 - 15	2s	18.2	14
5	13.0	9 *	2s	15.2	14
5	13.0	9 - 11 *	5	21.4	15
1e	20.3	14 - 15	5	40.0	15
2s	20.5	15	5	34.8	15 - 17
5	32.6	15 - 17	2s	39.0	15 - 17
2s	44.9	18 - 21	2s	{26.8}	15 - 17
2s	41.5	18 - 21		{31.8}	
2s	48.4	18 - 21	2s	44.9	17 - 18
5	25.3	15	2s	64.5	17 - 18
5	27.0	15	5	1.7	3 *
5	34.8	15 - 17	5	2.5	3 *
5	27.5	18 - 21	5	6.3	6 *
5	34.3	15 - 17	5	2.8	4 *
1e	27.3	15 - 17	5	2.0	3 *
1e	{25.2}		1e	8.5	8 *
	{8.7}	17	1e	7.7	9 *
	{34.8}		1e	8.5	9 *
1e	{21.2}	14	1e	4.2	3 *
	{24.8}		1e	{13.2}	
	{8.8}			{12.2}	14
1e	{11.0}	14		{9.5}	
	{24.5}				
	{19.5}				
5	26.4	15 - 17			
1e	23.7	15 - 17			
1e	22.5	15 - 17			
1e	28.8	15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 17.5m x 20m

(A) 11.0m x 20m

(A)

(B) 24m x 20m

(B) 50.5m x 20m

(B) 69.0m x 20m

RECORDERS Allaway
Myerscough
Wells

LOCATION 56km

BANK L.H.B.

TOMKINSON RIVER

DATE 12.2.77

STATION T4

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 12, 18

QUADRAT 5

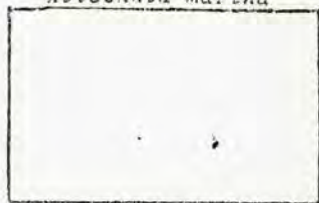
* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

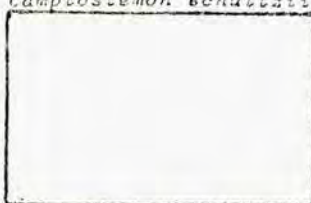
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
2s	34.2	14 - 15	1e	29.3	15 - 17
5	4.8	6 *	2s	23.5	14 - 15
5	9.6	6 *	2s	18.3	14 - 15
5	1.8	2.5 *	2s	43.2	15 - 17
5	4.7	6 *	2s	41.4	15
2s	{17.6}	12 - 14	1e	76.0	15
	{42.1}		5	16.9	14
2s	13.5	14 - 15	5	19.4	14 - 15
2s	16.9	14 - 15	5	{17.3}	15
2s	22.5	14 - 15		{49.9}	
5	10.5	9 *	5	{6.6}	15
1e	15.9	14 - 15		{20.5}	
5	10.8	9 *	5	22.3	14
5	19.6	14 - 15			
1e	13.5	14 - 15			
1e	7.7	9 *			
1e	16.0	14 - 15			
1e	17.2	15 - 17			
5	36.4	14 - 15			
1e	21.1	15 - 17			
1e	15.3	15			
1e	21.2	15			
1e	25.8	15 - 17			
5	18.3	14			
1e	13.1	11 *			
5	20.0	14 - 15			
5	22.5	15 - 17			
2s	16.6	15			

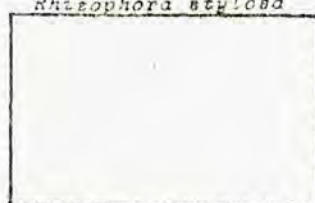
Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 12m x 20m

(A) 10m x 20m

(A)

(B) 26m x 20m

(B) 36m x 20m

(B) 23.5m x 20m

RECORDERS Hauser
Wells

TOMKINSON RIVER

DATE 2.8.77

LOCATION 65km

STATION T5

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 18, 20

QUADRAT 1

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	{65.8} {21.4}	18			
1e	53.3	18 - 20			
1e	98.0	18 - 20			
1e	102.0	15 - 17			
5	31.5	17			
5	21.3	6 *			
5	40.4	17 - 18			
5	20.2	8 *			
5	31.8	15			
5	27.8	15 - 17			
5	13.2	9 *			
5	17.8	15			
5	21.3	15			
5	28.4	17			
5	21.2	18			
5	38.0	17			
5	31.6	14 - 15			
1e	21.3	17			
1e	18.2	14 - 15			
1e	20.8	14 - 15			
1e	94.0	17			
1e	{14.7} {10.5} {16.7}	15			
1e	27.6	15 - 17			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 35m x 20m

(A)

(B)

55m x 20m

(B)

37m x 20m

(B)

RECORDERS
Hauser
Wells

TOMKINSON RIVER

DATE 2.8.77

LOCATION 65km

STATION T5

SANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 8, 18, 20

QUADRAT 2

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'Is' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	{19.8} {13.3}	14 - 15				
1e	17.0	14	*			
1e	27.4	14	*			
5	21.4	14 - 15				
1e	22.3	15				
1e	6.2	6	*			
5	23.7	17				
5	27.2	15 - 17				
5	13.2	14 - 15				
5	14.7	11	*			
5	15.4	14 - 15				
5	19.7	15 - 17				
5	28.2	15 - 17				
1e	7.5	8	*			
5	31.3	15				
1e	17.3	15				
1e	19.0	14 - 15				
1e	21.7	17				
1e	21.0	17				
5	60.3	15 - 17				
1e	65.4	17				
1e	79.0	15 - 17				
5	{30.7} {11.0}	14 - 15				
1e	31.0	18 - 20				
1e	42.8	18 - 20				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 20m x 20m

(A) 33m x 20m

(A)

(B) 60m x 20m

(B) 55m x 20m

(B)

RECORDERS Hauser
Wells

TOMKINSON RIVER

DATE 2.8.77

LOCATION 65km

STATION T5

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT
1, 7, 8, 16, 20, 21

QUADRAT 3

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

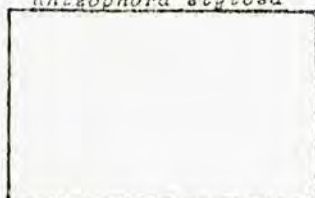
KEY
'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	{37.0}	15 - 17	5	20.4	15
	{39.7}		1e	56.0	18
1e	{19.2}	14 - 15	1e	78.0	18 - 20
	{21.6}		5	{29.0}	17
1e	30.8	15		{16.2}	
5	28.5	15	5	29.2	14 - 15
5	31.1	15			
1e	{49.7}	15			
	{39.5}				
5	27.4	15			
1e	37.4	15 - 17			
5	11.0	8 *			
5	13.9	8 *			
5	18.3	11 *			
5	17.3	12 *			
1e	{6.5}	6 *			
	{7.8}				
1e	7.7	6 *			
5	11.0	8 *			
1e	46.7	15 - 17			
1e	{48.7}	18			
	{40.3}				
1e	74.0	21			
5	22.5	11 *			
5	29.2	15			
5	29.4	17			
5	31.5	17			
5	34.2	18			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 48m x 20m

(A) 50m x 20m

(A)

(B) 60m x 20m

(B) 62m x 20m

(B)

RECORDERS Hauser
Wells

TOMKINSON RIVER

DATE 2.8.77

LOCATION 65km

STATION T5

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 4

1, 7, 8, 16, 18, 20

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	{37.5}	15 - 17			
	{41.8}				
1e	{23.4}	15 - 17			
	{9.8}				
	{9.0}				
1e	{19.0}	15 - 17			
	{29.2}				
1e	41.9	15 - 17			
1e	42.2	17 - 18			
1e	46.1	17 - 18			
1e	28.2	17			
1e	{30.6}	18			
	{29.7}				
1e	36.2	18			
1e	37.0	17 - 18			
5	33.2	17			
5	32.4	17			
5	14.6	8 *			
5	28.8	15			
5	28.6	17			
5	15.8	15			
5	17.8	9 *			
5	18.4	12 *			
5	13.8	14			
5	22.5	17			
5	38.8	15			
5	44.8	17			
5	28.1	15			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A)

(B) 18.5m x 20m

(B) 50m x 20m

(B)

RECORDERS Hauser
Wells

TOMKINSON RIVER

DATE 2.8.77

LOCATION 65km

STATION T5

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT
1, 7, 8, 18, 20, 21

QUADRAT 5

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2e' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	12.8	12 *			
1e	48.8	18			
5	43.9	18			
5	26.8	14 - 15			
5	13.8	9 *			
5	33.2	17			
5	38.6	17 - 18			
5	89.0	17 - 18			
1e	30.2	17			
1e	25.5	17			
1e	24.4	15 - 17			
1e	30.7	15 - 17			
1e	33.2	18			
1e	25.2	15 - 17			
1e	48.2	18 - 20			
5	21.3	15			
1e	75.0	18			
5	48.3	15			
1e	42.6	15			
5	49.6	15			
5	38.5	15			
5	37.0	15 - 17			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 70m x 20m

(A)

(B) 72m x 20m

(B) 78m x 20m

(B)

RECORDERS Gifford
Gifford
Wells

LOCATION 68km

BANK L.H.B.

TOMKINSON RIVER

DATE 8.4.77

STATION T6

OTHER PLANT SPECIES IN QUADRAT

1, 4, 8, 18, 20, 22

QUADRAT 1

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2e' *Rhinophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	{38.7 39.8 42.8 61.5}	14 - 15			
1e	68.2	18			
1e	48.5	15 - 18			
1e	12.4	8 *			
1e	22.4	15			
1e	7.2	6 *			
1e	38.4	15			
1e	22.4	14			
1e	64.2	15 - 18			
1e	13.0	8 *			
1e	104.0	18 - 21			
1e	{81.5 28.2}	15 - 18			
1e	41.8	15			

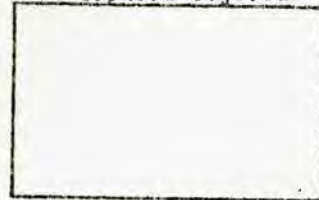
Avicennia marina



Camptostemon schultzei



Rhinophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 40m x 20m

(A)

(A)

(B) 300m x 20m

(B)

(B)

RECORDERS Gifford
Gifford
Wells

LOCATION 68km

BANK R.H.B.

TOMKINSON RIVER

DATE 8.4.77

STATION T6

OTHER PLANT SPECIES IN QUADRAT

1, 4, 8, 18, 20, 22

QUADRAT 2

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	41.7	15			
1e	105.0	15			
1e	103.0	15 - 18			
1e	50.4	14			
1e	29.7	11 - 12 *			
1e	(27.5)	11 - 12 *			
	(24.8)				
1e	17.0	11 - 12 *			
1e	(39.2)	15			
	(27.0)				
1e	33.9	14 - 15			
1e	78.0	21			
1e	30.4	15			
1e	27.3	15			
1e	32.0	18			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 100m x 20m

(A)

(A)

(B) 120m x 20m

(B)

(B)

RECORDERS

Gifford
Gifford
Wells

TOMKINSON RIVER

DATE 8.4.77

LOCATION 68km

STATION T6

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 8, 18, 20, 22

QUADRAT 3

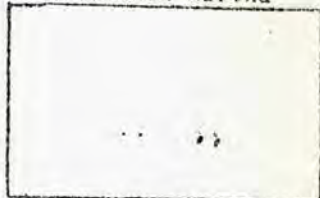
TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2a' *Rhinophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	64.5	20				
1e	8.7	8 *				
1e	21.6	15				
1e	45.2	18 - 21				
1e	32.8	15 - 18				
1e	42.4	18 - 21				
1e	21.6	12 *				
1e	27.8	15				
1e	23.3	12 - 14 *				
1e	75.2	18 - 21				
1e	70.0	15				
1e	64.7	14 - 15				
1e	79.4	20				

Avicennia marina



Camptostemon schultzei



Rhinophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 25m x 20m

(A)

(A)

(B) 40m x 20m

(B)

(B)

RECORDERS

Gifford
Gifford
Wells

TOMKINSON RIVER

DATE

8.4.77

LOCATION

68km

STATION

T6

BANK

L.H.B.

OTHER PLANT SPECIES IN QUADRAT

8, 18, 20, 22

QUADRAT

4

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2a' *Rhinophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	81.0	18 - 20			
1e	73.2	18			
1e	{34.5}	15			
	{46.8}				
1e	{58.7}				
	{31.7}	18			
	{19.3}				
1e	24.3	14 - 15			
1e	{30.5}	14 - 15			
	{26.4}				
1e	59.2	18			
1e	61.3	15			
1e	{21.6}	14 - 15			
	{36.8}				
1e	32.3	14 - 15			

Avicennia marina

Camptostemon schultzei

Rhinophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A)

(B)

400m x 20m

(B)

(B)

RECORDERS Gifford
Gifford
Wells

LOCATION 68km

BANK R.H.B.

TOMKINSON RIVER

DATE 8.4.77

STATION T6

OTHER PLANT SPECIES IN QUADRAT

8, 18, 20, 22, 23, 24

QUADRAT 5

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	{50.7}	15 - 17			
	{46.3}				
	{44.8}				
1e	46.4	15 - 17			
1e	21.2	11 - 12 *			
1e	{63.8}				
	{30.0}	15			
	{105.0}				
1e	37.9	14 - 15			
1e	24.4	12 - 14 *			
1e	77.4	15 - 17			
1e	{69.6}	17 - 18			
	{47.5}				
1e	32.4	14			
1e	34.4	14			
1e	25.3	12 *			
1e	73.1	15			
1e	{16.5}				
	{61.5}	15			
	{53.2}				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 400m x 20m

(A)

(A)

(B) 550m x 20m

(B)

(B)

RECORDERS Allaway
Myerscough
Wells

MUNGARDOBOLO CREEK

DATE 15.2.77

LOCATION 17.5km

STATION M1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 1

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

3, 6, 7, 13, 14, 15

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	16.0	14	2s	11.4	14
5	4.0	4 *	1e	16.3	14
5	2.8	2.5 *	1e	20.1	14
5	15.6	14	5	12.2	14
5	10.3	9 *	5	10.7	12 - 14
5	19.0	14	1e	31.3	14
2s	13.2	14	1e	25.2	14
2s	16.7	14	1e	24.6	15
5	17.5	14	1e	34.2	15
5	3.2	14	1e	25.7	15
5	9.2	14	1e	22.0	15
5	10.8	14			
5	9.0	14			
5	14.2	14			
5	18.8	14			
2s	13.2	14			
2s	5.8	5 *			
1e	14.5	14			
2s	12.5	14			
2s	14.4	14			
2s	11.6	14			
2s	10.2	13			
2s	13.8	14			
2s	14.0	14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 2.5m x 20m

(A) 8.3m x 20m

(B) 111.5m x 20m

(B) 9.0m x 20m

(B) 9.0m x 20m

RECORDERS Allaway
Myercoough
Nelle

MUNGARDOBOLO CREEK

DATE 15.2.77

LOCATION 17.5km

STATION M1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT
3, 8, 10, 13, 15, 17

QUADRAT 2

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2a' *Rhinophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	
5	9.2	11 - 12	*	1e	15.2	14	
1e	11.0	11	*	1e	12.8	14	
2s	13.7	14		1e	18.3	14	
1e	12.4	14		5	8.2	11	*
1e	12.4	14		5	6.5	11	*
1e	8.9	6	*	5	9.5	14	
1e	6.3	4.5	*	5	8.4	11 - 12	*
1e	5.4	3	*	5	6.5	8	*
1e	4.3	4	*	5	6.7	8	*
2s	9.8	14		5	5.5	8	*
2s	5.3	11	*	5	7.7	8	*
2s	6.7	11	*	5	6.7	8	*
1e	10.8	14		5	9.2	14	
2s	9.2	14		5	9.2	14	
2s	{15.8}	14		5	8.4	14	
	{13.6}			5	10.5	14	
2s	15.0	14		1e	15.3	12 - 14	
2s	19.5	14		5	11.2	14	
2s	10.7	14		5	13.6	14	
2s	9.8	14		5	19.8	14	
2s	22.8	15		5	20.0	14	
1e	25.2	14 - 15		5	17.0	14	
2s	14.2	14		1e	11.3	14	
1e	(23.3)	14					
	(8.6)						

Avicennia marina

Camptostemon schultzei

Rhinophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 10.5m x 20m

(A) 29.0m x 20m

(A) 5.0m x 20m

(B) 39.0m x 20m

(B) 85.0m x 20m

(B) 7.5m x 20m

RECORDERS Allaway
Myerscough
Wells

MUNGARDOBOLO CREEK

DATE 15.2.77

LOCATION 17.5km

STATION M1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 3, 8, 13, 14

QUADRAT 3

* TREE NOT AT Canopy Height
FIRST IO TREES OF SPECIES
AT ALL Inclusive Heights
FIRST IO TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	
2s	8.9	9	*	2s	7.9	9 - 11	*
2s	8.0	9	*	2s	18.8	14	
2s	15.7	14		1e	19.0	14	
2s	7.3	11	*	1e	14.0	14	
2s	13.0	14		1e	12.0	14	
2s	8.8	14		2s	11.0	14	
2s	8.6	11 - 12	*	2s	15.9	14 - 15	
5	10.0	11	*	2s	12.9	14	
5	9.3	11 - 12	*	2s	9.9	14	
1e	23.4	15		2s	17.2	14 - 15	
1e	3.8	4.5	*	5	6.3	9	*
1e	16.8	14 - 15		5	6.5	9	*
1e	22.0	14 - 15		5	6.4	9	*
1e	13.0	14		5	4.8	8	*
1e	9.8	11	*	5	4.3	6	*
5	13.7	14		5	10.5	12 - 14	
1e	6.2	14		5	10.3	14	
1e	16.2	14 - 15		5	11.3	14 - 15	
1e	13.2	9	*	5	22.3	15	
2s	10.3	14		5	9.5	14	
5	7.8	11	*	5	18.3	15	
1e	7.7	14		5	16.8	15	
5	13.0	14		5	12.2	14 - 15	
2s	4.9	6	*				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST IO TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A) 7.0m x 20m

(A) 22.8m x 20m

(A) 5.5m x 20m

(B) 11.3m x 20m

(B) 73.0m x 20m

(B) 18.5m x 20m

RECORDERS Allaway
Myercoough
Wells

MUNGARDOBOLO CREEK

DATE 15.2.77

LOCATION 17.5km

STATION M1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT
3, 6, 7, 13, 14, 15

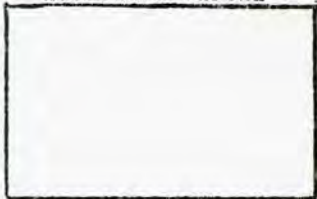
QUADRAT 4

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

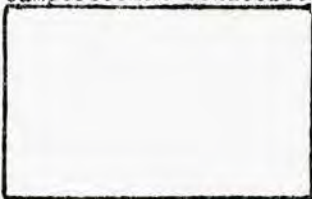
KEY
's' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	19.7	14	1e	17.3	14
2s	{17.6}	14	5	13.0	14
	{14.3}		5	13.5	14
2s	19.3	12 - 14	1e	11.4	14
5	13.0	14	1e	10.5	11 - 12 *
5	6 - 7	8 *	1e	32.9	14 - 15
2s	16.0	12 - 14	1e	22.8	14 - 15
2s	29.8	14	1e	31.9	14 - 15
2s	11.2	14	1e	48.8	15
2s	17.8	14	1e	{18.4}	14
2s	7.2	12 - 14		{6.0}	
2s	7.2	11 - 12 *	1e	41.4	15 - 17
2s	17.0	14	1e	21.6	14
2s	{19.8}	12 - 14			
	{22.5}				
5	21.7	14 - 15			
5	16.2	14 - 15			
1e	15.3	14			
5	13.3	14			
5	17.2	14 - 15			
5	9.8	14			
5	17.4	14			
5	9.2	12 *			
5	11.6	14			

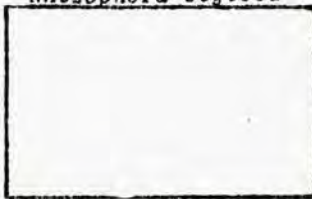
Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 135.5m x 20m

(A) 56.0m x 20m

(A) 12.0m x 20m

(B) 137.0m x 20m

(B) 59.5m x 20m

(B) 12.0m x 20m

RECORDERS Allaway
Myercoough
Wells

MUNGARDOBOLO CREEK

DATE 15.2.77

LOCATION 17.5km

STATION M1

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT
7, 8, 10, 13, 14, 15

QUADRAT 5

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	3.4	3	*	5	16.6	14 - 15
2s	25.0	14		5	23.8	14 - 15
5	14.0	14		1e	36.2	15 - 18
5	6.3	8	*	5	17.5	14
2s	{14.0}	14		5	14.9	14
	{11.3}			5	16.7	14 - 15
2s	25.8	14 - 15		1e	30.0	14 - 15
5	6.3	8	*	1e	35.8	14 - 15
5	8.5	9	*	1e	42.3	15 - 17
5	8.0	9	*	1e	39.2	17 - 18
1e	20.8	14		1e	69.0	15 - 18
5	11.2	14		1e	12.5	14
2s	23.6	14		1e	20.2	14
2s	17.2	14		1e	14.7	14 - 15
2s	13.0	14				
2s	9.8	14				
2s	{13.8}	14				
	{9.3}					
2s	8.8	11	*			
2s	13.4	14				
2s	16.9	14				
5	11.4	14 - 15				
5	7.9	14				
5	17.0	14 - 15				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 21.5m x 20m

(A) 9.0m x 20m

(B) 128.5m x 20m

(B) 40.0m x 20m

(B) 11.5 x 20m

RECORDERS Allaway
Myerscough
Kells

MUNGARDOBOLO CREEK

DATE 12.2.77

LOCATION 22km

STATION M2

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 6, 7, 8, 10, 13, 15

QUADRAT 1

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	12.8	12 - 14	2s	20.6	12 - 14
2s	11.0	12	1e	{21.3}	15
2s	14.7	12		{26.7}	
1e	{23.5}	12 - 14	1e	17.6	12 - 14
	{20.2}		1e	{17.0}	12 - 14
5	4.5	4 - 5 *		{14.4}	
5	5.7	6 *	5	11.0	11 - 12
5	4.7	6 *	5	7.8	11
5	5.1	6 *	5	7.8	11 - 12
2s	3.2	3 *	5	5.7	11
5	4.8	6 *	5	9.8	11
5	5.5	6 *	5	13.3	12 - 14
5	6.2	8 *	5	9.6	11 - 12
5	8.5	6 *	5	10.2	12 - 14
2s	15.8	12	5	13.8	12
2s	11.2	12	1e	19.8	12 - 14
2s	10.2	12	1e	17.8	12 - 14
2s	11.4	11 - 12	1e	7.5	12 - 14
2s	5.4	8 *	1e	{19.9}	12 - 14
2s	4.5	8 *		{13.5}	
2s	5.4	6 *	1e	14.8	11
2s	13.8	11 - 12	5	21.0	12 - 14
2s	14.8	11 - 12			
2s	14.6	12 - 14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 8.5m x 20m

(A) 11.3m x 20m

(B) 54m x 20m

(B) 70.7m x 20m

(B) 13.5m x 20m

RECORDERS Allaway
Myerscough
Kelle

MUNGARDOBOLO CREEK

DATE 12.2.77

LOCATION 22km

STATION M2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

6, 7, 10, 13, 14, 15

QUADRAT 2

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	21.5	12 - 14	1e	{ 23.6 } { 11.0 } { 12.2 }	12 - 14
2s	15.4	12 - 14	2s	9.3	12 - 14
5	20.3	12	2s	12.2	14
5	14.0	12 - 14	1e	13.6	12
2s	19.7	12	1e	22.3	11 *
2s	15.6	8	5	12.4	11 - 12
5	19.2	14	5	12.4	11 - 12
2s	18.2	12	5	14.0	14
2s	12.3	11 - 12	5	14.0	12 - 14
2s	{ 14.7 } { 10.0 }	12 - 14	1e	{ 36.6 } { 30.3 } { 18.5 }	11 - 12
5	14.4	14	1e	10.5	9 *
5	7.1	9	1e	13.1	11 - 12
5	13.7	15	1e	13.8	11 - 12
2s	{ 7.2 } { 7.8 }	9 *	1e	30.8	14
2s	{ 12.2 } { 18.2 } { 16.3 }	12 - 14	1e	{ 27.8 } { 8.3 }	12 - 14
1e	5.5	8 *			
2s	23.3	14			
2s	13.5	12 - 14			
5	16.0	14			
1e	{ 41.3 } { 14.3 } { 12.2 }	14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 51.0m x 20m

(A) 20.5m x 20m

(A) 10.0m x 20m

(B) 55m x 20m

(B) 21.5m x 20m

(B) 15.0m x 20m

RECORDERS Allaway
Myaracough
Kells

MUNGARDOBOLO CREEK

DATE 12.2.77

LOCATION 22km

STATION M2

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT
6, 7, 11, 13, 14, 15

QUADRAT 3

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	3.2	3 - 4.5	*	2s	16.0	14 - 15
2s	4.0	8	*	1e	49.4	14
2s	5.8	8 - 9	*	1e	24.6	14
2s	8.5	8 - 9	*	5	11.0	14
2s	15.8	12 - 14		2s	12.8	14
5	(12.5)	14		5	16.0	14
	{ 8.0 }			1e	84.0	15
2s	5.8	11	*	5	9.8	9
2s	14.2	14		5	10.9	14
2s	12.2	14		1e	71.0	15 - 18
2s	12.5	14		5	13.6	14
2s	11.0	14		5	22.2	14 - 15
1e	6.0	8 - 9	*	5	14.8	11 - 12
1e	6.0	8	*	5	22.5	14
1e	6.5	8	*	5	19.6	14 - 15
1e	5.4	8	*	5	13.2	14 - 15
1e	7.6	8	*	1e	21.7	14
1e	5.0	8	*	1e	15.1	14
1e	3.8	6	*	1e	19.4	14 - 15
1e	10.5	8 - 9	*	1e	15.3	14
1e	3.2	4.5	*	1e	16.2	13
2s	8.5	14		1e	15.2	14
2s	20.5	14				
2s	15.3	14				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A) 17.5m x 20m

(A)

(A) 23m x 20m

(B) 127.5m x 20m

(B) 116m x 20m

(B) 52m x 20m

RECORDERS Allaway
Myerough
Nells

MUNGARDOBOLO CREEK

DATE 12.2.77

LOCATION 22km

STATION M2

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

5, 6, 8, 10, 11

QUADRAT 4

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	3.3	3 *	2s	10.2	14
1e	4.9	4 *	1e	15.3	12 - 14
1e	7.3	4 *	2s	14.8	14
1e	4.6	4 *	5	11.2	14
1e	10.8	4 - 4.5 *	2s	12.6	14
1e	{42.7}	12	5	10.4	12
	{7.3}		2s	4.8	8 *
5	10.0	14	2s	16.2	12
5	19.4	14	2s	11.6	14
5	12.3	12 - 14	2s	19.8	14
5	11.8	12 - 14	1e	16.2	14
5	15.0	14	1e	5.6	4 *
2s	12.9	14	1e	18.4	14
5	22.7	14	5	10.0	14
1e	8.2	12	1e	25.2	14
5	12.2	11 *	5	18.3	14 - 15
5	12.5	11 *	1e	21.0	14
5	3.8	3 *	1e	28.6	14
2s	6.3	11 *	1e	21.3	14 - 15
5	7.4	11 *			
1e	61.0	15			
2s	17.8	14			
2s	14.2	14			
2s	15.0	14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 53.0m x 20m

(A) 21.0m x 20m

(A) 40.0m x 20m

(B) 106m x 20m

(B) 61.5m x 20m

(B) 41.5m x 20m

RECORDERS Allanay
Myercoough
Wells

MUNGARDOBOLO CREEK

DATE 12.2.77

LOCATION 22km

STATION M2

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

5, 6, 7, 8, 10, 13, 14,
15

QUADRAT 5

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'5' *Camptostemon schultzei*
'2a' *Rhinophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	13.5	14	5	7.3	6 - 8 *
5	17.2	14	5	4.3	4.5 *
2s	11.2	12 - 14	5	7.8	9 *
1e	{19.4}	14	5	12.8	8 *
	{35.3}		2s	16.7	14
1e	12.7	11 - 12	2s	18.7	14
1e	13.1	11 - 12	2s	14.6	14
1e	5.5	3 *	5	14.3	12 - 14
1e	5.8	3 *	2s	16.7	14
1e	{22.3}	12 - 14	2s	17.5	14
	{19.7}		2s	14.7	14
1e	{31.6}	11 - 12	5	6.4	8 - 9 *
	{15.2}		2s	14.8	14 - 15
1e	14.0	8 *	5	14.5	14
1e	{34.4}	14	5	5.5	4.5 *
	{30.3}		2s	15.0	14
1e	13.1	4.5 *	5	12.5	14
1e	42.7	14	5	12.7	12 - 14
1e	{15.5}	11 - 12	5	16.6	12 - 14
	{17.3}		1e	{37.0}	
2s	5.4	8 *		{14.0}	12 - 14
2s	2.7	6 *		{23.6}	
2s	5.7	9 - 11 *		{38.7}	
5	5.3	6 - 8 *	1e	21.3	11 - 12

Avicennia marina

Camptostemon schultzei

Rhinophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A)

(B)

(B)

(B)

BANK L.H.B.

DATE 12.2.77

STATION M2

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 5

• TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'8' *Rhizophora stylosa*
'1e' *Avicennia marina*

[illegible]

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 17m x 20m

(A) 34.0m x 20m

A) 25m x 20m

(B) 56.5m x 20m

(B) 87.5m x 20m

(B) 26.5m x 20m

RECORDERS Allaway
Myercoough
Kells

MUNGARDOBOLO CREEK

DATE

LOCATION 23km

STATION M3

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 6, 7, 8, 14

QUADRAT 1

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

's' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	6.8	9	*	2s	16.6	14
1e	12.9	14		2s	15.0	14
2s	16.7	14		2s	10.5	14
1e	9.3	9 - 12		2s	10.	14
2s	3.0	6	*	5	9.8	12 - 14
2s	10.5	11		5	13.9	11
2s	5.5	6	*	2s	8.5	14
1e	9.5	8	*	5	12.9	14 - 15
5	15.5	14		5	12.9	14
5	9.0	14		5	13.3	14 - 15
5	14.7	14 - 15		1e	3.4	4.5
2s	9.2	14		1e	56.5	14 - 15
5	13.0	14		1e	15.3	14 - 15
5	4.2	6	*	1e	15.0	9 - 11
2s	22.5	14 - 15		1e	21.9	14 - 15
2s	5.5	8	*	1e	10.3	12
1e	4.5	8	*	1e	(22.8)	
1e	5.4	8	*		(20.0)	15 - 18
5	12.2	14			(18.4)	
2s	15.0	14		1e	(18.5)	
5	(15.0)	14			(37.3)	14
	(13.2)				(10.4)	
1e	14.5	12 - 14		1e	70.0	15
2s	31.7	15 - 17				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 57.5m x 20m

(A) 15.5m x 20m

(A) 9.0m x 20m

(B) 138.0m x 20m

(B) 39.0m x 20m

(B) 20m x 20m

RECORDERS Allaway
Myercoough
Wells

LOCATION 23km

BANK R.H.B.

MUNGARDOBOLO CREEK

DATE

STATION M3

OTHER PLANT SPECIES IN QUADRAT

1, 6, 7, 8, 10, 13,
15

QUADRAT 2

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	4.8	6	*	5	12.4	14
2s	12.7	14		2s	29.5	15 - 18
5	8.6	11	*	5	11.4	14 - 15
5	7.8	11	*	2s	10.5	14
5	6.4	6	*	2s	9.5	14 - 15
2s	9.3	14		5	15.2	14 - 15
1e	52.0	15 - 17		1e	{80.0}	18
2s	9.2	14			{16.9}	
2s	10.5	14		1e	{71.7}	
5	14.8	14			{8.4}	18 - 20
5	7.0	11 - 12	*		{6.9}	
5	13.5	14 - 15		1e	{49.0}	
1e	30.5	15			{14.0}	15 - 18
1e	{30.7}	15			{6.0}	
	{5.2}			1e	{59.3}	
2s	5.8	11 - 12	*		{6.0}	18
2s	4.7	12	*		{8.0}	
5	8.4	14 - 15		5	9.5	14
2s	23.2	15 - 17		5	16.9	15 - 18
2s	8.0	11 - 12	*	1e	51.4	18 - 20
5	4.8	6 - 8	*	5	16.3	15
5	24.7	14		1e	76.2	18
2s	10.9	12 - 14		1e	{44.2}	15
2s	11.7	14			{27.3}	

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 29.0m x 20m

(A) 29.0m x 20m

(B) 100.5m x 20m

(B) 100.0m x 20m

(B) 35.5m x 20m

RECORDERS Allaway
Myercoough
Wells

MUNGARDOBOLO CREEK

DATE 7.8.77

LOCATION 23km

STATION M3

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT
1, 6, 7, 8, 13, 14, 15

QUADRAT 3

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
5	15.8	12	1e	36.3	14
2s	18.5	12 - 14	1e	39.0	14
1e	50.4	14	1e	54.0	14
2s	10.3	12	5	{10.2}	12 - 14
2s	18.3	12 - 14		{12.2}	
2s	14.1	12	5	8.2	12
2s	19.8	12 - 14	5	21.0	14
2s	33.2	14	5	15.8	14
2s	13.1	12			
2s	30.5	14			
5	23.3	14			
1e	{22.5}	12			
	{14.8}				
1e	49.4	12 - 14			
1e	46.7	12 - 14			
5	14.7	12 - 14			
5	16.0	12 - 14			
5	13.2	12			
2s	21.8	12 - 14			
2s	31.9	14			
5	23.3	14			
1e	60.3	14			
1e	55.0	14			
1e	36.6	14			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A)

(A)

(B) 60.0m x 20m

(B) 75.0m x 20m

(B) 40m x 20m

RECORDERS Allaway
Myerrough
Wells

MUNGARDOBOLO CREEK

DATE 7.8.77

LOCATION 23km

STATION M3

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 7, 13, 14, 15

QUADRAT 4

* TREE NOT AT Canopy Heights
FIRST TO TREES OF SPECIES
AT ALL Inclusive Heights
FIRST TO TREES OF SPECIES
AT Forest Canopy Height

KEY

's' *Camptostemon schultzei*
'e' *Rhizophora stylosa*
'le' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	15.1	14		le	34.1	12 - 14
2s	21.0	14		le	67.0	12
2s	23.0	14		le	33.5	12
2s	16.2	12 - 14		le	{ 37.4 } { 18.5 }	12
5	19.7	14		le	72.0	12 - 14
5	17.2	9	*	le	60.8	14
5	14.6	9	*	le	52.3	14
5	13.5	8	*	le	24.2	12 - 14
5	10.8	12		5	13.6	12 - 14
5	17.9	14				
5	19.7	14				
2s	10.0	9	*			
2s	9.6	9	*			
5	19.8	14				
5	14.1	12 - 14				
5	14.2	12 - 14				
2s	23.8	14				
2s	23.5	14				
2s	24.8	12 - 14				
5	14.3	14				
2s	17.1	14				
le	{ 31.0 } { 18.5 }	12 - 14				
2s	10.0	11	*			
2s	31.5	12 - 14				
5	18.2	14				
2s	19.0	14				
le	{ 37.4 } { 26.2 }	14				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A) 40.0m x 20m

(A) 35.0m x 20m

(A) 45.0m x 20m

(B) 90m x 20m

(B) 105m x 20m

(B) 50.0m x 20m

RECORDERS Allanay
Myrceboagh
Kelle

MUNGARDOBOLO CREEK

DATE 7.8.77

LOCATION 23km

STATION M3

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 10, 11, 13, 14, 15

QUADRAT 5

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Including Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	15.2	12 - 14	2s	19.0	12 - 14
2s	14.7	12 - 14	1e	54.0	14
2s	19.0	12 - 14	2s	6.7	8 *
2s	15.0	12 - 14	2s	18.2	12 - 14
1e	{79.0}	14	2s	13.6	12 - 14
	{16.8}	14	5	13.0	12 - 14
1e	71.5	14	5	21.0	12 - 14
1e	{48.5}	14			
	{15.0}	14			
1e	58.5	14			
5	13.2	12			
5	9.8	12			
2s	30.7	14			
5	27.8	14			
2s	11.8	12			
1e	52.0	14			
5	17.3	14			
5	17.5	12 - 14			
5	14.2	12 - 14			
5	18.8	14			
2s	21.3	14			
1e	75.5	14			
1e	{27.2}	14			
	{44.3}	14			
1e	52.0	14			
2s	16.6	12 - 14			
1e	{13.0}	14			
	{38.1}				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Including Heights (B) At the Canopy Height

(A)

(A)

(A) 90m x 20m

(B) 60.0m x 20m

(B) 110.0m x 20m

(B) 95.0m x 20m

RECORDERS Allaway
Myerscough
Wells

MUNGARDOBOLO CREEK

DATE 9.2.77

LOCATION 24km

STATION M4

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

6, 7, 11, 13, 14

QUADRAT 1

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	17.4	12 - 14	1e	28.3	14
2s	12.2	12	2s	14.0	11 - 12
2s	6.4	11	2s	15.0	11 - 12
2s	8.3	11	5	18.4	12
2s	17.7	11 - 12	1e	34.5	14
5	16.9	12	5	28.1	15
2s	6.4	9 *	5	22.5	15
2s	20.2	12	5	13.5	14
2s	6.3	11			
1e	44.5	12 - 14			
1e	{ 9.6 }	11 - 12			
	{ 29.5 }				
1e	31.7	12 - 14			
5	17.2	12 - 14			
1e	39.7	12 - 14			
1e	39.8	12 - 14			
1e	27.8	12			
5	15.3	12 - 14			
2s	8.8	11			
2s	5.3	8 *			
2s	8.8	11			
5	10.0	11			
5	13.5	11			
5	14.4	6 *			
1e	54.5	14 - 15			
1e	6.6	8 *			
1e	9.8	11 - 12			
1e	7.7	9 *			

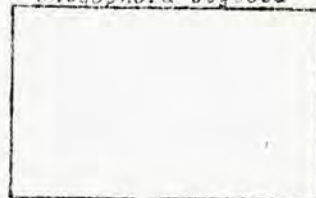
Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



LENGTHS OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 33.5m x 20m

(A) 48.5m x 20m

(A) 29.5m x 20m

(B) 50.5m x 20m

(B) 52.5m x 20m

(B) 41.5m x 20m

RECORDERS Allaway
Hyercough
Kells

MUNGARDOBOLO CREEK

DATE 9.2.77

LOCATION 24km

STATION M4

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

6, 7, 11, 14

QUADRAT 2

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

's' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'Je' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	8.8	8 *	5	10.5	12
1e	17.7	11	5	13.3	12 - 14
1e	22.5	11 - 12	5	{18.8}	14
1e	10.4	11 - 12		{12.0}	
1e	8.5	11 - 12	2s	6.4	9 *
1e	3.0	4 *	2s	12.8	12
1e	32.6	12 - 14	2s	11.0	12
1e	22.4	12 - 14	2s	9.2	12
1e	25.8	12 - 14	2s	18.5	12
1e	5.2	4 *	2s	5.2	6 *
1e	25.5	12 - 14	2s	3.8	4 *
1e	15.7	12	2s	26.4	14 - 15
2s	13.2	12			
2s	13.0	12			
2s	13.4	12			
1e	9.9	11 - 12			
2s	8.4	11			
5	23.2	12			
5	25.7	14			
5	11.8	12			
5	11.3	12			
2s	24.2	14 - 15			
5	9.2	11 *			
5	17.2	12			
5	23.2	14			
5	{19.2}	11 - 12			
	{9.8}				
5	11.6	11 *			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

LENGTHS OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 9.0m x 20m

(A) 34.2m x 20m

(A) 80.0m x 20m

(B) 14.5m x 20m

(B) 44.0m x 20m

(B) 99.5m x 20m

RECORDERS Allaway
Myercoough
Kells

MUNGARDOBOLO CREEK

DATE 9.2.77

LOCATION 24km

STATION M4

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

6, 7, 11, 13, 14

QUADRAT 3

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	{19.4 5.7 51.4}	12 - 14	5	13.9	12 - 14
2s	11.2	11	5	4.8	8 *
2s	9.4	11	2s	5.7	9 *
5	10.2	11	2s	6.5	8 *
5	27.3	12	2s	{5.5 6.3}	8 *
1e	2.2	3 *	2s	4.0	6 *
1e	{15.7 37.5}	14	5	22.0	14
5	31.3	14	2s	9.8	11
2s	14.8	12	2s	14.8	11
1e	25.3	12	2s	9.3	11
1e	15.0	12	2s	13.2	11
1e	12.4	11 - 12	2s	10.2	11
1e	17.3	12			
1e	17.5	12			
1e	92.5	12			
1e	53.4	12			
1e	54.0	14			
5	23.8	14			
5	14.8	14			
5	15.2	12 - 14			
5	17.7	14			
5	16.6	12			
2s	11.8	12			
2s	11.0	11			
2s	6.2	8 *			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 47.0m x 20m

(A) 98.5m x 20m

(A) 100m x 20m

(B) 47.0m x 20m

(B) 123.0m x 20m

(B) 241m x 20m

RECORDERS Allaway
Myerscough
Wells

MUNGARDOBOLO CREEK

DATE 10.2.77

LOCATION 24km

STATION M4

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 6, 7, 14, 15

QUADRAT 4

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

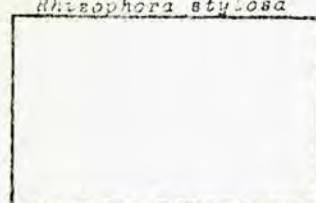
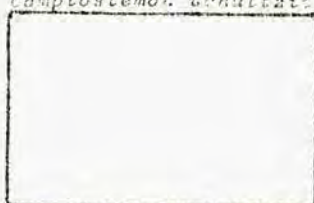
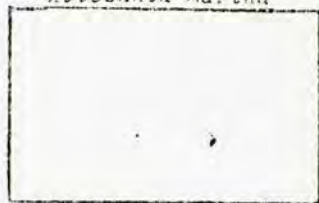
KEY
'5' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	21.7	14	1e	24.7	12 - 14
1e	{16.8}	14	1e	15.7	12 - 14
	{18.5}		1e	16.4	12 - 14
2s	5.3	8 *	1e	25.3	12 - 14
2s	12.9	12	5	16.7	12 - 14
2s	10.0	12 - 14	5	16.2	12
2s	6.2	12	5	9.2	8 *
2s	15.3	12 - 14	5	23.3	12 - 14
5	11.8	12 - 14	5	10.7	11 - 12
2s	19.8	12 - 14	5	11.2	12
5	9.2	12			
2s	10.4	12			
2s	9.3	11 - 12			
5	3.8	6 *			
2s	9.5	11 - 12			
2s	7.4	9 *			
5	15.2	14 *			
1e	7.5	11 *			
2s	16.2	14			
2s	10.2	14			
5	11.3	14			
5	17.3	14			
1e	18.5	11			
1e	8.4	11 - 12			
1e	18.4	12			
1e	5.3	6 *			
1e	{22.7}	9 - 11			
	{73.7}				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) ALL Inclusive Heights (B) At the Canopy Height

(A) 13.5m x 20m

(A) 23.5m x 20m

(A) 7.0m x 20m

(B) 14.0m x 20m

(B) 33.5m x 20m

(B) 9.0m x 20m

RECORDERS Allaway
Myerscough
Wells

MUNGARDOBOLO CREEK

DATE 10.2.77

LOCATION 24km

STATION M4

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

6, 7, 14, 15

QUADRAT 5

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
2s	11.8	11 - 12	5	{17.2}	11
1e	14.3	11		{13.5}	
1e	19.8	11 - 12	5	12.6	8 *
2s	11.7	11	5	17.2	14 - 15
2s	16.3	12 - 14	5	20.5	14
2s	8.6	12	5	21.9	14
5	17.7	12 - 14			
2s	10.4	11 - 12			
5	15.2	12 - 14			
2s	18.8	12			
2s	11.4	12			
5	16.8	12 - 14			
2s	17.2	12 - 14			
1e	15.5	12 - 14			
1e	11.7	12			
1e	15.2	12 - 14			
1e	17.2	12 - 14			
1e	19.8	12 - 14			
1e	21.6	12 - 14			
1e	17.5	12			
5	16.6	14			
1e	16.4	12 - 14			
2s	17.3	14			
2s	{17.5}	12 - 14			
	{19.7}				
5	18.2	12			
5	8.3	9 *			
5	13.8	11			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A)

(A) 58.5m x 20m

(A)

(B) 13.5m x 20m

(B) 112.5m x 20m

(B) 15.5m x 20m

RECORDERS Allanay
Myaracough
Kells

MUNGARDOBOLO CREEK

DATE 9.2.77

LOCATION 25km

STATION M5

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

6, 7, 8, 11, 13, 14

QUADRAT 1

TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
5	23.8	14 - 15	2s	9.3	9 *
2s	11.2	9 *	5	15.6	11
5	16.0	12	2s	7.9	8 *
5	25.0	11	2s	14.4	11
2s	17.3	14	2s	10.2	11 - 12
5	9.2	8 *	2s	15.3	11 - 12
2s	15.4	14	2s	10.8	11
1e	15.5	12 - 14	2s	13.7	11
1e	9.9	11 - 12	2s	13.0	11
1e	9.9	11 - 12	2s	{13.2}	11
1e	7.7	11 - 12		{10.7}	
1e	9.9	11 - 12			
1e	12.7	12			
1e	12.5	11 - 12			
1e	13.8	12			
1e	16.8	12			
1e	57.3	14			
5	12.8	11			
5	13.7	11			
5	10.1	9 *			
5	23.3	12			
2s	13.8	12			
5	15.0	11 - 12			
5	10.1	9 *			
2s	8.2	6 *			
2s	8.5	6 *			
5	18.0	11			
5	16.2	11 - 12			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITY OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive heights (B) At the Canopy Height

(A)

(A) 18.0m x 20m

(A) 37.3m x 20m

(B) 17.5m x 20m

(B) 30.5m x 20m

(B) 82.0m x 20m

RECORDERS Allaway
Myerscough
Kelle

MUNGARDOBOLO CREEK

DATE 9.2.77

LOCATION 25km

STATION M5

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

7, 8, 10, 11

QUADRAT 2

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'1s' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	14.4	11		2s	17.0	11
1e	14.0	11		5	7.6	11
1e	9.9	6	*	2s	8.2	11
1e	21.9	11		5	19.8	11 - 12
1e	14.8	11		5	10.4	11
1e	16.2	11		2s	7.7	9
1e	22.0	11		5	7.7	9 - 11
1e	22.9	11		5	9.2	9 - 11
1e	9.7	11		2s	19.2	12
1e	15.1	11		2s	19.7	12 - 14
1e	20.8	11		2s	14.9	12 - 14
5	6.0	4	*	2s	20.0	12 - 14
5	2.8	3	*	2s	16.8	12
5	3.7	3	*	2s	18.1	12
5	5.0	4	*	2s	8.6	11
2s	4.8	4	*	5	16.5	12
5	7.0	4	*	5	10.7	11
5	4.0	3	*	5	11.7	11
5	2.5	3	*	5	19.0	12 - 14
5	6.5	3	*	5	14.0	12 - 14
2s	7.0	6	*			
2s	5.2	6	*			
5	2.0	2	*			
5	3.0	4	*			
2s	9.4	9	*			
2s	7.5	9	*			
2s	7.5	9	*			
2s	10.7	11				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 3.5m x 20m

(A) 14.5m x 20m

(A) 31.5m x 20m

(B) 6.1m x 20m

(B) 57.5m x 20m

(B) 41.2m x 20m

RECORDERS Allaway
Myercoough
Kells

MUNGARDOBOLO CREEK

DATE 9.2.77

LOCATION 25km

STATION M5

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

6, 7, 10, 14, 15

QUADRAT 3

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	29.3	11	2s	8.8	11
1e	37.5	11	2s	{13.2}	12
1e	8.2	6 *		{10.0}	
1e	17.7	11	2s	8.5	8 *
1e	8.2	11	5	8.7	11
1e	11.8	11	2s	12.3	11
1e	8.6	11	2s	11.5	12
1e	6.8	6 *	2s	11.8	11
1e	9.9	8 *	2s	13.2	11
1e	{17.1}	11	2s	15.1	12
	{24.3}				
1e	39.8	11 - 12			
1e	45.4	11 - 12			
1e	15.0	11 - 12			
5	18.8	14			
5	23.3	14			
5	12.6	12			
5	14.2	11			
5	11.8	11 - 12			
5	16.8	12			
5	18.7	12			
5	9.2	11			
5	4.1	6 *			
5	16.4	12			
2s	12.6	11 - 12			
2s	10.2	11			
2s	{5.7}				
	{11.4}	11			
	{13.8}				

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 4.2m x 20m

(A) 56.7m x 20m

(A)

(B) 5.5m x 20m

(B) 65.3m x 20m

(B) 188m x 20m

RECORDERS Allanay
Myerscough
Kells

MUNGARDOBOLO CREEK

DATE 9.2.77

LOCATION 25km

STATION M5

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 4, 6, 7, 11, 14, 16

QUADRAT 4

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'Sa' *Rhinophora stylosa*
'Is' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	56.0	15			
1e	12.3	6 *			
1e	6.3	6 *			
1e	3.4	3 *			
1e	2.9	2.5 *			
1e	2.0	2.5 *			
1e	5.5	8 *			
1e	49.5	11			
1e	{ 3.4				
	{ 2.5				
	{ 3.5	6 *			
	{ 6.2				
	{ 3.0				
	{ 4.3				
1e	3.0	3 *			
1e	5.6	8 *			
1e	54.6	11			
1e	46.0	11			
1e	{ 15.6				
	{ 19.2	11 - 12			
	{ 32.0				
1e	12.0	11			
1e	8.5	11			
1e	{ 19.0				
	{ 22.2	11			
	{ 1.7				
1e	12.2	11			
1e	9.4	11			

Avicennia marina



Camptostemon schultzei



Rhinophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 6.8m x 20m

(A)

(A)

(B) 38.0m x 20m

(B)

(B)

RECORDERS Allaway
 Myercoough
 Wells

MUNGARDOBOLO CREEK

DATE 9.2.77

LOCATION 25km

STATION M5

BANK R.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 5

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	42.0	11			
1e	9.8	6			
1e	{11.0}	11			
	{8.5}				
1e	53.2	11			
1e	12.6	11			
1e	18.9	11			
1e	5.7	6			
1e	8.0	6			
1e	16.2	11			
1e	21.4	9 - 11			
1e	16.0	9 - 11			
1e	35.2	8			
1e	23.6	8			

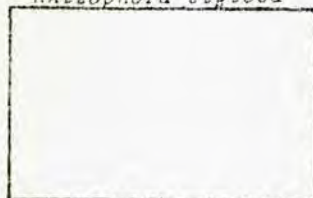
Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 6.0m x 20m

(A)

(A)

(B) 10.0m x 20m

(B)

(B)

RECORDERS Allaway
 Mjercanough
 Kelle

MUNGARDOBOLO CREEK

DATE 6.2.77

LOCATION 26.5km

STATION M6

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

1, 4, 6, 7, 10

QUADRAT 1

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT ALL Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1s' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	11.5	4 *			
1e	{ 19.6 11.4 9.7 }	6			
1e	{ 18.8 6.5 }	6			
1e	7.3	8			
1e	{ 6.3 4.0 }	4.5 *			
1e	{ 7.5 7.2 4.6 }	4 - 5 *			
1e	{ 6.5 6.8 }	4 - 5 *			
1e	13.5	6			
1e	17.0	6			
1e	17.7	6			
1e	20.9	6			
1e	25.8	6			
1e	16.7	6			
1e	17.4	6			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 3.5m x 15.5m

(A)

(A)

(B) 5.4m x 15.5m

(B)

(B)

RECORDERS Allaway
Myerscough
Wells

MUNGARDOBOLO CREEK

DATE 6.2.77

LOCATION 26.5km

STATION M6

BARK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

6, 7, 10

QUADRAT 2

TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY
'S' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate		SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	{ 25.4 12.1 }	8				
1e	12.4	8				
1e	7.8	4	*			
1e	7.4	4	*			
1e	13.6	8				
1e	19.3	8				
1e	21.8	8				
1e	6.4	4	*			
1e	6.0	4	*			
1e	5.9	3	*			
1e	25.7	8				
1e	13.3	8				
1e	13.4	8				
1e	{ 16.1 5.6 7.7 }	8				
1e	22.7	8				

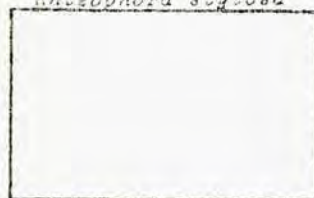
Avicennia marina



Camptostemon schultzei



Rhizophora stylosa



DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 4.0m x 14m

(A)

(A)

(B) 8.4m x 14.0m

(B)

(B)

RECORDERS Allaway
Myerscough
Wells

MUNGARDOBOLO CREEK

DATE 6.2.77

LOCATION 26.5km

STATION M6

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 3

6, 7, 10

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2e' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (Cm)	HEIGHT (Metres) Visual Estimate
1e	12.5	8			
1e	6.7	4 *			
1e	{ 6.3 }	4 *			
	{ 2.5 }				
1e	3.2	3 *			
1e	3.9	3 *			
1e	2.0	3 *			
1e	{ 3.7 }	3 *			
	{ 3.2 }				
1e	2.5	3 *			
1e	4.7	4 *			
1e	5.0	4 *			
1e	13.9				
1e	8.8	8			
1e	14.3	8			
1e	14.4	8			
1e	10.6	8			
1e	15.8	8			
1e	10.4	8			
1e	14.4	8			
1e	10.8	8			
1e	8.9	8			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 0.6m x 17.5m

(A)

(A)

(B) 4.4m x 17.5m

(B)

(B)

RECORDERS Allaway
Myerscough
Kelle

MUNGARDOBOLO CREEK

DATE 6.2.77

LOCATION 26.5km

STATION M6

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 4

7, 10

* TREE NOT AT Canopy Heights
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'5' *Camptostemon schultzei*
'2s' *Rhizophora stylosa*
'1e' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	12.2	4.5 *			
1e	{ 8.7 }	6			
	{ 3.4 }				
1e	{ 9.4 }	6			
	{ 10.4 }				
1e	5.3	4.5 *			
1e	3.0	3 *			
1e	{ 5.0 }	4.5 *			
	{ 2.9 }				
1e	9.8	6			
1e	2.3	3 *			
1e	3.5	4 *			
1e	3.7	4 *			
1e	{ 14.2 }	6			
	{ 11.7 }				
1e	15.0	6			
1e	16.5	6			
1e	10.4	6			
1e	8.1	6			
1e	11.0	6			
1e	9.4	6			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 0.5m x 18.0m

(A)

(A)

(B) 3.7m x 18.0m

(B)

(B)

RECORDERS Allaway
Myrceogough
Wells

MUNGARDOBOLO CREEK

DATE 6.2.77

LOCATION 26.5km

STATION M6

BANK L.H.B.

OTHER PLANT SPECIES IN QUADRAT

QUADRAT 5

10

* TREE NOT AT Canopy Height
FIRST 10 TREES OF SPECIES
AT All Inclusive Heights
FIRST 10 TREES OF SPECIES
AT Forest Canopy Height

KEY

'S' *Camptostemon schultzei*
'2a' *Rhizophora stylosa*
'1a' *Avicennia marina*

SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate	SPECIES	D.B.H. (cm)	HEIGHT (Metres) Visual Estimate
1e	{ 8.8 11.5 }	6			
1e	7.6	8			
1e	10.7	8			
1e	{ 3.2 7.5 3.2 9.1 }	7			
1e	7.7	7			
1e	{ 6.5 7.3 }	7			
1e	{ 8.4 9.2 8.5 4.2 }	7			
1e	7.7	6			
1e	9.0	7			
1e	8.9	7			
1e	4.2	3 *			
1e	3.8	3 *			

Avicennia marina

Camptostemon schultzei

Rhizophora stylosa

DENSITIES OF THE FIRST 10 TREES OF EACH SPECIES AT
(A) All Inclusive Heights (B) At the Canopy Height

(A) 1.5m x 20m

(A)

(A)

(B) 3.4m x 20m

(B)

(B)

MANGROVE ECOSYSTEMS IN AUSTRALIA

Structure, function and management

BF Clough Editor

Proceedings of the Australian National Mangrove Workshop
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4

Mangrove Vegetation of Northern
Australia

A.G. Wells

Mangrove Vegetation of Northern Australia

A.G. Wells

Introduction

A survey of mangrove communities across a wide area of northern Australia was commenced in 1975. To date, seventy-seven tidal river and creek systems have been examined, most of them at least twice. The survey area (Fig. 4.1) extends from the Kimberleys in the north-west of Western Australia, around the coastline of the Northern Territory to and including rivers and creeks entering the western and southern shorelines of the Gulf of Carpentaria.

It is the purpose of this paper to report primarily on the distribution of mangrove species in the survey area, and on the highest water salinities recorded for each species. Some comments are also included on the shade tolerance of different species based on extensive field observations.

Details of variation in density, girth and height of a number of mangrove species in different types of tidal rivers will be given in a series of papers now in preparation. Brief descriptions of fringing riverside mangrove vegetation along many tidal waterways in the study area have already been given in a series of monographs (Messel *et al.*, 1979).

Twenty-five species of mangroves were recorded in the Northern Territory, although one, *Nypa fruticans*, occurs only at one site on Melville Island. Fourteen species were recorded in the Kimberley region of Western Australia (Wells, 1981a). An additional species, *Scyphiphora hydrophyllacea*, has been reported in this area by Semeniuk *et al.* (1978). One species, *Avicennia officinalis*, has not been recorded previously in Australia. *Bruguiera sexangula*, *Ceriops decandra*, *Ceriops tagal*, *Rhizophora apiculata* and *Sonneratia caseolaris* are previously unrecorded in the Northern Territory, and *Xylocarpus granatum* has not been recorded previously in Western Australia.

Survey area

The area surveyed (Fig. 4.1) included several types of tidal river and creek systems. Rivers showing major structural control of drainage were covered in the north-west Kimberleys of Western Australia and parts of the Cambridge Gulf-southern Joseph Bonaparte Gulf regions of Western Australia and the Northern Territory. A detailed discussion of mangrove ecology and deltaic estuarine geomorphology for the Ord River (which lies within the survey area) is given by Thom *et al.* (1975). Other rivers entering Hyland and Anson Bays (N.T.) in this region meander across alluvial floodplains. Included also are the relatively short tidal river systems along the north coast of Melville Island (N.T.), the long meandering river systems flowing across the extensive alluvial floodplains that drain into Van Diemen Gulf, the admixture of drowned river

valley systems and meandering rivers that occurs across the north coast of Arnhem Land (N.T.) and the relatively short tidal rivers that enter the western shores of the Gulf of Carpentaria. Within the survey area, the estuarine tidal portions of rivers draining the north-west Kimberleys experience a semi-diurnal tidal range of up to 11 m whereas rivers at the other extremity of the study area (western shores of the Gulf of Carpentaria) normally experience a diurnal tidal range up to 1.5 m.

Drainage basin characteristics, tidal ranges, currents, salinity regimes, climatic patterns and the variety of substrates suitable for colonisation and seedling establishment are considered to be major factors influencing the present distribution and abundance of mangrove species in the survey area.

Methods

The tidal river systems were surveyed from the University of Sydney's 21 m research vessel. A 5.5 m boat was used for work within rivers. All navigable tidal waterways in the river and creek systems in the survey area were examined and lists made of the mangrove species present. Mangrove swamps on the majority of rivers within the area were also surveyed from the air.

Locations were marked on maps prepared from aerial photographs (accurate to ± 0.1 km). Quadrats 100 m long and 20 m wide—or the maximum width of the mangrove forest if it was less than 20 m—were located on both banks at 2.5 km intervals on each tidal waterway. Within each quadrat, mangrove species were listed and their percentage cover assessed.

High and low tide salinity profiles were normally taken in the tidal waterway adjacent to each quadrat location. Measurements were made at the surface, midwater and bottom using an Autolab (Model 602) salinity/temperature bridge. Surface salinity was also measured with a refractometer (American Optical Co.). Up to three Foxboro tidegauges were used simultaneously on the various rivers in order to record tidal information.

Identifications were based on keys for mangroves in eastern Australia (Jones, 1971), in Sarawak, Malaysia (Chai, 1972, 1973) and in Sabah, Malaysia (Fox, 1970). Mangroves collected have been deposited at the Herbarium Australiense (Canberra), the John Ray Herbarium (University of Sydney) and the Northern Territory Herbarium (Darwin).

Regional distribution

Within the survey area, five broad biogeographical regions were distinguished on the basis of changes in species number, climate and geomorphological features. These regions are shown in Fig. 4.1.

Region 1: North West Kimberley Area.

This region is characterised by an extremely rugged coastline and a large tidal range of 8-11 m during spring tides. The lack of suitable sites for colonisation by many species is accentuated by steep topographic gradients along the banks of a number of coastal river systems. Rainfall (1000-1250 mm annually) is strongly seasonal, all falling during the summer monsoonal wet season. For the

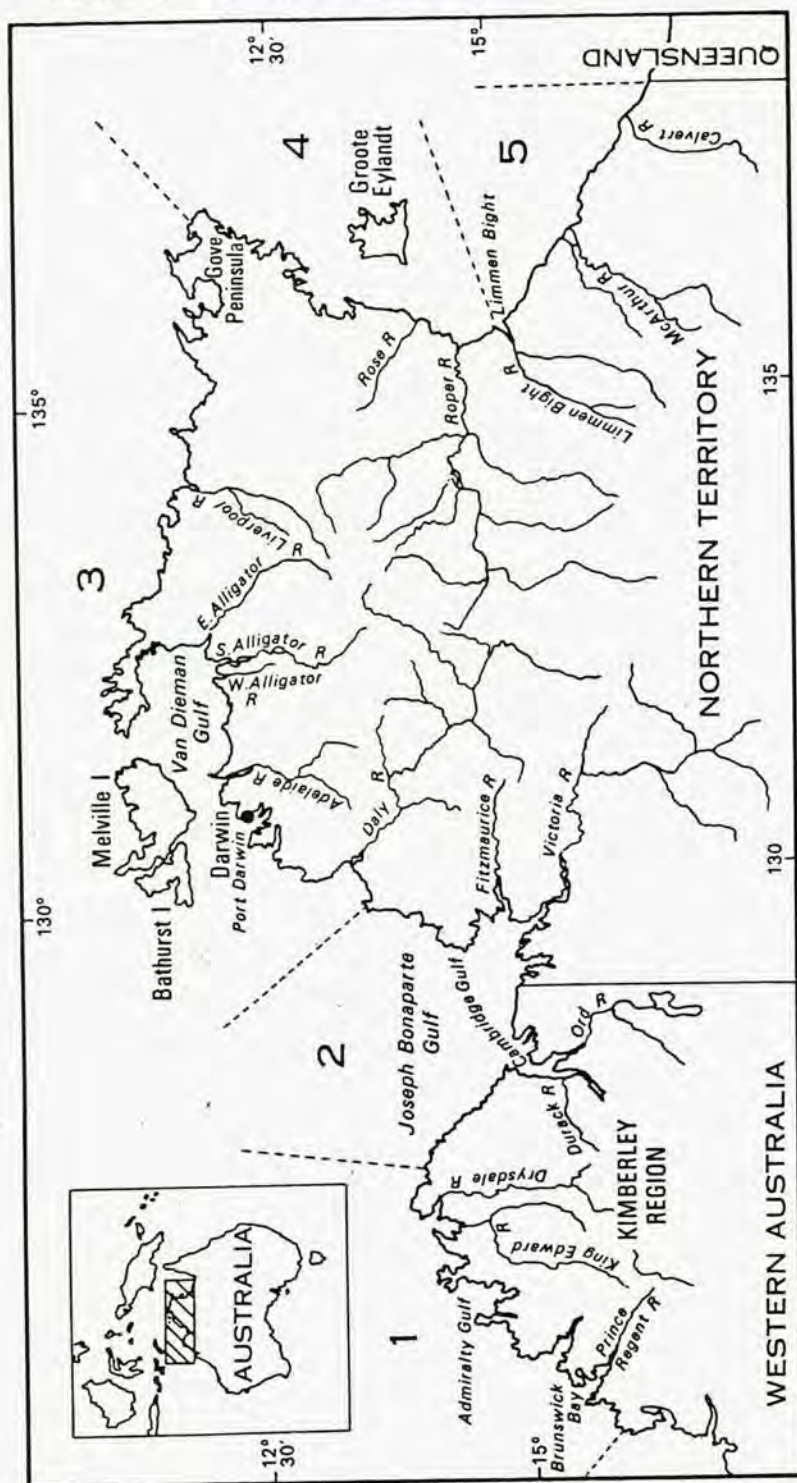


Fig. 4.1. Map of northern Australia showing the survey area and the biogeographic regions into which it was divided

Table 4.1 Distribution of mangrove species in Biogeographic Regions of the survey area.

Family	Species	Region 1	Region 2	Region 3	Region 4	Region 5
Acanthaceae	<i>Acanthus ilicifolius</i>			X	X	X
Avicenniaceae	<i>Avicennia marina</i>	X	X	X	X	X
	<i>Avicennia officinalis</i>			X		
Bombacaceae	<i>Camptostemon schultzei</i>	X	X	X	X	
Combretaceae	<i>Lumnitzera littorea</i>			X	X	
	<i>Lumnitzera racemosa</i>	X	X	X	X	X
Euphorbiaceae	<i>Excoecaria agallocha</i>	X	X	X	X	X
Meliaceae	<i>Xylocarpus granatum</i>	X		X		
	<i>Xylocarpus australasicus</i>	X	X	X	X	X
Myrsinaceae	<i>Aegiceras corniculatum</i>	X	X	X	X	X
Myrtaceae	<i>Osbornia octodonta</i>	X	X	X	X	X

remainder of the year the climate is arid. Local climatic factors thus may influence the number of mangrove species colonising this area.

Fifteen species of mangrove have been recorded in this region (Wells, 1981a; Table 4.1.). Monospecific stands of *Bruguiera* are noticeably absent from this region. The occurrence of *Xylocarpus granatum* amongst the fringing riverside vegetation in the upstream reaches of the Prince Regent River (Wells, 1981a) is unusual and obviously reflects local site conditions; this part of the river remains brackish for most of the dry season. *Xylocarpus granatum* was not found at any other site in the Kimberley region.

Region 2: Ord River-Victoria River Area.

Straddling the Western Australian-Northern Territory border, this region, with an annual rainfall of 750-900 mm, is more arid than Region 1. The extremely seasonal rainfall pattern is likely to be a major factor influencing species diversity (Fosberg, 1975).

A total of thirteen species were recorded from this region (Table 4.1). Twelve species were found in the Ord River system (almost twice the number previously reported by Thom *et al.*, 1975), and ten and eleven species were recorded respectively in the Victoria and Fitzmaurice river systems.

Family	Species	Region 1	Region 2	Region 3	Region 4	Region 5
Plumbaginaceae	<i>Aegialitis annulata</i>	X	X	X	X	X
Rhizophoraceae	<i>Bruguiera exaristata</i>	X	X	X	X	X
	<i>Bruguiera gymnorhiza</i>			X	X	
	<i>Bruguiera parviflora</i>	X	X	X	X	
	<i>Bruguiera sexangula</i>			X		
	<i>Ceriops decandra</i>			X		
	<i>Ceriops tagal</i> var. <i>australis</i>	X	X	X	X	X
	<i>Ceriops tagal</i> var. <i>tagal</i>			X		
	<i>Rhizophora apiculata</i>			X		
	<i>Rhizophora stylosa</i>	X	X	X	X	X
Rubiaceae	<i>Scyphiphora hydrophyllacea</i>	X		X	X	
Sonneratiaceae	<i>Sonneratia alba</i>	X	X	X		
	<i>Sonneratia caseolaris</i>			X		

Region 3. Daly River-Gove.

This region has the highest annual rainfall (1100-1600 mm) of the five regions in the survey area. Although rain is restricted to the summer wet season, conditions over the remainder of the year are considerably less arid than in other regions within the survey area.

Although a total of twenty-four species were recorded for this region (Table 4.1), only 15-20 commonly occur within most tidal waterways. The greatest diversity (18-20 species) was found in Arnhem Bay where the tidal reaches of a number of tributaries feeding the bay remain fresh or slightly brackish throughout most of the year. The low salinity of these rivers affords greater scope for colonisation by species with a low tolerance to high salinity.

Region 4. Gove-Limmen Bight River.

This region of the coastline can be considered seasonally arid, with considerable evaporation during the latter half of the dry season. Annual rainfall is 750-1000 mm.

Sixteen species have been recorded for this region (Table 4.1), but two of

these, *Camptostemon schultzei* and *Bruguiera parviflora*, were found only on the Limmen Bight River. Most tidal waterways in the region have 8-13 species. The extreme aridity and increasing latitude of this section of the coastline may account for the less diverse mangrove flora of this region.

Region 5: Limmen Bight River-Calvert River (Northern Territory/Queensland Border).

This is the most arid of the five regions within the survey area, receiving less than 750 mm rainfall annually, most of which falls during the summer wet season.

Eleven species were recorded in this region (Table 4.1), though more commonly only 7-9 species were found in a given river. As in the previous region, the extreme aridity is probably the major factor limiting the number of species. About 25 species of mangrove are found in the region of Cairns at a similar latitude on the moist, humid east coast of Australia (N. Duke, personal communication, 1979).

Species distribution and ecological features

Acanthus ilicifolius L. (Family Acanthaceae)

Acanthus ilicifolius occurs as a small sparsely branched herb or small shrub, 1-2 m high. It has a restricted distribution in the survey area, being found on only 41 of the 77 tidal waterways examined.

This species is commonly found colonising accreting portions of river meanders. On such sites, it may form a monospecific understorey within pioneer stands of *Sonneratia alba*, *Avicennia officinalis* or *Avicennia marina*. *Acanthus ilicifolius* is frequently observed amongst understorey of fringing riverside vegetation along tidal waterways particularly along portions of rivers that remain brackish for a considerable period of the year.

The species tolerates up to 7 months' inundation by freshwater annually but is frequently observed along banks of tidal waterways that become hypersaline at the end of the dry season. Within the survey area, *A. ilicifolius* was found in areas inundated by waters of salinity up to 65 parts per thousand.

Australian distribution. The southernmost limits of distribution reported for *A. ilicifolius* are the Daly River (13°10'S, 130°14'E) on the west coast of the Northern Territory and St Lawrence, Qld (22°15'S) on the east Australian coast (Jones, 1971).

The species has not been recorded south of the Walker River (13°35'S, 135°53'E) on the east coast of the Gulf of Carpentaria (N.T.). It occurs at least as far south as Weipa (12°40'S, 141°50'E) on the eastern shores of the Gulf of Carpentaria, but is not abundant there (L. Love, personal communication, 1978). Saenger and Hopkins (1975) found the species at Tarrant Point (17°23'S, 139°25'E) in the south-eastern portion of the Gulf of Carpentaria.

A closely related species, *Acanthus ebracteatus* Vahl., has been reported once in Australia, at King River near Wyndham (15°30'S, 128°05'E) in Western Australia (Semeniuk *et al.*, 1978).

Aegialitis annulata R. Br. (Family Plumbaginaceae)

This species grows as a herb or small shrub of up to 3 m height. It is widely distributed throughout the survey area and was found on 71 of the 77 tidal waterways examined.

Aegialitis annulata is frequently observed on rock/mud substrate in estuarine locations, particularly around headlands. It occurs as a shrub in mixed associations of *Avicennia marina*, *Excoecaria agallocha*, *Lumnitzera racemosa* and *Ceriops tagal* var. *australis* in the more landward, less frequently inundated zones. It may also occur as a monospecific community, principally on sand/mud substrates within estuaries. *Aegialitis annulata* often occurs as a carpet-like understorey beneath *Sonneratia alba* on consolidated muds in the Kimberley area of Western Australia and within Darwin and Bynoe Harbours. It is common as an understorey amongst fringing riverside vegetation (sometimes in association with *Avicennia marina*) in tidal waterways that become hypersaline by the end of the dry season. It is also often observed as a stunted shrub (height ≤ 0.5 m) on the periphery of saltpans.

Aegialitis annulata appears intolerant of long periods of inundation by freshwater and normally occurs only on substrates that are inundated by highly saline waters for most of the year. Within the survey area, the species was found in areas inundated by waters of salinity up to 85 parts per thousand.

Propagules of *A. annulata* are dispersed easily by the tides and colonise sites with high light intensities. Seedlings do not appear to survive in heavy shade. A dense seedling cover is often observed along riverbanks of hypersaline waterways.

Australian distribution. The southernmost limits of distribution reported for *A. annulata* are at Exmouth Gulf (21°53'S, 114°22'E) on the west Australian coast (Semeniuk *et al.*, 1978) and Fraser Island, Qld (25°30'S) on the east Australian coast (Jones, 1971).

Aegiceras corniculatum (L.) Blanco. (Family Myrsinaceae)

This species occurs as a shrub, up to 5 m high. It is particularly widespread and was found on 71 of the 77 tidal waterways examined.

Aegiceras corniculatum is frequently observed as understorey in fringing riverside tree associations along tidal rivers. The species colonises consolidated muds and may also form groves at the landward edge of swamps, particularly along portions of rivers that remain brackish for long periods during the dry season. In upstream areas of tidal waterways that become hypersaline by the end of the dry season, *A. corniculatum* may form an association with *Sonneratia alba* on soft unconsolidated muds, forming impenetrable thickets beneath the *Sonneratia* tree canopy. *Aegiceras corniculatum* forms associations with most mangrove species. It tolerates a wide range of environmental conditions, and can withstand up to 9 months of flooding by freshwater. It also occurs frequently in hypersaline waterways. Within the survey area, the species was found at sites inundated by waters of salinity up to 67 parts per thousand.

Dense crops of seedlings are often observed under mature shrubs fringing

tidal waterways. The seedlings appear intolerant of heavy shade, but odd shrubs may occupy sites within the inner mangrove zones if the canopy is broken. Seedlings often establish along the exposed inner margins of mangrove swamps.

Australian distribution. The southernmost limits of distribution reported for *A. corniculatum* are at Cossack (20°1'S, 117°12'E) on the west Australian coast (Semeniuk *et al.*, 1978) and Merimbula, N.S.W. (36°53'S, 149°55'E) on the south-east coast of N.S.W. (P. Weate, personal communication, 1978).

Avicennia marina (Forsk.) Vierh. Syn. *A. eucalyptifolia* Zipp ex Miq. (Family Avicenniaceae)

This species occurs as a tree (canopy height ≤ 25 metres) to small shrub (canopy height ≤ 1 metre). It is widespread, being found on 76 of the 77 tidal waterways examined in the survey area.

Avicennia marina often forms a monospecific pioneer community on newly accreting mudbanks in estuaries. It may also be found in a mixed pioneer association with either *Sonneratia alba*, *Camptostemon schultzei* or both. *Avicennia marina* forms associations with all mangrove species but more commonly with *Rhizophora stylosa* and *Camptostemon schultzei* along riverside fringes. It also occurs in association with *Ceriops tagal* var. *australis* and *Excoecaria agallocha* in less frequently inundated, more landward sites, and with *Aegiceras corniculatum* in many upstream areas of tidal rivers that remain fresh for most of the year.

Avicennia marina also forms a paired association with *Aegialitis annulata*, typically in areas that are inundated infrequently. This association sometimes occurs as a fringe in rivers along the southern coastline of the Gulf of Carpentaria. It may also form a near monospecific woodland in the most landward mangrove zone where tidal inundation is infrequent and soil salinities rise to values greater than 70 parts per thousand by the middle of the dry season.

The species tolerates a wide range of environmental conditions. It has been observed growing in sites that are inundated by freshwater to a depth of over m for up to 3 months of the year. Within the study area, *A. marina* was found at sites inundated by waters of salinity up to 85 parts per thousand, and it probably tolerates even higher water salinities.

The propagule is dispersed by the tide. Seedlings initially establish throughout the mangrove forest in the wet season but most subsequently die apparently due to low light intensity on the forest floor. Other seedlings may initially colonise bare mudflats during the wet season but most die during the dry season. Successful seedling colonisation is most noticeable on bare muds of accreting banks and within the more landward mangrove zones.

Australian distribution. The southernmost limits of distribution of *A. marina* in Australia are at Bunbury (33°16'S, 115°42'E) on the west Australian coast and on the south-east Australian coast at Corner Inlet, Vic. (38°45'S, 146°30'E), the southernmost limit of mangroves in the world.

Avicennia officinalis L. (Family Avicenniaceae)

The growth form of *A. officinalis* varies from a shrub to small tree with a canopy height up to 7 m. The species is restricted in distribution and was found on only 15 of the 77 tidal waterways examined.

Avicennia officinalis colonises soft muds along banks of rivers in Region 3 (Fig. 4.1) that remain brackish for most of the year. There it is found frequently on accreting convex parts of meanders where it occurs as a pioneer shrub, often with *Sonneratia alba*. The understorey in this association is normally provided by *Acanthus ilicifolius*.

The restricted distribution of this species is unusual insofar as it is absent from many portions of river systems in the same latitudinal belt which appear to provide suitable habitat for colonisation. Seedlings of *A. officinalis* colonise bare mud on accreting portions of river meanders. They appear intolerant of shade and have not been observed amongst the understorey of fringing riverside vegetation on tidal waterways. Within the survey area, the species was found in areas inundated by waters of salinity up to 63 parts per thousand.

Australian distribution. This is the first record of this species in Australia. The restricted distribution of *A. officinalis* in terms of tidal waterways and the area surveyed and the habitat it occupies suggest that this species is at the southern limits of its geographical range. That it does not occur in rivers entering the north coast of Melville Island is also unusual as the species is quite widely distributed throughout South-east Asia (Chai, 1973; Chapman, 1975).

The species was not recorded west of Buffalo Creek (Shoal Bay, near Darwin), N.T. (12°20'S, 130°57'E) or east of the Clyde River (12°16'S, 135°03'E) in eastern Arnhem Land.

Bruguiera exaristata Ding Hou (Family Rhizophoraceae)

This species grows as a shrub to tall tree of up to 12 m in height. It is widespread throughout the survey area, being found on 64 of the 77 tidal waterways.

In the northernmost parts of its range in Australia, *B. exaristata* is found frequently along the riverside fringe in mixed association with other species. It sometimes occurs as monospecific stands but more commonly forms associations with *Bruguiera parviflora*, *Bruguiera gymnorhiza*, *Ceriops tagal* var. *australis*, *Avicennia marina*, *Rhizophora stylosa* and *Camptostemon schultzei*. It is sparsely represented in *Ceriops* dominated thickets.

Bruguiera exaristata normally colonises well drained sites that are regularly inundated by tides. It appears tolerant both of long periods of inundation by freshwater and of hypersaline conditions. Within the survey area, the species was found in areas inundated by waters of salinity up to 72 parts per thousand.

The light, relatively small propagules are dispersed by tides or floods. They quickly establish on muds throughout mangrove forests in the wet season but many seedlings within the forest die, probably due to the low light intensities on the forest floor.

Australian distribution. The southernmost limits of distribution reported for *B. exaristata* in Australia are at Cossack (20°41'S, 117°11'E) on the west Australian coast (Semeniuk *et al.*, 1978) and St Lawrence, Qld (22°15'S) on the east Australian coast (Jones, 1971). The species is reasonably well represented within these limits except along the west Australian coastline, where it is uncommon.

Bruguiera gymnorhiza (L.) Lamk. (Family Rhizophoraceae)

The growth form of this species varies from a shrub to a large tree of up to 18 m in height. It was found on 32 of the 77 tidal waterways examined.

Bruguiera gymnorhiza is frequently observed in backswamp areas that are inundated by spring high tides. The species occurs in association with most mangrove species and in particular with *Rhizophora stylosa*, *Rhizophora apiculata*, *Bruguiera exaristata*, *Lumnitzera racemosa*, *Camptostemon schultzei*, *Xylocarpus australasicus*, *Avicennia marina* and a strand plant, *Diospyros ferrea* var. *humilis*.

Bruguiera gymnorhiza is often abundant amongst the fringing vegetation along portions of tidal waterways that remain brackish for considerable periods of the year. It occurs most frequently on rock/mud substrates and on well drained soils having a high sand content, but may also occur on poorly drained soils. In estuaries, *B. gymnorhiza* may occur towards the landward edge of mangrove swamp, particularly in areas that receive considerable freshwater seepage throughout the year. It shows a preference for lower salinity sites and can tolerate up to 9 months of flooding by freshwater. Within the study area, the species was found in areas inundated by waters of salinity up to 37 parts per thousand.

The propagules are dispersed relatively easily by the tides and appear to be shade tolerant. Seedlings frequently regenerate in areas where tidal inundation is infrequent. Seedlings of *Bruguiera gymnorhiza* have not been observed colonising sites beneath the canopy of mature trees of their own species.

Australian distribution. In the present survey, *B. gymnorhiza* was not recorded west of Darwin, N.T. (12°25'S, 130°48'E), but occurred eastwards of there to as far south as the Rose River, N.T. (14°17'S, 135°44'E) in the Gulf of Carpentaria. On the eastern shores of the Gulf of Carpentaria, it has been reported as far south as Tarrant Point (17°23'S, 139°25'E) by Saenger and Hopkins (1975). Along the east Australian coastline, the species has been recorded south to 29°25'S, 153°21'E on the Clarence River, N.S.W. (W. McCormick, personal communication, 1978).

Bruguiera parviflora (Roxb) W. & A. ex Griff. (Family Rhizophoraceae)

The growth form of this species is variable, ranging from a shrub to a tree of up to 14 m in height. It was found on 56 of the 77 tidal waterways examined.

Bruguiera parviflora often forms monospecific stands in mangrove zones that are not frequently inundated. It may occur in mixed associations, principally with *Bruguiera exaristata*, *Rhizophora stylosa*, *Rhizophora*

apiculata, *Ceriops decandra*, *Camptostemon schultzei* and *Avicennia marina*. The species is also found as isolated small trees or shrubs amongst fringing riverside vegetation on rivers that are of seawater salinity or higher by the end of the dry season. Monospecific stands on consolidated mud substrate have been observed at sites mainly inundated by brackish water and also on sites inundated by seawater for most of the year. The species thus appears to be tolerant of a wide range of salinity and has been found in areas inundated by waters of salinity up to 66 parts per thousand.

The propagules are dispersed by the tide. This species quickly establishes itself in cleared or open areas of forest or at sites along the riverine margins of the forest where ample light penetrates to the forest floor.

Australian distribution. The southernmost limits of distribution reported for *B. parviflora* in Australia are the Sale River (15°57'S, 124°33'E) on the west Australian coast (this study) and Proserpine, Qld (20°30'S) on the east Australian coast (Jones, 1971).

The species does not appear to be abundant on the southern or eastern shores of the Gulf of Carpentaria. Neither Saenger and Hopkins (1975) nor Specht *et al.* (1977) report the species at Tarrant Point (17°40'S, 141°50'E), and Weipa (12°40'S, 141°50'E), respectively, in the Gulf of Carpentaria, but specimens have been seen recently by the author at Port Musgrave (12°00'S, 141°54'E), 65 km north of Weipa.

Bruguiera sexangula (Lour.) Poir. (Family Rhizophoraceae)

This species occurs as a tree up to 12 m high. It is not common, being found in only two of the 77 tidal waterways examined.

On the Cato and Peter John Rivers in Arnhem Bay (N.T.), *B. sexangula* occurs within the fringing riverside vegetation in mixed association with *Rhizophora stylosa*, *Camptostemon schultzei*, *Bruguiera parviflora* and *Avicennia marina* over a wide range of sediment types and tidal regimes. *Bruguiera sexangula* was found at sites inundated by brackish water at the end of the dry season and tolerates long periods of inundation by freshwater. This species seems to prefer low salinity conditions and was not found at sites flooded by water with a salinity above 33 parts per thousand.

Australian distribution. *Bruguiera sexangula* is previously unrecorded in the Northern Territory (specimens which were labelled *B. sexangula* in the N.T. Herbarium, Darwin, are *B. exaristata*).

Within the survey area, the species was recorded only on the Cato and Peter John Rivers in Arnhem Bay, N.T. (12°15'S, 136°21'E).

On the eastern shores of the Gulf of Carpentaria this species has been recorded south to 12°00'S, 141°54'E at Port Musgrave (Wells, 1981b) while on the east Australian coastline, *B. sexangula* has been recorded south to 18°15'S at Hinchinbrook Island, Qld (N. Duke and J. Bunt, personal communication 1979).

Camptostemon schultzei Mas. (Family Bombacaceae)

The growth form of this species varies from a shrub to a large tree, of up to 25 m in height. It is widespread, being found on 63 of the 77 tidal waterways examined.

Camptostemon schultzei occurs in association with most mangrove tree and shrub species within the survey area, often on well drained sites. It frequently forms an association with *Rhizophora stylosa* and *Avicennia marina* as fringing vegetation along tidal waterways.

On accreting mudbanks to seaward, particularly in the Kimberley area of Western Australia (Region 1, Fig. 4.1), *C. schultzei* may form a pioneer association with *Sonneratia alba* (canopy height ≤ 8 metres). Such an association is unusual for *Camptostemon*. This species normally prefers to colonise well drained soils at sites that are inundated only by spring high tides. However, on the extensive gently sloping mudbanks of many of the embayments of the Kimberley region (Wells, 1981a) (particularly Port Warrender) the species is inundated up to twice per day by tides of up to 8 m that allow high tide waters to inundate all but the upper portions of the canopy of this association.

Camptostemon schultzei is quite common in estuarine localities and along the banks of hypersaline waterways. Within the study area, the species was found in areas inundated by waters of salinity up to 75 parts per thousand.

The seeds are dispersed by the tides and seedlings survive below forest canopies in fringing riverside swamps.

Australian distribution. *Camptostemon schultzei* is one of the few mangrove species that comes close to being endemic to Australia. It has a wide distribution around the far north Australian coastline as well as throughout rivers entering into the Gulf of Papua (Percival and Womersley, 1975; Floyd, 1977). The species has also been observed on Ambon Island in the Moluccas (Chapman, 1976). The southernmost limits of distribution reported for *C. schultzei* are Cape Bossut (18°43' S, 121°38' E) on the west Australian coastline (Semeniuk *et al.*, 1978) and the Pascoe River, Qld (12°31' S) on the east Australian coast (N. Duke, personal communication 1979). On the eastern shores of the Gulf of Carpentaria, it occurs at least as far south as 12°40' S at Weipa (Specht *et al.*, 1977). The species was not found on any river system entering the eastern shores of the Gulf of Carpentaria, nor was it recorded by Saenger and Hopkins (1975) at sites in the south-eastern part of the Gulf of Carpentaria.

Ceriops decandra (Griff.) Ding Hou (Family Rhizophoraceae)

This species grows as a shrub to small tree of up to 5 m in height. It is relatively common in the survey area and was found on 40 of the 77 tidal waterways examined.

Ceriops decandra typically occurs as an understorey in various mixed associations of fringing riverside trees. It is commonly found beneath mixed canopies of *Rhizophora stylosa*, *Camptostemon schultzei*, *Bruguiera*

parviflora, *Bruguiera exaristata* and *Avicennia marina*. The species often occurs on consolidated muds on the riverine edge of stands dominated by either *Bruguiera parviflora* or *Ceriops tagal* var. *australis*. *Ceriops decandra* is also frequently observed as an understorey plant (mixed with *Aegiceras corniculatum* and *Aegialitis annulata*) on tidal waterways that become hypersaline by the end of the dry season. It appears intolerant of long periods of inundation by freshwater but more tolerant than *Ceriops tagal* var. *australis* or *Ceriops tagal* var. *tagal*. The species was found in areas inundated by waters of salinity up to 67 parts per thousand.

The small fluted propagules are easily dispersed by the tide. Seedlings appear intolerant of heavy shade.

Australian distribution. *Ceriops decandra* has not previously been recorded from the Northern Territory. In the present survey it was not found west of Darwin, N.T. (12°25'S, 130°48'E) or on any tidal waterway entering the western or southern shores of the Gulf of Carpentaria. The distribution of this species throughout the remainder of the Gulf of Carpentaria is largely unknown, although it occurs at least as far south as 12°00'S, at Port Musgrave on the eastern shoreline of the Gulf of Carpentaria (Wells, 1981b), and possibly as far south as Weipa (L. Love, personal communication, 1978). On the east Australian coastline, the species has been recorded as far south as 18°15'S at Hinchinbrook Island, Qld (Duke and Bunt, personal communication).

Ceriops tagal var. *australis* C.T. White (Family Rhizophoraceae)

This species occurs as a shrub to small tree up to 12 m high. The species is widespread, being found on 72 of the 77 tidal waterways examined.

Ceriops tagal var. *australis* frequently forms monospecific thickets in the landward, less frequently inundated zones. It is often in a mixed association with *Excoecaria agallocha*, *Avicennia marina*, and *Lumnitzera racemosa*, where it commonly forms the understorey. *Ceriops tagal* var. *australis* sometimes forms an association with *Bruguiera parviflora* on certain sites. Shrubs of *Osbornia octodonta* and *Bruguiera exaristata* may occur in the mixed *Ceriops* dominated association, particularly in thickets bordering portions of rivers that become hypersaline by the end of the dry season.

The species appears intolerant of long periods of flooding by freshwater. It is normally found on well drained consolidated clays in less frequently inundated zones of mangrove swamps. Within the survey area, the species was found at sites inundated by waters of salinity up to 72 parts per thousand.

Propagules are dispersed by the tide. Successful colonisation occurs only on sites infrequently inundated by tides. Seedlings are moderately shade tolerant. They often colonise bare salt pans during the wet season only to die during the dry season.

Australian distribution. The southernmost limits of distribution of *C. tagal* var. *australis* are at Exmouth Gulf (21°53'S, 114°22'E) on the west Australian

coast (Semeniuk *et al.*, 1978) and the Tweed River, N.S.W. ($28^{\circ}11'S$, $153^{\circ}32'E$) on the east Australian coast (Lear and Turner, 1977).

Ceriops tagal var. *tagal* (Perr). C.B. Rob. (Family Rhizophoraceae)

This species grows as a small shrub up to 3 m high. It is restricted in occurrence in the survey area and was found only on 7 of the 77 tidal waterways examined.

Ceriops tagal var. *tagal* occurs as an understorey in fringing riverside associations. It was observed with *Bruguiera gymnorhiza*, *Ceriops tagal* var. *australis*, *Excoecaria agallocha* and *Avicennia marina*.

The species colonises consolidated muds or rock/mud substrates, particularly in areas that are infrequently inundated. Within the survey area, the species was found at sites inundated by waters of salinity up to 36 parts per thousand.

Australian distribution. *Ceriops tagal* var. *tagal* was previously unrecorded from the Northern Territory. It has not been recorded in Western Australia or within the Gulf of Carpentaria.

In the study area, the species was not recorded west of the Goomadeer River, N.T. ($11^{\circ}50'S$, $133^{\circ}49'E$) or east of the Cato River, N.T. ($12^{\circ}16'S$, $136^{\circ}21'E$). In eastern Australia this species extends south to $24^{\circ}01'S$ at Bustard Head, Qld (R. Dowling, personal communication, 1978).

Excoecaria agallocha L. (Family Euphorbiaceae)

The growth form of this species ranges from a shrub to a large tree of up to 10 m in height. It is widespread, being found on 73 of the 77 tidal waterways examined.

Excoecaria agallocha frequently occurs in association with *Ceriops tagal* var. *australis*, *Avicennia marina* and *Lumnitzera racemosa* on consolidated muds in the more landward, less frequently inundated zones. It also occurs as tall trees amongst fringing riverside vegetation along portions of tidal waterways that remain brackish for the greater part of the dry season. *Excoecaria agallocha* in association with *Avicennia marina* is a noticeable component of fringing riverside vegetation on all upstream portions of tidal waterways in the north-west Kimberleys (W.A.) the Ord (W.A.), and the Victoria and Fitzmaurice rivers in the Northern Territory. This association is inundated only by spring high tides. The large tidal range and rapidly increasing land gradients back from the river banks that occur within these areas may be largely responsible for the lack of suitable sites for colonisation by other mangrove species. High soil salinities towards the end of the dry season at sites colonised by the *Excoecaria/Avicennia* association may also be above the tolerance levels of most other mangrove species. It is likely that the occurrence of this association as fringing riverside vegetation in these areas is the result of complex interactions of several environmental factors. *Excoecaria agallocha* also appears to tolerate long periods of flooding by freshwater. Within the survey area, the species was found at sites inundated by waters of salinity up to 85 parts per thousand.

Propagules are dispersed by the tide. Seedlings are often found in peripheral localities at the landward edge of mangrove swamps, particularly in areas abutting salt pans. Seedlings of the species are also frequently observed on consolidated muds within fringing mangrove forests and appear tolerant of low light levels.

Australian distribution. The southernmost limits of distribution of *E. agallocha* are at Thangoo Station (18°16'S, 122°10'E) on the west Australian coast (Semeniuk *et al.*, 1978) and the Clarence River, N.S.W. (29°25'S, 153°21'E) on the east Australian coast (W. McCormick, personal communication, 1978).

Lumnitzera littorea (Jack) Voigt (Family Combretaceae)

This species was observed as a shrub to small tree of up to 8 m in height. By contrast it occurs as a tree of up to 25 m in many situations in Malaysia and the northern parts of Cape York Peninsula. This species is not common in the survey area and was found in only 8 of the 77 tidal waterways examined.

Lumnitzera littorea normally occurs as a shrub on rocky or muddy substrates, commonly in landward mangrove zones where it often forms an association with another shrub, *Scyphiphora hydrophyllacea*.

Lumnitzera littorea is found mainly on sites which are infrequently flooded by the tide. Within the survey area, the species was found in areas inundated by waters of salinity up to 35 parts per thousand.

Australian distribution. *Lumnitzera littorea* was not recorded west of the Johnston River on Melville Island, N.T. (11°18'S, 131°10'E). Along the western shores of the Gulf of Carpentaria, it was recorded south to the Rose River (14°17'S, 135°44'E). On the eastern shore of the Gulf of Carpentaria the species occurs at least as far south as Weipa (L. Love, personal communication, 1978) and it has also been recorded at Mornington Island (Woolston, 1973), and Tarrant Point (17°23'S, 139°25'E) (Saenger and Hopkins, 1975) in the south-eastern portion of the Gulf of Carpentaria.

On the eastern Australian coast, *L. littorea* is recorded south to 18°32'S on the Herbert River, Qld (Jones, 1971).

Lumnitzera racemosa Willd. (Family Combretaceae)

This species is commonly found as a shrub to small tree of up to 8 m in height. It is widespread and was found on 61 of the 77 tidal waterways examined.

Lumnitzera racemosa colonises the more landward less frequently inundated mangrove zones. It occurs amongst fringing riverside vegetation along portions of tidal waterways that remain fresh or slightly brackish for the greater part of the year. It sometimes forms nearly monospecific stands on the landward fringe of mangrove forests, particularly in areas where the landward fringe merges into a sedge swamp. *Lumnitzera racemosa* also commonly occurs in association with *Ceriops tagal* var. *australis*, *Excoecaria agallocha*,

Avicennia marina and *Aegialitis annulata* on consolidated muds in areas that are flooded infrequently. In seasonally flooded areas, it often grows in mallee habit (canopy height ≤ 2 m).

Lumnitzera racemosa can withstand considerable periods of flooding by freshwater, but can also tolerate extremely saline conditions. The species was found in areas inundated by waters of salinity up to 78 parts per thousand.

Australian distribution. The southernmost limits of distribution of *L. racemosa* are Beagle Bay ($16^{\circ}56'S$, $122^{\circ}32'E$) on the west Australian coast (Semeniuk *et al.* 1978) and Moreton Bay, Qld ($27^{\circ}30'S$) on the east Australian coast (R. Dowling, personal communication, 1979).

Osbornia octodonta F.v.M. (Family Myrtaceae)

This species is found as a shrub to small tree up to 6 m high. It is widespread along the northern coastline and was found on 53 of the 77 tidal waterways examined.

Small trees or shrubs of *O. octodonta* are common on rocky headlands and in peripheral locations bordering sand beaches within estuaries. It also occurs, sometimes forming groves, along cutaway (concave) portions of meanders on waterways that become hypersaline by the middle of the dry season. It is common in *Ceriops* dominated thickets and is also found amongst mangrove species colonising the less frequently inundated inner zones. In the Kimberley area of Western Australia, *O. octodonta* commonly forms a closed shrub community bordering saline mudflats.

The species colonises sites that are inundated by waters of seawater salinity or greater on a wide range of substrates and appears to be absent from sites which receive more than 60 days flooding by freshwater annually. Within the survey area, the species was found at sites inundated by waters of salinity up to 56 parts per thousand.

Australian distribution. The southernmost limits of distribution reported for *O. octodonta* are at Cossack ($20^{\circ}41'S$, $117^{\circ}11'E$) on the west Australian coast (Semeniuk *et al.*, 1978) and Tin Can Bay, Qld ($25^{\circ}30'S$) on the east Australian coast (R. Dowling, personal communication, 1978). Specht *et al.* (1977) record this species at Weipa ($12^{\circ}40'S$, $141^{\circ}50'E$), but Saenger and Hopkins (1975) did not report its presence at Tarrant Point in the south-eastern portion of the Gulf of Carpentaria.

Rhizophora apiculata Blume (Family Rhizophoraceae)

The growth form of this species varies from a tall shrub to a small tree of up to 10 m in height. This species has a restricted distribution within the survey area, being recorded in only 8 of the 77 tidal waterways examined.

Rhizophora apiculata usually colonises estuarine areas that are inundated regularly. It normally occurs in mixed association with *Rhizophora stylosa*, *Campostemon schultzei*, *Bruguiera parviflora*, *Bruguiera gymnorhiza* and *Avicennia marina*.

On Dongau Creek, Melville Island (N.T.), *R. apiculata* forms an association with *Rhizophora stylosa*, both species being stunted (canopy height ≤ 1.5 m). Imperfect tidal flushing and poor drainage may account for the stunted habit of this association. Although *R. apiculata* was found at sites inundated by water of salinity up to 65 parts per thousand the species normally colonises sites inundated by waters of 35 parts per thousand or less. It tolerates long periods of inundation by freshwater.

Propagules of *R. apiculata* are produced in large numbers on mature trees and either embed themselves in muds below the parent tree or are carried by tides to other areas. They appear to tolerate shade. As the propagule is shorter than that of *Rhizophora stylosa*, *R. apiculata* seedlings are carried into shallower waters and hence can establish themselves on higher ground than *R. stylosa*.

Australian distribution.

Rhizophora apiculata has not been previously recorded from the Northern Territory. It has not been recorded in Western Australia. The species has not been recorded west of Andranangoo Creek, Melville Island, NT (11°21' S, 130°51' E) or east of Gove NT (12°15' E). On the east Australian coastline, the species has been recorded south to Port Clinton, Qld (22°30' S) (N. Duke and J. Bunt, personal communication, 1979).

Rhizophora stylosa Griff. (Family Rhizophoraceae)

This species grows to a tall tree of 20 m in height. It is common within the survey area, being found on 71 of the 77 tidal waterways examined.

Rhizophora stylosa is the dominant species along the banks of tidal creeks, commonly growing in nearly monospecific stands. It may occur as a seaward pioneering species or, alternatively, form a band of variable width behind a pioneer community of *Sonneratia alba*. However, the species also occurs frequently on firm consolidated muds in more landward zones which are inundated less often. Along tidal rivers and creeks, *R. stylosa* often forms a mixed tree association with *Camptostemon schultzei* and *Avicennia marina*. It is also present in other mixed associations, chiefly with *Bruguiera parviflora*, *Xylocarpus australasicus*, *Bruguiera gymnorhiza*, *Bruguiera exaristata*, *Aegiceras corniculatum* and *Ceriops decandra*. *Rhizophora stylosa* grows to maximum proportions in sections of tidal rivers that remain brackish for most of the year and it tolerates a considerable period of inundation by freshwater. Within the survey area, the species was found in areas inundated by waters of salinity up to 74 parts per thousand.

The propagules are dispersed by water. The great length of the fruit compared to other species may limit its landward dispersal by water. Species that colonise the shallower landward areas, generally have small fruits, e.g. *Ceriops* spp., *Avicennia marina*, *Aegiceras corniculatum*, *Lumnitzera* spp. The species is rarely observed colonising sites more than a few hundred metres inland. Further inland it is apparently replaced by other species with smaller fruits.

Australian distribution. The southernmost limits of distribution reported for *R. stylosa* in Australia are at Yardie Creek (22°20'S, 113°51'E) on the west Australian coast (Semeniuk *et al.*, 1978) and the Richmond River, N.S.W. (28°31'S) on the east Australian coast (Jones, 1971). The species is common throughout this range.

Scyphiphora hydrophyllacea Gaertn. (Family Rubiaceae)

This species grows as a shrub up to 4 m high. It has a restricted distribution in the survey area, and was found in only 15 of the 77 tidal waterways examined.

Scyphiphora hydrophyllacea occurs on mud/rock substrates, often forming a shrub layer along the banks of tidal waterways that are of seawater salinity or greater by the middle of the dry season. The species normally occupies sites that are inundated infrequently and appears intolerant of lengthy periods of inundation by freshwater. Within the survey area, the species was found in areas inundated by waters of salinity up to 63 parts per thousand.

Scyphiphora hydrophyllacea also appears intolerant of shady conditions. Sites on which it occurs (rock/mud substrates) appear unsuitable for colonisation by most other mangrove species.

Australian distribution. The limits of distribution reported for *S. hydrophyllacea* in Australia are at Cape Londonderry (13°48'S, 126°46'E), the most northerly point of Western Australia (Semeniuk *et al.*, 1978), and Townsville, Qld (19°12'S) on the east Australian coast (Jones, 1971).

Within this area of coastline, the distribution of *S. hydrophyllacea* is patchy. In the Northern Territory it was not found west of Darwin (12°25'S, 130°48'E) or on the west shore of the Gulf of Carpentaria. It has been reported as far south as Weipa (12°40'S, 141°50'E) on the eastern shore of the Gulf of Carpentaria (Specht *et al.*, 1977).

Sonneratia alba J. Sm. (Family Sonneratiaceae)

This species grows to a tree of up to 12 m in height. It is very common and was found on 57 of the 77 tidal waterways examined.

Sonneratia alba often occurs in monospecific stands or in mixed association with *Rhizophora stylosa*, *Camptostemon schultzii* and/or *Avicennia marina* on accreting mudbanks to seaward. Although a pioneering species, it occupies sites that are largely protected from strong wave action. In some rivers of the Kimberleys (W.A.), *Aegialitis annulata* forms a short carpet-like understorey beneath trees of *Sonneratia alba* (Messel *et al.*, 1977). *Sonneratia alba* occurs far upstream on some tidal rivers that do not receive a substantial freshwater input after commencement of the dry season (e.g. South Alligator River). In such saline rivers, it forms a shrub association with *Avicennia officinalis* on accreting mudbanks around convex portions of river meanders; *Acanthus ilicifolius* is often observed as understorey in this association.

Sonneratia alba colonises sites that are inundated by most high tides. It frequently occurs on consolidating soft muds and appears intolerant of long periods of exposure to freshwater. The species was found in areas inundated by

waters of salinity up to 44 parts per thousand. Seedlings of *Sonneratia alba* are never prolific but always occur on bare newly-accreting mudbanks. The species was not observed regenerating under tree canopies and appears intolerant of shade.

Australian distribution. The southernmost limits of distribution of *S. alba* in Australia are at Cape Bossut (18°43'S, 121°38'E) on the west Australian coast (Semeniuk *et al.*, 1978), and Port Clinton, Qld (22°30'S) on the east Australian coast (N. Duke and J. Bunt, personal communication, 1979). The species was prevalent in estuarine areas within the survey area, but was not recorded on any river system entering the western or southern shores of the Gulf of Carpentaria. *Sonneratia alba* occurs at least as far south as Weipa on the eastern shore of the Gulf of Carpentaria (L. Love, personal communication, 1978).

Sonneratia caseolaris (L.) Engl. (Family Sonneratiaceae)

This species grows to a tree of up to 18 m in height. It is restricted in distribution, being found on only 12 of the 77 tidal waterways examined.

Sonneratia caseolaris occurs as a pioneering species on accreting mudbanks in some rivers that remain fresh or slightly brackish over most of the year. It normally colonises soft muds but may occur on firmer more consolidated muds. It is restricted to riverine sites that are inundated by most tides. *Sonneratia caseolaris* may form monospecific stands along riverbanks or occur throughout the river course. It often forms mixed associations with other pioneering species such as *Avicennia marina*, *Avicennia officinalis*, *Aegiceras corniculatum* and *Acanthus ilicifolius*. In some localities, the species may occur in a mixed association with *Sonneratia alba*. *Sonneratia caseolaris* is more abundant at sites inundated by brackish waters, but can tolerate higher salinities. The species was found in areas inundated by waters of salinity up to 35 parts per thousand. In the more saline areas, *Sonneratia caseolaris* is a shrub. It only attains tree dimensions in brackish or predominantly freshwater sites. This species only regenerates on accreting exposed bare mudbanks. Seedlings appear to be intolerant of shade.

Australian distribution. *Sonneratia caseolaris* has not been recorded in Western Australia and this is the first report of this species in the Northern Territory, where the most westerly occurrence of the species is on Andranangoo Creek, Melville Island, N.T. (11°21'S, 130°51'E). It is abundant on river systems entering Van Diemen Gulf (N.T.) and also occurs in certain rivers in Arnhem Bay (N.T.), but was not recorded east of the Peter John River, N.T. (12°15'S, 136°21'E). The species has not been observed on any river system entering the Gulf of Carpentaria. On the east Australian coast, it occurs south to the Murray River, Qld (N. Duke and J. Bunt, personal communication, 1978).

Xylocarpus australasicus Ridl. (Family Meliaceae)

Xylocarpus australasicus grows as a shrub to large tree up to 14 m high. It is

widespread, being found on 72 of the 77 tidal waterways examined.

Xylocarpus australasicus is common amongst fringing riverside vegetation in Northern Australia. In portions of rivers that remain brackish for long periods of the dry season, *Xylocarpus australasicus* occurs as the dominant tree species in association with *Diospyros ferrea* var. *humilis*, *Bruguiera parviflora* and *Rhizophora stylosa*. The most extensive forest types of this nature occur on Andranangoo Creek, Melville Island and the Koolatong River (Blue Mud Bay, N.T.). *Xylocarpus australasicus* has not been observed as a pioneering species. The species can withstand long periods of inundation by freshwater (up to 8 months) and also tolerates limited periods of hypersaline conditions. Within the survey area, the species was found in areas inundated by waters of salinity up to 76 parts per thousand.

Seeds of *X. australasicus* are widely distributed by the tide but many are attacked by boring insects and fail to germinate. Seedlings appear to tolerate low light levels.

Australian distribution. The southernmost limits of distribution reported for *X. australasicus* are King Sound, Derby (17°19'S, 123°38'E) on the west Australian coast (Semeniuk *et al.*, 1978) and Gladstone, Qld (23°50'S) on the east Australian coast (Saenger and Robson, 1977).

Xylocarpus granatum Koen. (Family Meliaceae)

This species occurs as a shrub to small tree up to 9 m high. Its distribution within the survey area is very restricted, being found in only 2 of the 77 tidal waterways examined.

Xylocarpus granatum occurs on various substrates, but seems to prefer consolidated muds. It is often associated with *Rhizophora apiculata*, *Rhizophora stylosa*, *Bruguiera gymnorhiza*, *Xylocarpus australasicus* and the mangrove fern *Acrostichum speciosum*. It can withstand considerable periods of inundation by freshwater, but occurs most frequently in brackish water at sites that are flooded infrequently by seawater. The species was found at sites inundated by waters of salinity up to 34 parts per thousand.

Australian distribution. The southernmost limits of distribution reported for *X. granatum* are the Prince Regent River (15°27'S, 125°03'E) on the west Australian coast (Wells, 1981a) and Fraser Island, Qld (25°30'S) on the east Australian coast (R. Dowling, personal communication, 1979).

In the Northern Territory, it occurs on Andranangoo Creek, Melville Island (11°21'S, 130°51'E) and Yirrkala on the Gove Peninsula (Specht, 1958). Specht *et al.*, 1977 have also recorded the species at Weipa, and Saenger and Hopkins (1975) have reported the species at Tarrant Point, Qld (17°23'S, 139°25'E) in the south-eastern portion of the Gulf of Carpentaria, though in the latter case there is a possibility that *X. australasicus* has been misidentified as *X. granatum*. *Xylocarpus granatum* has not previously been recorded from Western Australia.

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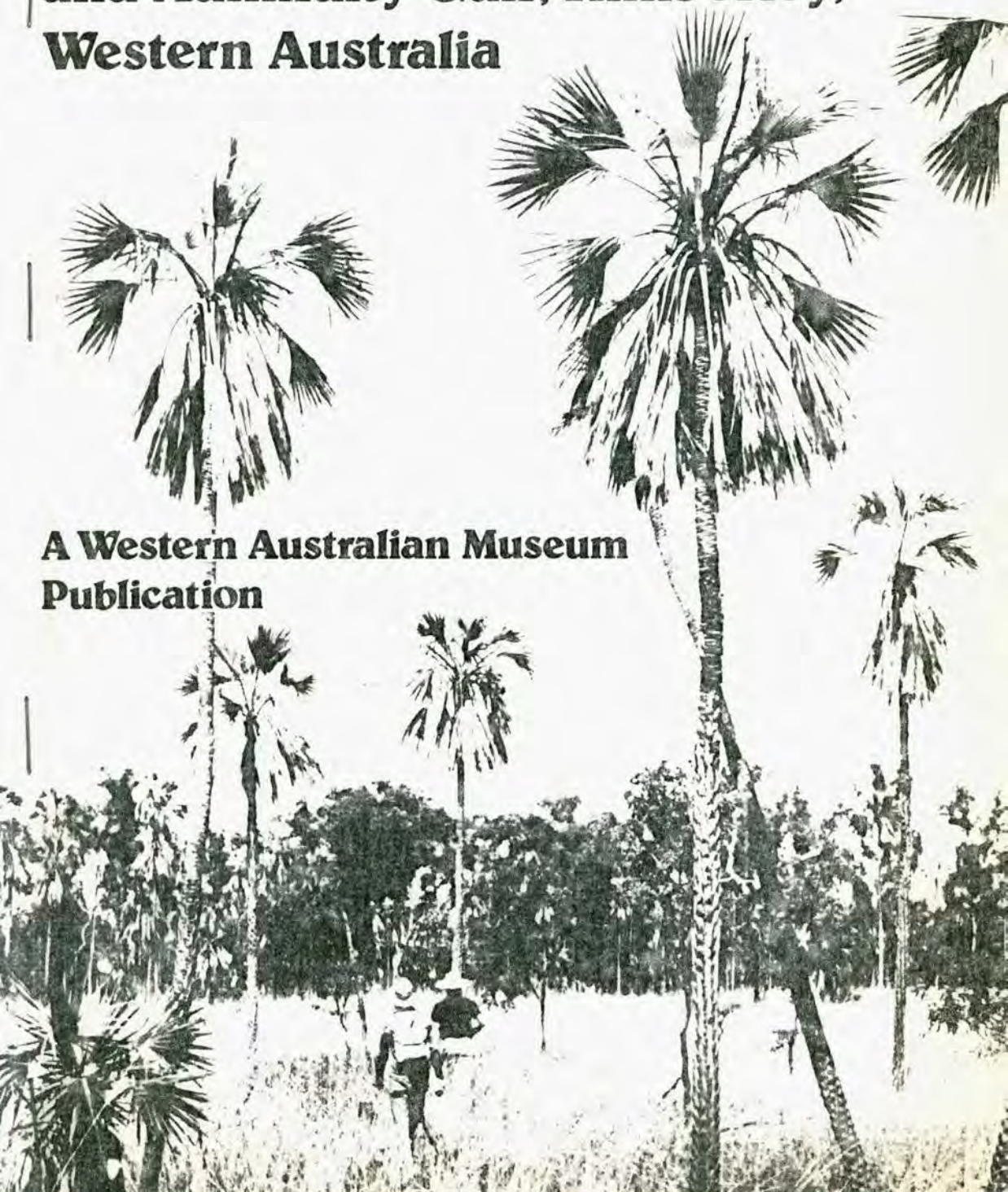
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Biological Survey of Mitchell Plateau and Admiralty Gulf, Kimberley, Western Australia

**A Western Australian Museum
Publication**



**BIOLOGICAL SURVEY OF MITCHELL PLATEAU
AND ADMIRALTY GULF, KIMBERLEY,
WESTERN AUSTRALIA**

Papers resulting from a joint field expedition to
Mitchell Plateau, Kimberley, by the Western Australian Museum,
Perth, and the Field Museum of Natural History,
Chicago, U.S.A., 1976-1977

A Western Australian Museum Publication

PERTH 1981

A SURVEY OF RIVERSIDE MANGROVE VEGETATION FRINGING TIDAL RIVER SYSTEMS OF KIMBERLEY, WESTERN AUSTRALIA

A.G. WELLS*

ABSTRACT

Distribution, assessment of cover abundance and pertinent ecological observations are given for mangrove species fringing five tidal river systems in Kimberley, Western Australia.

Fourteen species of mangroves were observed, one of which (*Xylocarpus granatum*) has not previously been recorded from Western Australia.

INTRODUCTION

Limited information is available on the mangrove flora of the Kimberley region in Western Australia. Brief reports have been provided by Gardner (1923), Sauer (1965), Beard (1967) and Perry (1970). Miles *et al.* (1975), Thom *et al.* (1975), Messel *et al.* (1977) and Semeniuk *et al.* (1978) have provided more detailed accounts of tidal wetland plant distribution of the area.

The region described here includes five tidal river systems along the north-west Kimberley coast of Western Australia (Fig. 1). All systems are located within deep structural embayments. Floodplain development is minimal and tides in the area are semi-diurnal with amplitudes of up to 10 m.

The 14 species recognized as mangroves in the study area during this survey are listed below and follow the nomenclature of Jones (1971).

Aegialitis annulata R. Br.

Aegiceras corniculatum (L.) Blanco.

Avicennia marina (Forsk.) Vierh.

Bruguiera exaristata Ding Hou.

Bruguiera parviflora (Roxb.) Wright and Arn ex Griff.

Camptostemon schultzei Masters.

Ceriops tagal (Perr.) C B Robinson var. *australis* C T White.

Excoecaria agallocha L.

Lumnitzera racemosa Willd.

Osbornia octodonta F. Muell.

Rhizophora stylosa Griff.

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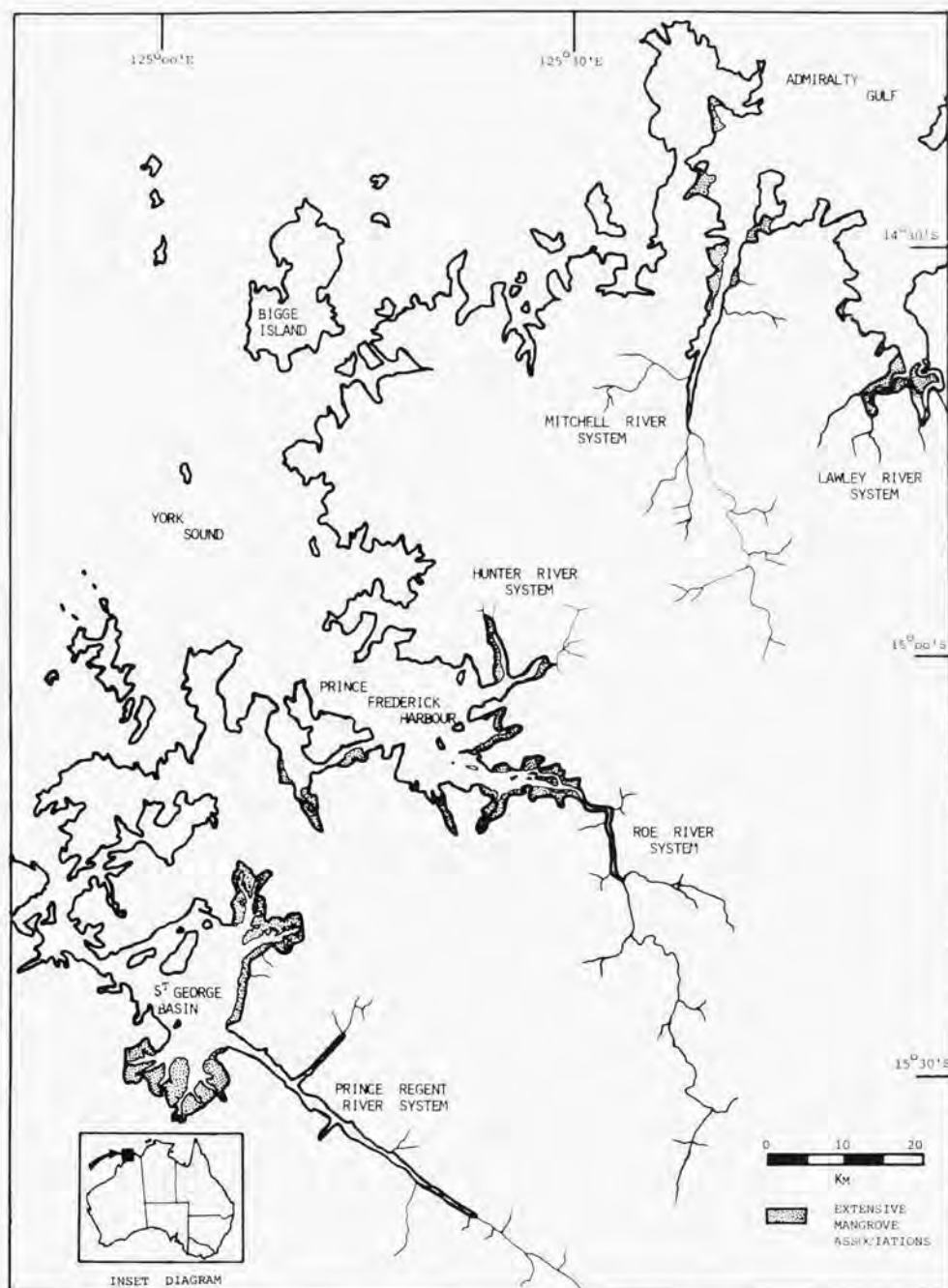


Fig. 1: Study area in the Kimberley District, Western Australia.

Sonneratia alba J E Smith

Xylocarpus granatum Koen.

Xylocarpus moluccensis (Lamk.) Roem. Syn *X. australasicus*? Ridl.

The purpose of this paper is to outline the distribution and abundance of mangrove species occurring as fringing riverside vegetation and to discuss pertinent ecological observations.

METHODS

The study was carried out during July 1977 from the University of Sydney's 21 m Research Vessel *The Harry Messel* while it was involved in surveys to determine the status of the salt-water crocodile in the north-west Kimberley (Messel *et al.*, 1977). Surveys were made from a 5 m boat. Locations were marked on maps prepared from aerial photographs (accurate to ± 0.1 km).

Quadrats 100 m long (along each bank) and 20 m deep (back into the fringing riverside vegetation) were determined at 2.5 km intervals on each river. In areas where rocks abut the banks and the depth of mangrove swamp extends less than 20 m back from the bank, the quadrat is still 100 m long with variable width. The scale of cover abundance used is modified from Braun-Blanquet (1932). It consists of:

1. Cover up to 5%.
3. Cover between 25-50% of area.
4. Cover between 50-75% of area.
5. Cover between 75-100% of area.

High and low tide salinity profiles were taken at 2.5 km intervals along the rivers. Measurements were made at the surface, midwater and bottom using an Autolab (Model 602) salinity/temperature meter.

Lawley River System

The Lawley River, with two major creeks, Mindjau Creek and Rail Creek, (Fig. 2), enters the southern portion of Port Warrender. Tidal range is approximately 7 m. Maximum distance upstream of tidal influence is 10-20 km in all three arms.

Basalt cliffs rise towards the Mitchell Plateau and delimit the catchment areas; 41 km² and 149 km² of Mindjau and Rail Creeks respectively. The catchment area of the Lawley River—573 km²—lies for the greater part within Precambrian sandstones.

High and low tide salinity profiles were determined for the 3 tidal arms (Fig. 5). These indicate that even into July (mid dry season), some fresh water is still entering the tidal portion of the river from drainage areas upstream. Mindjau Creek has

salinity values typical of seawater at both high and low tides because of its small catchment area.

The Lawley River and Rail Creek show slight decreases in salinity as distance upstream increases, indicating that some fresh water is still entering from the catchment area. Complete vertical mixing of salinity profiles was evident only in Mindjau Creek. Rivers in Arnhem Land, N.T., which have similar salinity profiles in the mid dry season, become hypersaline by the end of the dry season, when fresh water ceases flowing in from the catchment areas. It is considered that all 3 tidal arms of the Lawley River System could become hypersaline by the end of the dry season.

There is approximately 47 km² of mangal within the Lawley River-Port Warrender system. The extent of the mangal is:

Lawley River	10.5 km ²	Mindjau Creek	12.0 km ² (CK A)
Port Warrender	11.5 km ²	Rail Creek	13.0 km ² (CK B)

Along the Lawley, the dominant riverside mangrove community is a low closed forest (canopy height ≤ 8 m) of *Avicennia marina*, *Camptostemon schultzei* and *Rhizophora stylosa*. A shrub understorey (canopy height ≤ 2 m) of *Aegiceras corniculatum* occurs along the banks while the pioneer species *Sonneratia alba* (canopy height ≤ 8 m) occurs along convex portions of river meanders and also colonizes accreting mudbanks to seaward.

Distributions and assessments of cover abundance for mangrove species along the tidal arms of the river system are shown in **Fig. 4**.

Around the river mouth, *Sonneratia alba* forms an association with *Avicennia marina* and *Camptostemon schultzei* on extensive gently shelving mudbanks (**Plate 1**). During high tides, these pioneer mangrove associations are inundated nearly to the top of their canopy.

Dominant mangrove vegetation along Mindjau and Rail Creeks was also low closed forests of *Avicennia marina*, *Camptostemon schultzei* and *Rhizophora stylosa* (canopy height ≤ 8 m), a shrub understorey of *Aegiceras corniculatum* (canopy height ≤ 2 m) being present in both arms. In Rail Creek, *Aegiceras corniculatum* forms an association with *Aegialitis annulata* (canopy height ≤ 0.5 m). Shrubs of *Osbornia octodonta*, *Aegialitis annulata*, *Lumnitzera racemosa* and stunted *Avicennia marina* (canopy height ≤ 2.5 m) occupy peripheral positions around many of the saline mudflats.

An association of *Ceriops tagal* var. *australis*, *Excoecaria agallocha* and *Lumnitzera racemosa* (canopy height ≤ 4.5 m) occur as the landward extension of mangroves bordering the saline mudflats that are colonized in some areas by various samphires—*Arthrocnemum* sp, *Suaeda australis* and *Sporobolus virginicus* being dominant. Most of the saline mudflats are devoid of vegetative cover. As shown in **Fig. 4**, *Xylocarpus moluccensis* was infrequently observed. *Bruguiera* spp. were also sparsely represented in the mangrove forests.

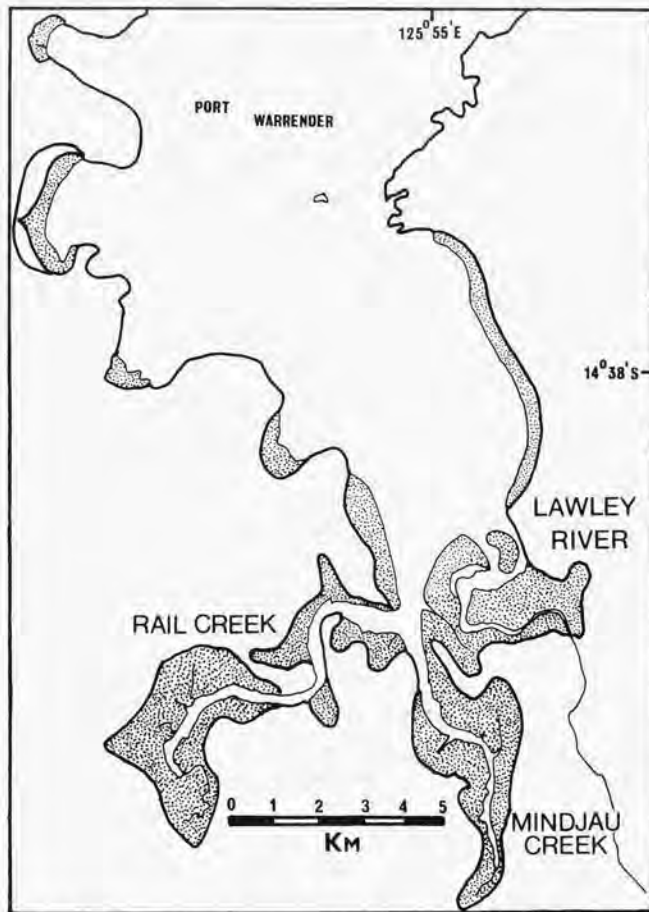


Fig. 2: Port Warrender-Lawley River system showing distribution of mangrove swamps.

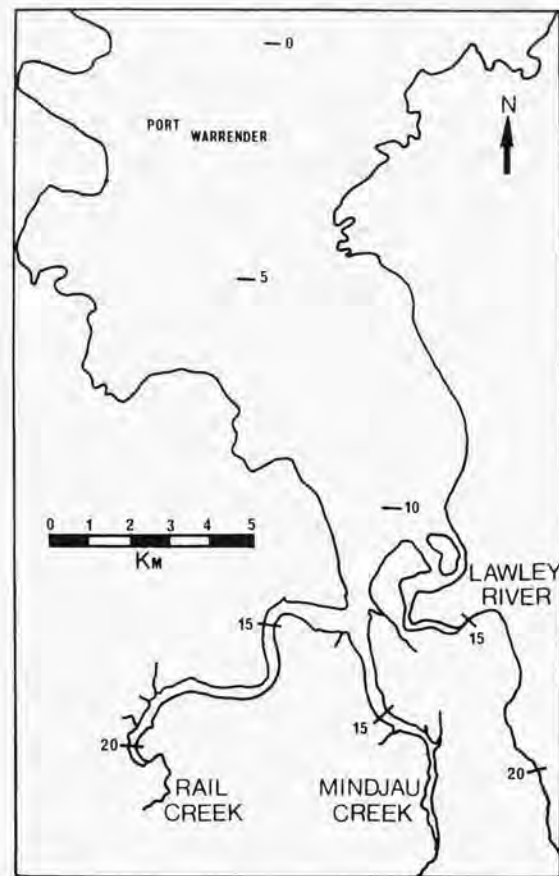


Fig. 3: Port Warrender-Lawley River system showing distances upstream (in km) for location of survey sites.

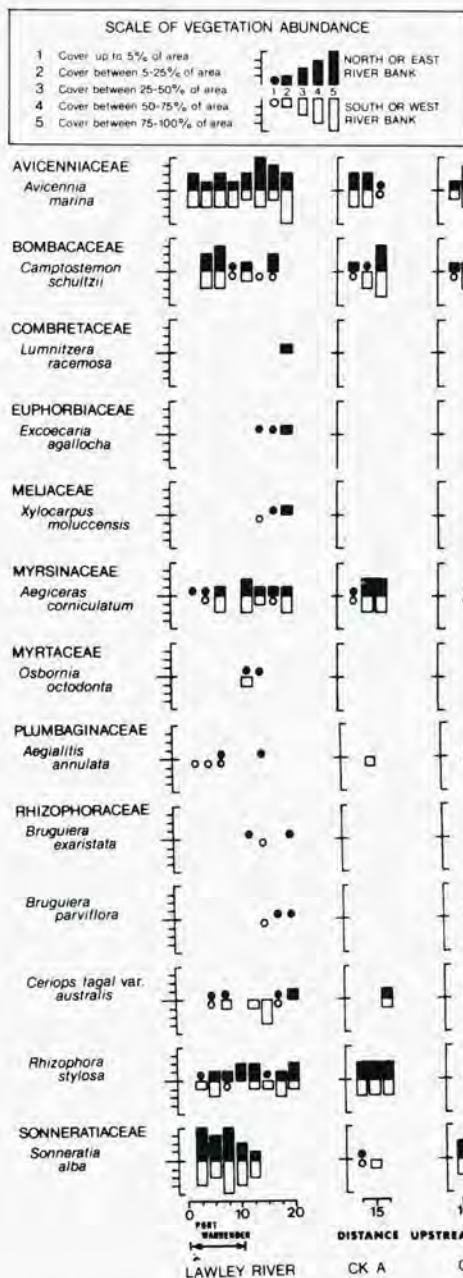


Fig. 4: Distribution and assessment of cover abundance for mangrove species within 100 m (length) x 20 m (depth) quadrats of fringing river-side vegetation along each river bank at 2.5 km intervals.

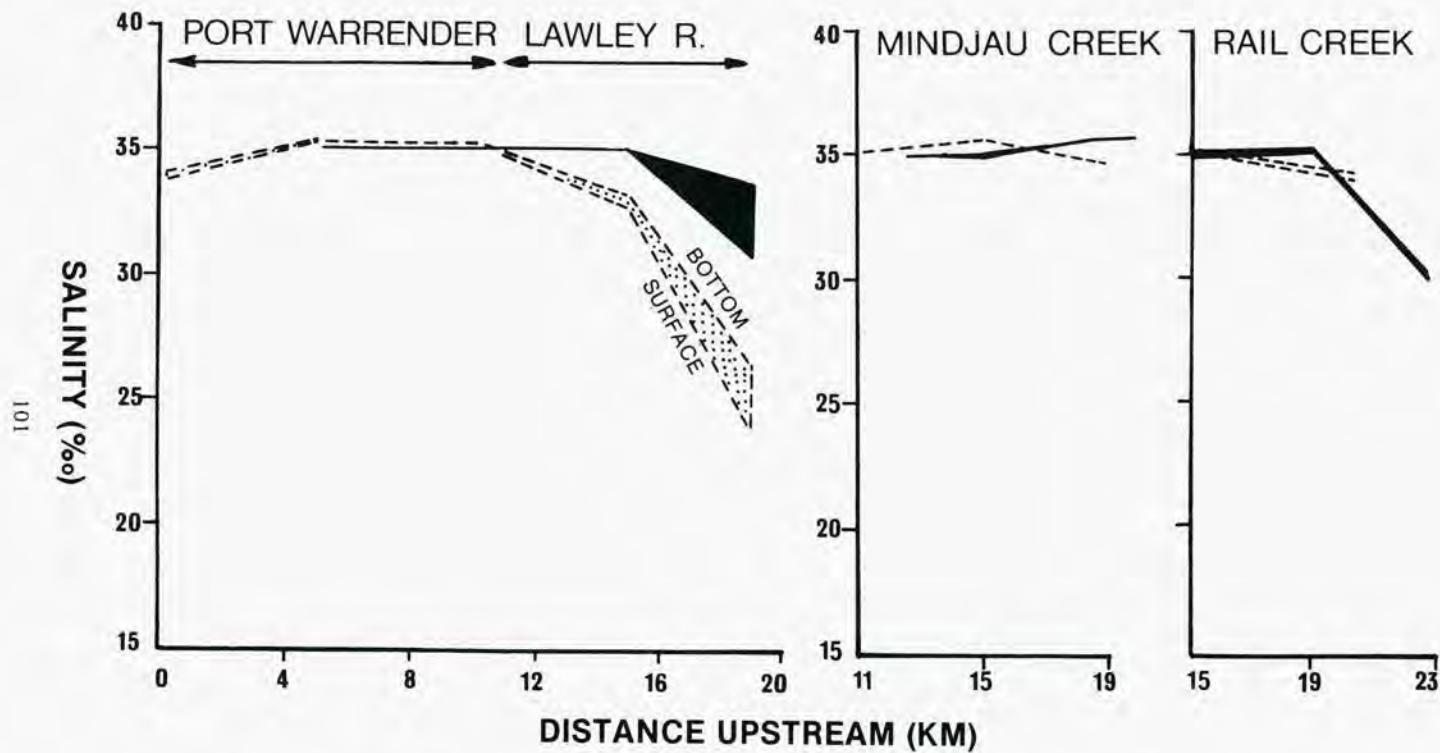


Fig. 5: High (black) and low tide (dotted) profile measurements of salinity in the Port Warrender-Lawley River system (July 1977). After Messel *et al.* 1977.

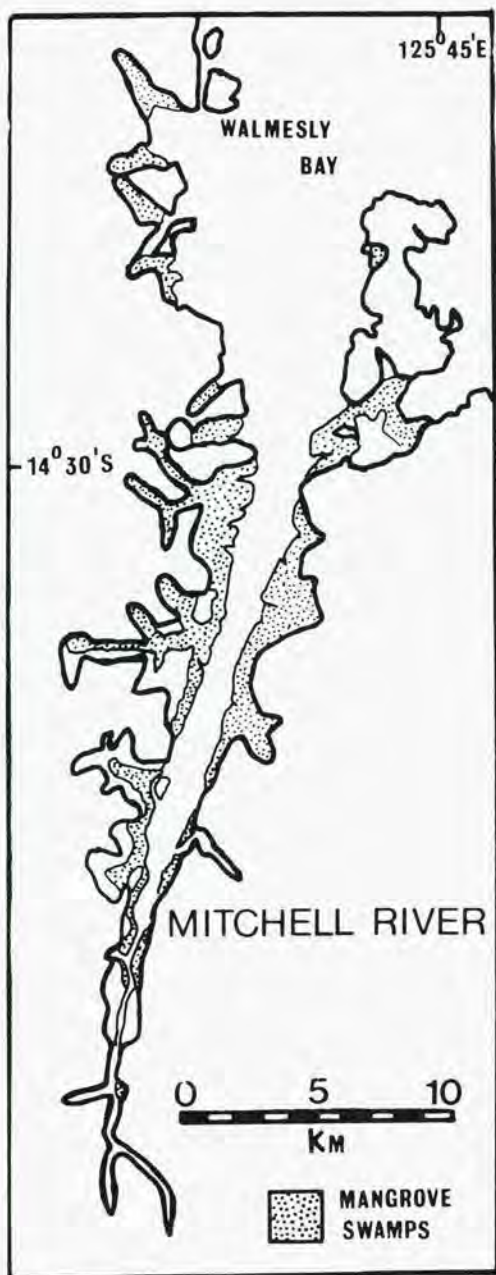


Fig. 6: Mitchell River system showing distribution of mangrove swamps.

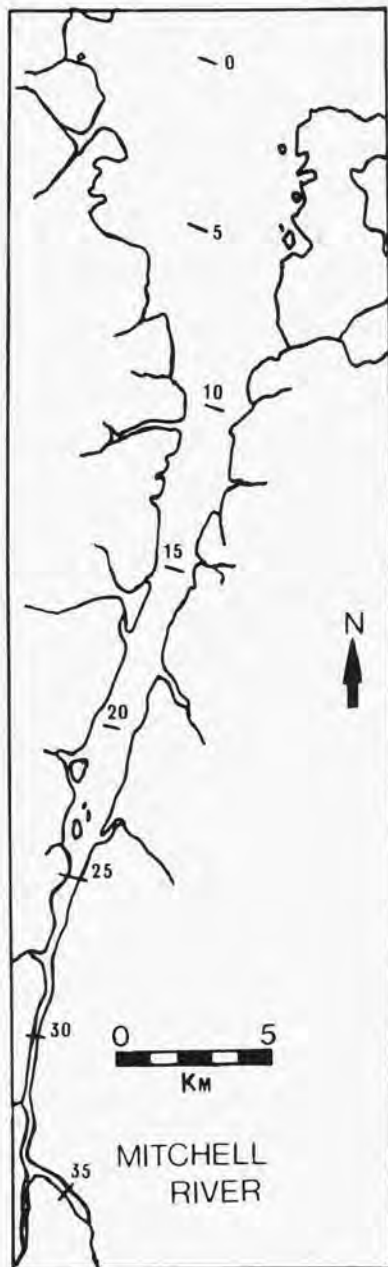


Fig. 7: Mitchell River system showing distances upstream (in km) for location of survey sites.

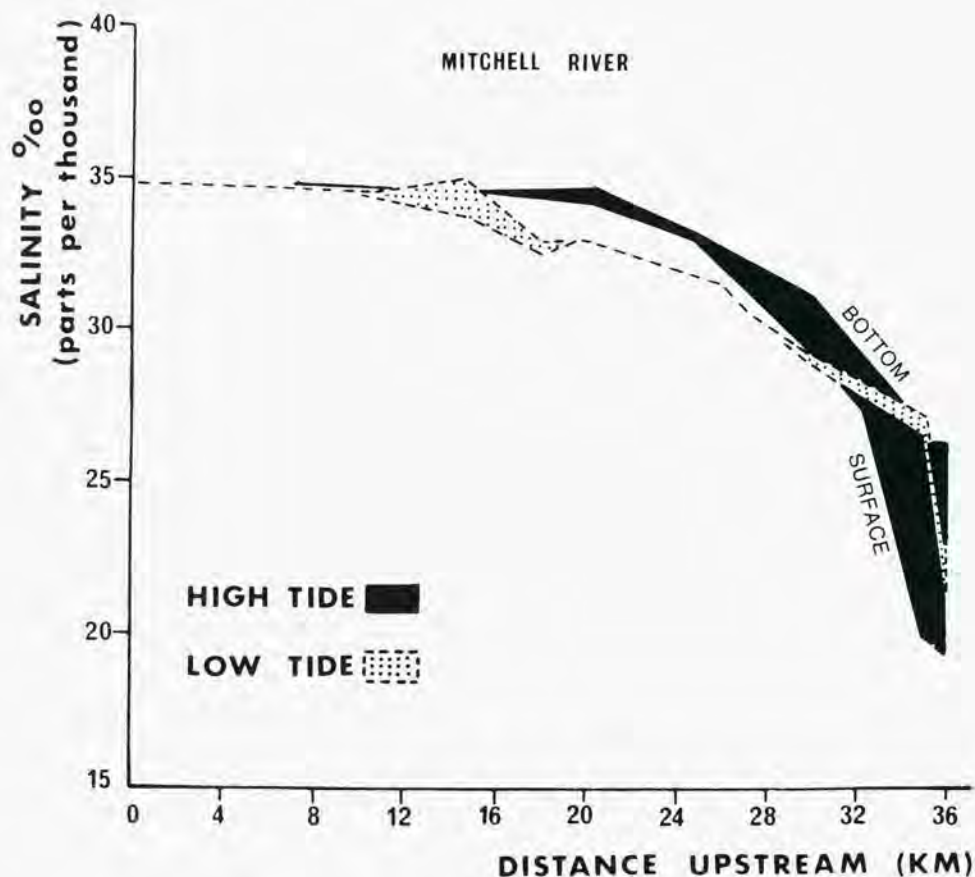


Fig. 8: High and low tide profile measurements of salinity in the Mitchell River (July 1977). After Messel *et al.* 1977.

Mitchell River System

The Mitchell River follows a fault line entering Admiralty Gulf through Walmsley Bay (Fig. 7). Deeply dissected Precambrian sandstones occur along both banks. The catchment area occupies 3193 km². Mangal occupies 45 km² along the river and the short sidecreeks (Fig. 6). From Pickering Point about 8 km upstream, there are a number of wide shallow embayments encompassing a further 14 km² of swamp—the dominant species here is *Rhizophora stylosa*.

Measurements of high and low tide salinity profiles (Fig. 8) illustrate that during July there is a decrease in salinity from 35‰ (seawater) near the river mouth to 20‰ at 36 km—the furthest limit of tidal influence.

Mangals are widespread along the sidecreeks but a relatively narrow mangrove fringe lines the main channel up to 36 km. The landward extension of the mangal is limited by rocky terrain along both banks (**Plate 2**). Extensive, gently sloping mudbanks are found throughout the entire river system, particularly along the first 20 km. The pioneer community on these mudbanks is an association of *Sonneratia alba* and *Avicennia marina* (canopy height ≤ 8 m). Low closed forest of *Rhizophora stylosa* (canopy height ≤ 8 m) occurs immediately behind this riverine fringe. The more landward forests include associations of *Camptostemon schultzei*, *Avicennia marina*, *Rhizophora stylosa* and *Xylocarpus moluccensis*.

Thickets of *Ceriops tagal* var. *australis* occur on heavy clay soils—at sites having slightly higher physiographic relief.

Distribution and assessments of cover abundance of mangrove species occurring as fringing riverside vegetation are shown in **Fig. 9**. The most abundant species are *Avicennia marina*, *Rhizophora stylosa* and *Aegiceras corniculatum*. Fringing forests of *Avicennia marina* and *Sonneratia alba* occur up to 26 km upstream. From this point, fringing riverside vegetation species merge into a tree association of *Avicennia marina*, *Rhizophora stylosa* and *Camptostemon schultzei* often with a shrub understorey of *Aegiceras corniculatum*. On rocky sites from 22.5 km upstream, an association of *Excoecaria agallocha* and *Xylocarpus moluccensis* occurs. The species *Bruguiera exaristata*, *Lumnitzera racemosa* and *Osbornia octodonta* occur within the river system but were not observed at any of the specified quadrats.

Roe River System

The Roe River enters Prince Frederick Harbour. On each side of the river mouth is a sheltered embayment with numerous short tidal creeks (**Fig. 10**). The catchment area of the Roe/Moran River System occupies 3570 km². The river course winds between Precambrian sandstone gorges—some cliffs, particularly to the north, are of basalt. The tidal range is up to 8 m and tidal influence extends 33 km upstream. Around Prince Frederick Harbour, 68 km² is vegetated by mangrove species. A further 25 km² of mangal occurs along the Roe River (**Fig. 11**). Salinity profiles upstream are shown in **Fig. 12** and are similar to other systems still receiving some fresh water input at this time of year. Several of the side creeks were also found to have significant fresh water inputs.

Distribution and assessments of cover abundance of the various mangrove species occurring as fringing riverside vegetation are shown in **Fig. 13**.

Around the river entrance and within the adjacent embayments (**Fig. 11**), *Sonneratia alba* and *Avicennia marina* form the seaward pioneer plant association. *Rhizophora stylosa* forms a band of variable width—up to 80 m—immediately behind this *Sonneratia* zone. A mixed association of *Camptostemon schultzei*, *Avicennia marina* and *Rhizophora stylosa* (canopy height ≤ 8 m) is present behind the *Rhizophora* zone. On more landward sites, thickets of *Ceriops tagal* var. *australis*, *Excoecaria agallocha* and *Avicennia marina* occur. These *Ceriops* zones

are usually less than 5 m canopy height. This zone merges into the most landward mangrove community of *Avicennia marina* (canopy height ≤ 5 m). Tidal flat areas found beyond this *Avicennia* zone are in most cases devoid of any vegetative cover. Tidal flats do not occur further upstream than 17 km.

Riverside vegetation (**Fig. 13**) is a low closed forest of *Camptostemon schultzei* and *Avicennia marina* (canopy height ≤ 10 m) with a shrub understorey of *Aegiceras corniculatum* and *Aegialitis annulata*.

Although the Roe River winds through steep sandstone gorges, extensive mudbanks are present—particularly around the convex portions of the river channel. *Rhizophora stylosa* and *Sonneratia alba* are almost entirely absent from upstream riverside vegetation. An association of *Avicennia marina* and *Excoecaria agallocha* (canopy height ≤ 5 m) becomes the dominant riverside vegetation along the last 8 km of the tidal portion of the river.

Hunter River System

The Hunter River enters Prince Frederick Harbour flowing through deeply dissected sandstone cliffs. A tributary creek meets the Hunter River 4 km from its mouth (**Fig. 10**). Tidal influence extends some 15 km up both arms. The catchment area of the Hunter River System occupies some 352 km². The area of mangal is not extensive, being 7.5 km² within the Hunter River and 13.5 km² within 'Porosus Creek'.

Measurements of high and low tide salinity are illustrated in **Fig. 12**. The flow of fresh water entering the river system at this time of year is minimal. It is likely therefore that the Hunter River System becomes hypersaline by the end of the dry season.

Along fringing mudflats, groves of *Sonneratia alba* (canopy height ≤ 8 m) are abundant, often with a carpet-like understorey of *Aegialitis annulata* (canopy height ≥ 0.5 m) (**Plates 5 and 6**). Further upstream along both arms, this pioneer *Sonneratia* fringe merges into a mixed association of *Sonneratia alba*, *Camptostemon schultzei* and *Avicennia marina*. Behind this riverine fringe is a closed forest of *Rhizophora stylosa* (canopy height ≤ 8 m) (**Plate 3**). As steep rocky terrain borders the actual river channels in many places, the more landward mangrove communities are often absent. Scattered thickets of *Ceriops tagal* var. *australis* and *Excoecaria agallocha* occur on consolidated clays at a slightly higher level of physiographic relief.

Distribution and assessments of cover abundance for mangrove species occurring as fringing riverside vegetation on the Hunter River System are shown in **Fig. 14**.

It should be noted that although the species *Lumnitzera racemosa*, *Osbornia octodonta*, *Bruguiera exaristata* and *Bruguiera parviflora* were not recorded at the time in any of the quadrats, all these species occur in the river system.

Prince Regent River System

The course of the Prince Regent River follows a fault line and enters St George Basin (**Fig. 15**). The catchment area of the river system occupies 3218 km². The tidal

range can reach 10 m and tidal influence extends 45 km upstream along the main river course. Rugged Precambrian sandstone cliffs form much of the banks, and there are few areas of mudbank along the river. Within the north bay of St George Basin, mangals occupy 70 km². A further 72 km² of mangal occurs within the southern bay of the basin (Fig. 15). These two bays contain the largest mangals in Western Australia. A further 24 km² of mangal occurs along the river and its creeks.

The low tide salinity profile (Fig. 17) shows that considerable fresh water was still flowing into the river system from areas of upstream drainage in July 1977. Salinity readings taken in St George Basin were as of seawater salinity (34‰).

Creekside vegetation within the north and south bays is comprised predominantly of *Camptostemon schultzei* with *Rhizophora stylosa* and *Avicennia marina* interspersed throughout (canopy height ≤ 8 m) with an inner zone of *Rhizophora stylosa*. Groves of *Sonneratia alba* (canopy height ≤ 9 m) occur nearest the seaward extremities of the bays on accreting mudbanks.

Fig. 18 illustrates the distribution and assessments of cover abundance of mangrove species occurring as fringing riverside vegetation in the Prince Regent River. Along the downstream portion of the main channel, narrow fringe forest of *Camptostemon schultzei*, *Rhizophora stylosa* and *Avicennia marina* (canopy height ≤ 8 m) occurs.

Plate 4 illustrates the different growth habits of *Camptostemon schultzei* on mud and rock substrate. *Sonneratia alba* is frequently observed as the pioneer species colonizing accreting mudbanks in sheltered bays along the main river course to 65 km. A shrub understorey of *Aegialitis annulata* and *Aegiceras corniculatum* is present throughout the riverside vegetation. Thickets dominated by *Ceriops tagal* var. *australis*, *Excoecaria agallocha* and *Avicennia marina* (canopy height ≤ 4.5 m) are limited along the river, due in part to the rocky terrain that precludes a landward extension of the mangal. *Xylocarpus moluccensis* is sparsely represented throughout the riverside vegetation while *Xylocarpus granatum* appears from 63 km upstream, forming an association with *Camptostemon schultzei* and *Avicennia marina*.

Although mangrove associations were only studied to 70 km upstream, it appears from inspection of aerial photographs that this tree association could continue to around 79 km upstream—the limit of tidal influence. *Bruguiera exaristata* and *Bruguiera parviflora* were infrequently observed. *Lumnitzera racemosa* did not occur within any of the riverside quadrats, this species normally being found in more landward mangrove associations. *Osbornia octodonta* was observed on rocky banks around the mouth of the river to 45 km upstream.

DISCUSSION

Within the study area, mangroves are present as fringing riverside vegetation along sheltered tidal waterways and within coastal embayments that provide protection from strong wave action. Species differ in their tolerance ranges for aeration and salinity. This is evident because plants are zoned in relation to frequency of tidal flooding. It is also demonstrated by the different species composition of the fringing riverside vegetation in lower and upper reaches of a river.

Pedley and Isbell (1971), Bird (1972) and Thom *et al.* (1975) have described somewhat similar mangrove habitat in northern Australia. Along the east Australian coastline, Macnae (1966) classified habitat zones using dominant mangrove species. His six zones comprised:

- | | |
|---------------------------------------|-----------------------------|
| 1. The landward fringe | 4. <i>Bruguiera</i> forests |
| 2. The landward <i>Avicennia</i> zone | 5. <i>Rhizophora</i> zone |
| 3. <i>Ceriops</i> thickets | 6. The seaward fringe |

Within the Kimberley area, all of these habitat zones occur, with the exception of zone 4—the *Bruguiera* forests. *Bruguiera* spp. were absent from nearly all quadrats. This is reflected in the fact that this area of the Western Australian coastline approaches the southernmost limit of distribution of this genus (Semeniuk *et al.*, 1978).

Thirteen species recognized as mangroves were observed in each of the river systems. An additional species, *Xylocarpus granatum*, was observed only in the upper reaches of the Prince Regent River and represents a new mangrove species recorded for Western Australia.

In many of the rivers studied, *Rhizophora stylosa* and *Sonneratia alba* are confined to sites in the outer estuaries. They are usually absent from mangrove associations occurring in the upper reaches of portions of the rivers. Thom *et al.* (1975) postulate that the distribution of *Rhizophora stylosa* could be a result of the species' inability to tolerate periodic low salinities in upstream areas. From my own examination of numerous tidal river systems in northern Australia (unpublished data), it is evident that *Rhizophora stylosa* can in fact tolerate periodic low salinities. An explanation offered here for the absence of the species from upstream sites is that sites of suitable physiographic relief for colonization are lacking. In the upper reaches of tidal portions, the most common riverside tree association is of *Avicennia marina* and *Excoecaria agallocha*. This association is normally found on more landward sites that are inundated only by spring tides. Steep rises in river and surrounding land gradients in the Kimberley result in the more landward mangrove associations now becoming the fringing riverside tree association in upstream areas. Such sites are only inundated by spring tides. *Rhizophora stylosa* normally grows in areas frequently inundated by the tide and because the upstream sites are only periodically inundated soil salinities experienced in the *Avicennia/Excoecaria* association could be well above the tolerance level of *Rhizophora stylosa* by the end of the dry season.

Sonneratia alba colonizes accreting mudbanks in the outer estuarine areas. The salinity tolerance of this species is not as wide as *Rhizophora stylosa*, but again the restricted distribution of the species is most likely a combination of lack of suitable sites for colonization and the relatively high soil salinities that would occur in the riverside *Avicennia/Excoecaria* association towards the end of the dry season.

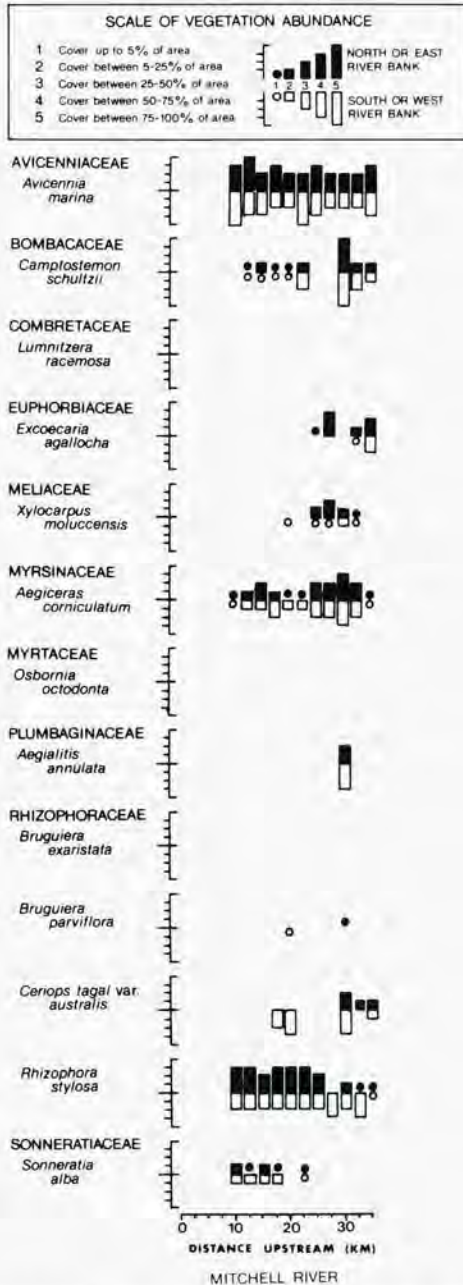


Fig. 9: Distribution and cover abundance of mangrove species within 100 m (length) x 20 m (depth) quadrats of fringing riverside vegetation along each river bank at 2.5 km intervals.

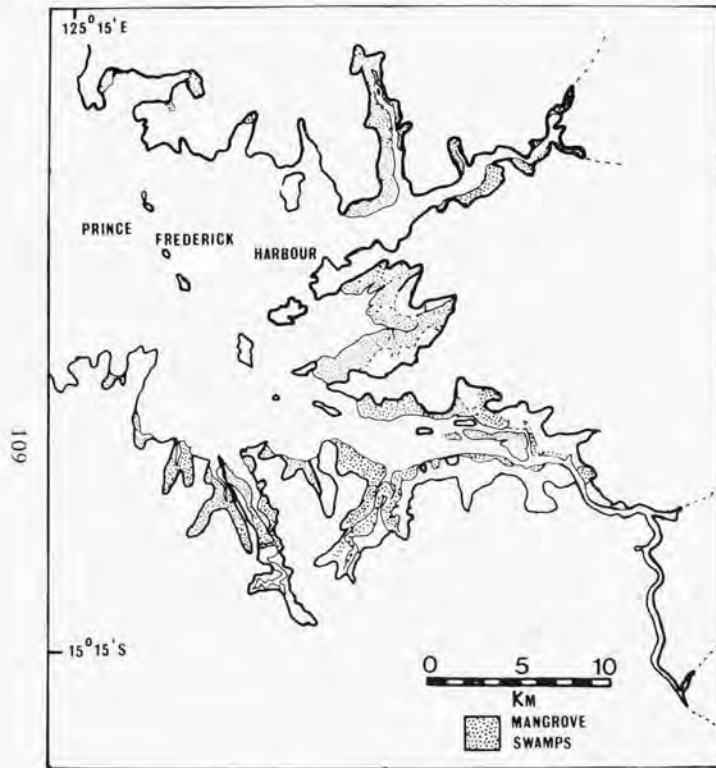


Fig. 10: Roe and Hunter River systems showing distribution of mangrove swamps.

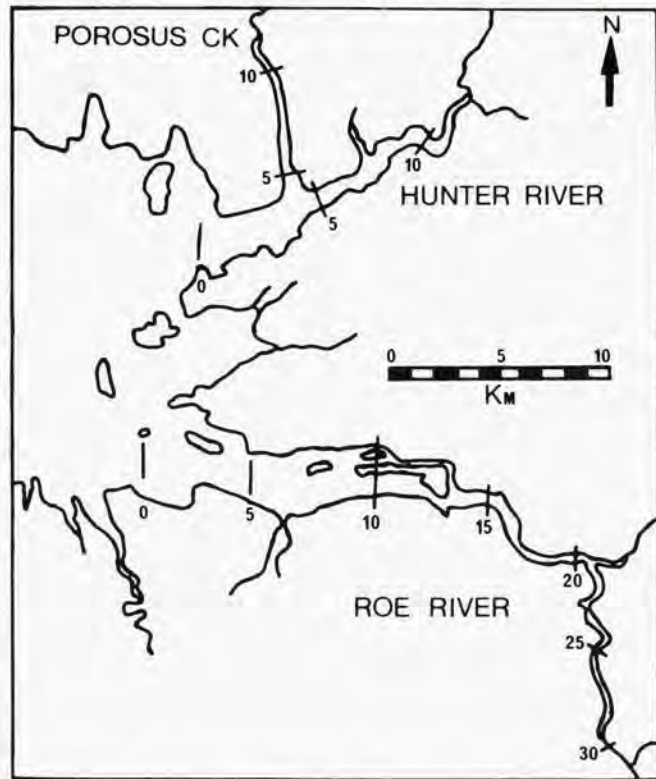


Fig. 11: Roe and Hunter River systems showing distances upstream (in km) for location of survey sites.

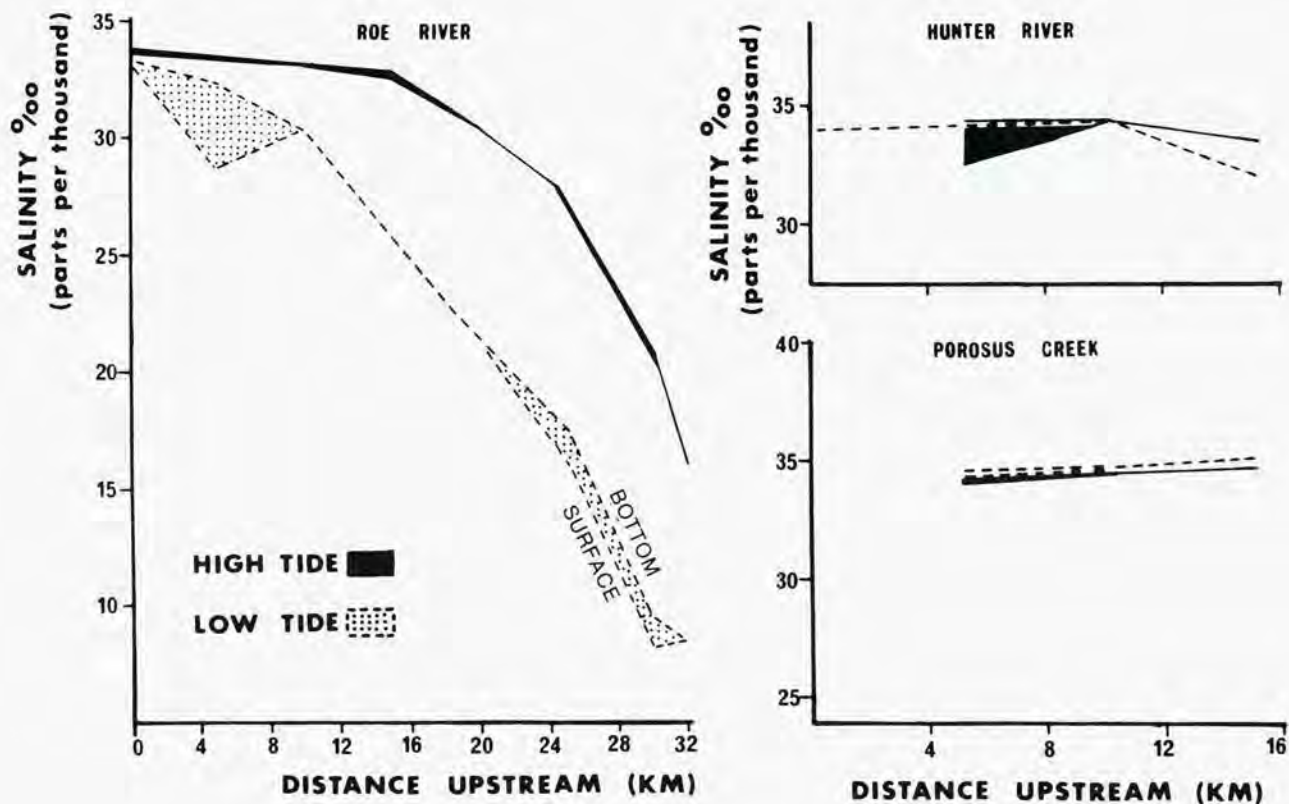


Fig. 12: High and low tide profile measurements of salinity in the Roe and Hunter River systems (July 1977). After Messel *et al.* 1977.

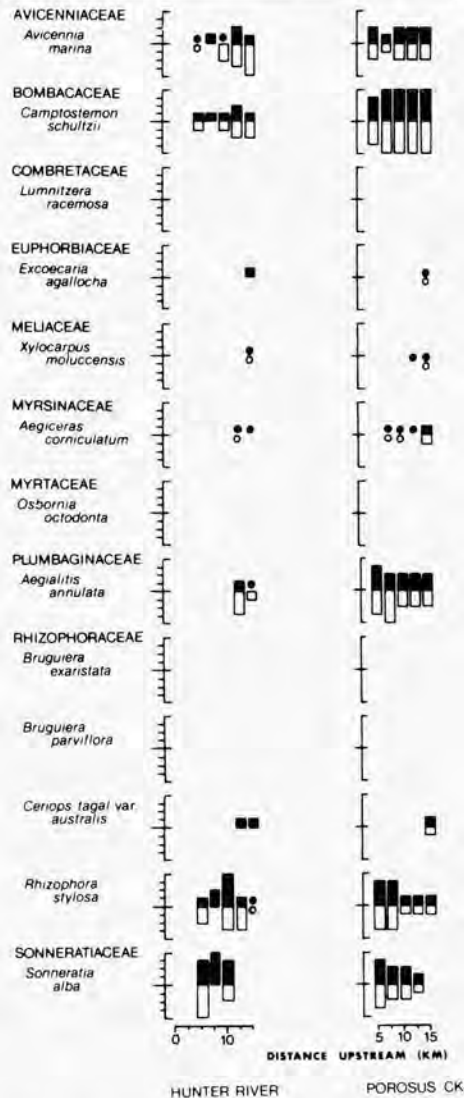
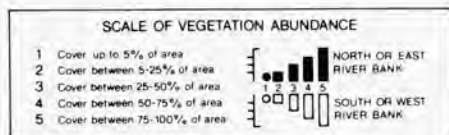
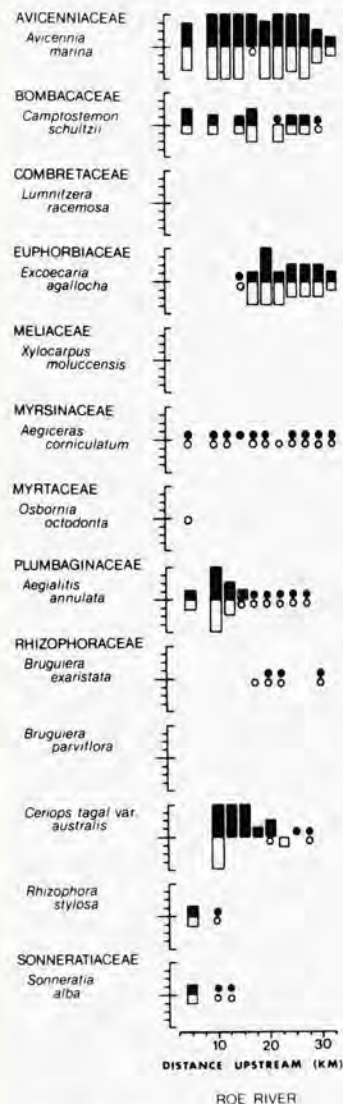
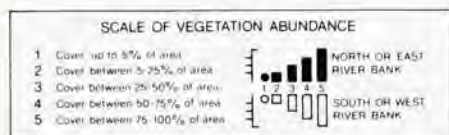


Fig. 13: Distribution and assessment of cover abundance for mangrove species within 100 m (length) x 20 m (depth) quadrats of fringing riverside vegetation along each river bank at 2.5 km intervals.

Fig. 14: Distribution and assessment of cover abundance for mangrove species within 100 m (length) x 20 m (depth) quadrats of fringing riverside vegetation along each river bank at 2.5 km intervals.

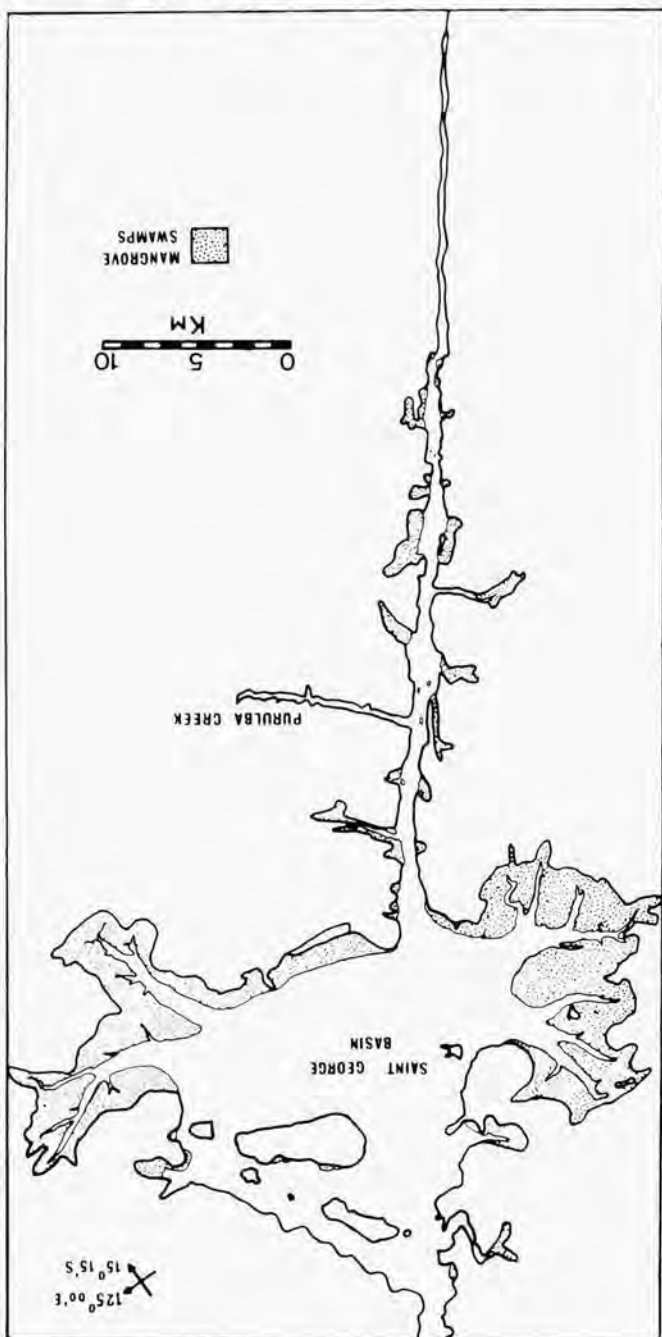


Fig. 15: Prince Regent River system showing distribution of mangrove swamps.

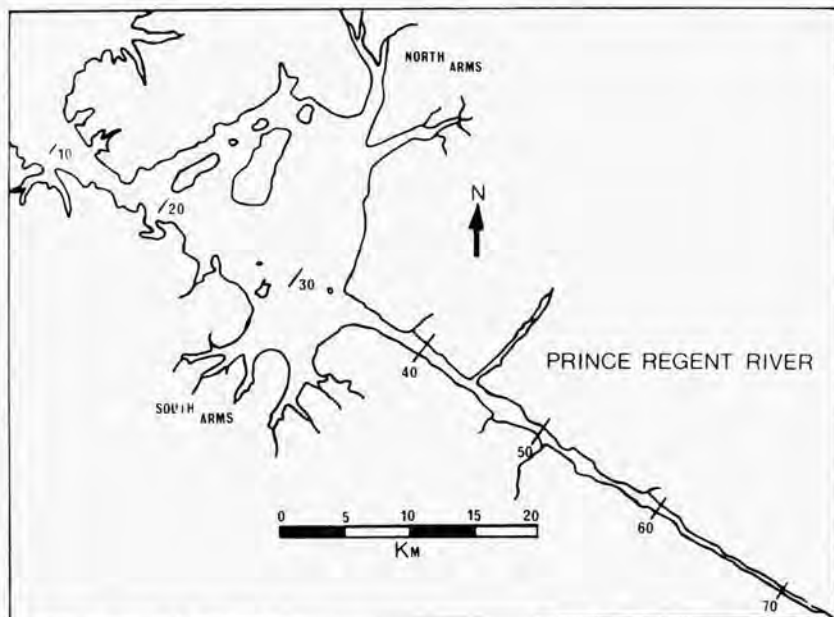


Fig. 16: Prince Regent River system showing distance upstream (in km) for location of survey sites.

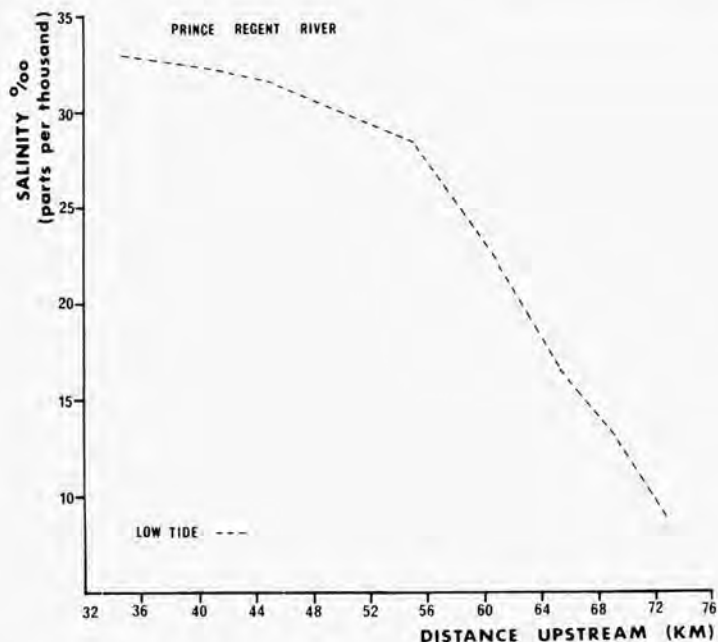


Fig. 17: Low tide profile measurements of salinity in the Prince Regent River (July 1977). After Messel *et al.* 1977.

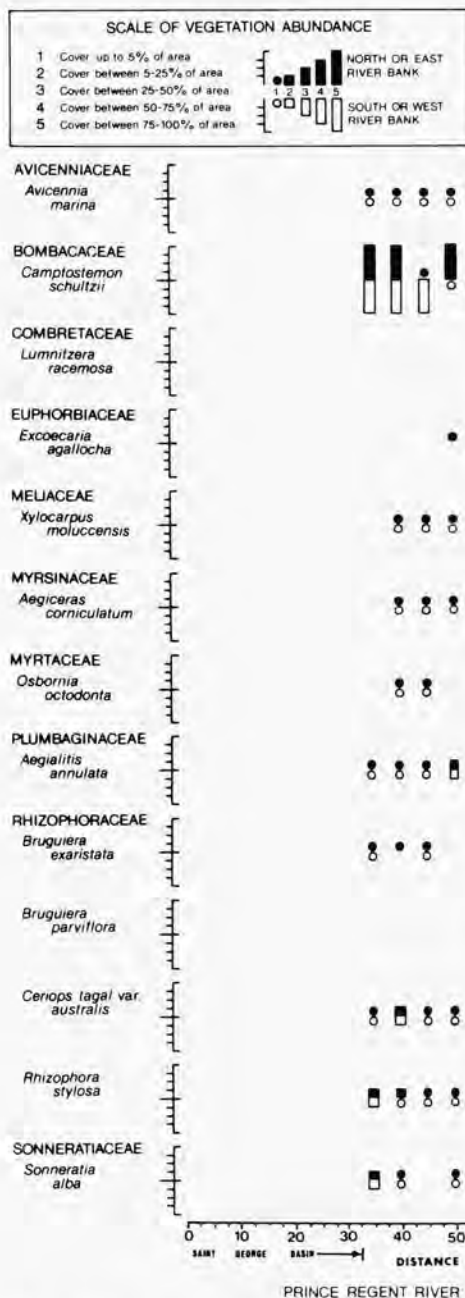


Fig. 18: Distribution and assessment of cover abundance for mangrove species within 100 m (length) x 20 m (depth) quadrats of fringing river-side vegetation along each river bank at 2.5 km intervals.



Plate 1: Association of *Avicennia marina* and *Camptostemon schultzei* colonizing low gradient mudbank near the mouth of the Lawley River.



Plate 2: *Avicennia/Excoecaria* association established in mud substrate along the sandstone banks of Surveyors Creek — a tidal arm of the Mitchell River system.



Plate 3: *Rhizophora stylosa* showing two growth habits (with and without aerial roots). *Avicennia marina* is in the centre with seedlings of *Aegialitis annulata* in the foreground. 'Porosus' Creek — Hunter River system.



Plate 4: Growth habits of *Campylopus schultzei* on mud and rock substrates, Prince Regent River.



Plate 5: Saplings of *Sonneratia alba* with dense carpet-like understorey of *Aegialitis annulata*, Hunter River system. Note the rocky terrain limiting landward extension of the mangrove swamp.

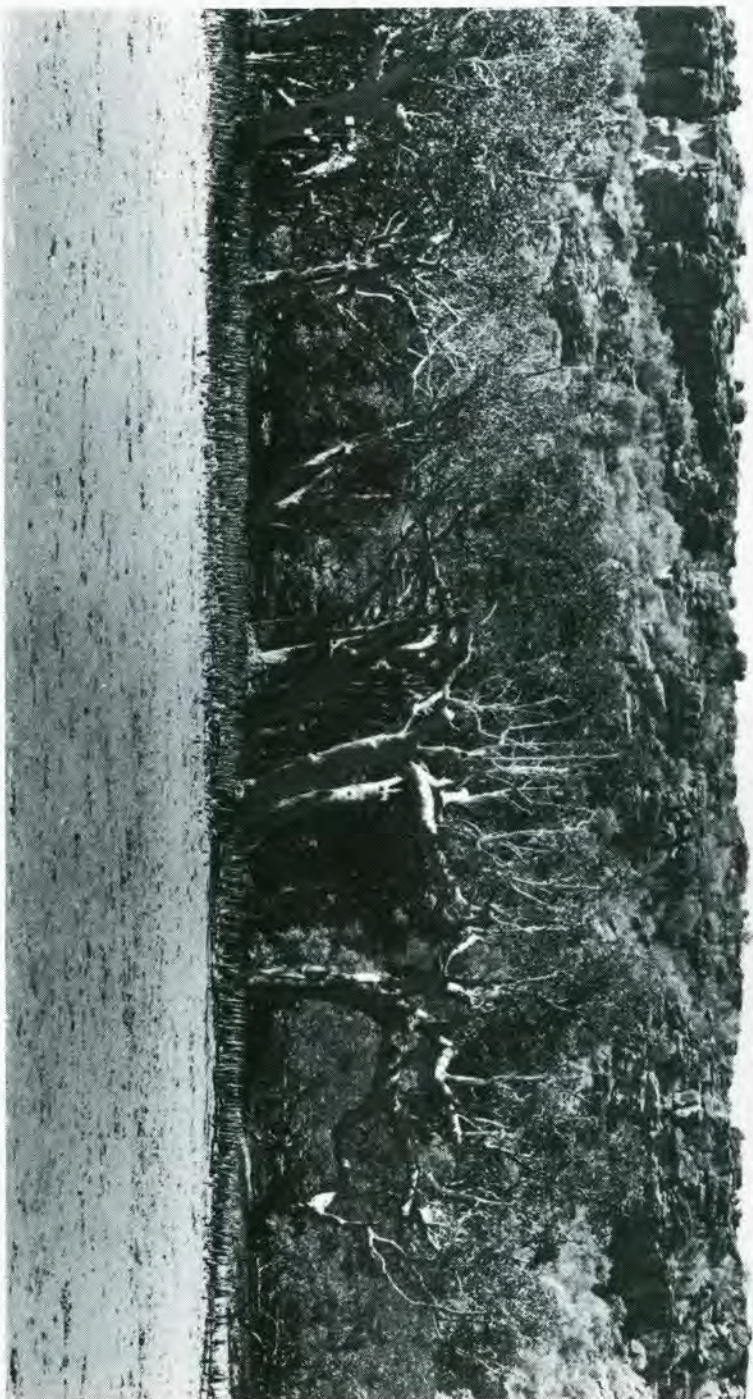


Plate 6: Grove of *Sonneratia alba* with characteristic pneumatophores (breathing roots), Hunter River.

ACKNOWLEDGEMENTS

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Distribution of mangrove species in Australia

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Abstract. In Australia, mangroves occur in small pockets around the coastline. They are most prominent around the northern coastline and have only isolated occurrences in Victoria, South Australia and south of Carnarvon in Western Australia. No mangrove species is recorded for Tasmania.

The geographical location of the continent provides scope to look at present distribution of the various species through an extremely wide latitudinal range (11° – 38° S). Many species show restricted distributions which may be attributed to past and present historical and environmental conditions. The number of mangrove species in Australia (33) decreases with increasing latitude with most distributions extending further down the eastern than the western coastline and at the southernmost limit of mangroves in the world – Corner Inlet, Victoria ($38^{\circ}45'$ S, $146^{\circ}30'$ E) – only the species *Avicennia marina* var. *australasica* remains.

Introduction

Within Australia, studies by various workers, over-viewed by Gill (1975) and Saenger et al. (1977) and additional researches by George and Kenneally (1975); Lear and Turner (1977); Messel et al. (1977); Saenger and Robson (1977); Specht et al. (1977); Semeniuk et al. (1978); Bunt (1978); Dowling (1979); Duke and Bunt (1979); Messel et al. (1979, a–g), (1980, a–f), (1981, a–c); Bunt and Williams (1980); Olsen et al. (1980); Semeniuk et al. (1980); Dowling and McDonald (1981); Kenneally (1981) and Wells (1981a, b), now provide considerable information on occurrences of the various mangrove tree, shrub and herb species around this continent.

With a mainland coastline estimated at 19,650 km and extending from 11° to 39° S, mangrove communities change in floristics and structure under various climatic, physiographic and edaphic conditions. The area occupied by mangrove vege-

tation is estimated by Galloway (1981) at 11,617 km², of which 10,827 km² occurs north of the Tropic of Capricorn (23° S). His estimate for the Queensland coastline (4,629 km²) is closely followed by the Northern Territory (4,130 km²) and Western Australia (2,517 km²), with the southern mainland states of New South Wales, Victoria and South Australia accounting for only 341 km², or 3%, of mangrove swamp in Australia (Galloway, 1981).

Floristically and structurally, mangrove vegetation shows greatest development in north-eastern Queensland where at least thirty-three 'mangrove' species belonging to sixteen families of angiosperms have been recorded. Within the Northern Territory occur twenty-six species from thirteen plant families, whilst only seventeen species from twelve families are presently recorded from Western Australia (Table 2).

From the point of view of species distributions, the only portion of the coastline that now requires

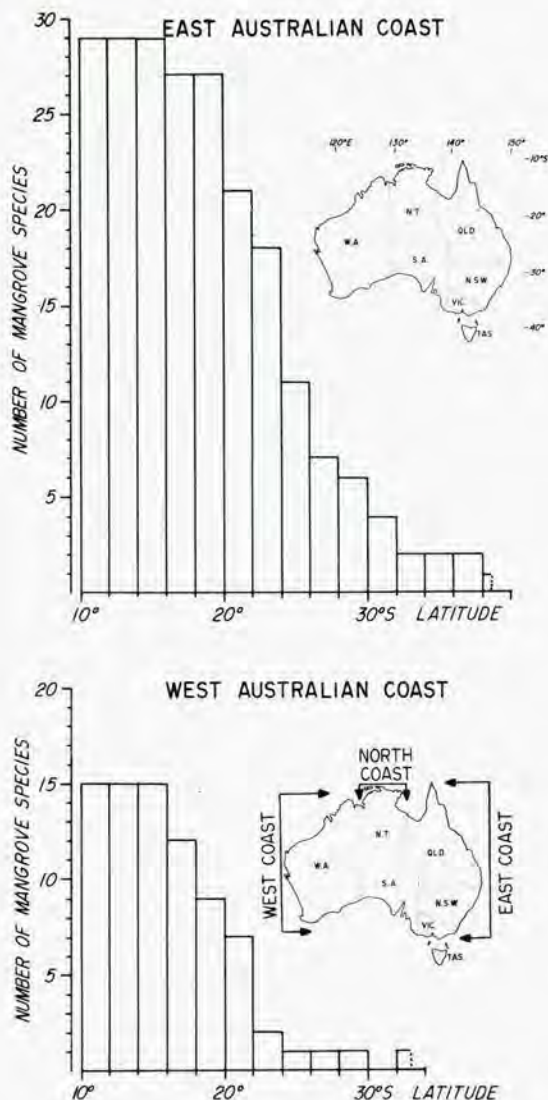


Fig. 1. Number of Mangrove species recorded in 2° latitudinal subdivisions down the east and west coasts of Australia.

intensive study lies between Weipa and Karumba on the eastern shores of the Gulf of Carpentaria (Queensland). Work is currently underway at the Australian Institute of Marine Science to describe several new *Sonneratia* species and their respective distributions.

Methods

This study involved a detailed survey of species

Table 1. Mangrove species recorded in Australia.

Acanthaceae	<i>Acanthus ebracteatus</i> Vahl.
	<i>Acanthus ilicifolius</i> L.
Avicenniaceae	<i>Avicennia marina</i> (Forsk.) Vierh.
	<i>Avicennia officinalis</i> L.
Bignoniaceae	<i>Dolichandrone spathacea</i> (L.f.) K. Sch.
Bombacaceae	<i>Camptostemon schultzei</i> Mas.
Combretaceae	<i>Lumnitzera littorea</i> (Jack.) Voigt.
	<i>Lumnitzera racemosa</i> Willd.
	<i>Lumnitzera rosea</i> (Gaud.) Presl.
Euphorbiaceae	<i>Excoecaria agallocha</i> L.
Leguminosae	<i>Cynometra ramiflora</i> var. <i>Bijuga</i> (Spanoghe) Benth.
Meliaceae	<i>Xylocarpus australasicus</i> Ridl.
	<i>Xylocarpus granatum</i> Koen.
Myrsinaceae	<i>Aegiceras corniculatum</i> (L.) Blanco
Myrtaceae	<i>Osbornia octodonta</i> F. Muell.
Nypaceae	<i>Nypa fruticans</i> Wurmb.
Plumbaginaceae	<i>Aegialitis annulata</i> R. Br.
Rhizophoraceae	<i>Bruguiera cylindrica</i> (L.) Bl.
	<i>Bruguiera exaristata</i> Ding Hou.
	<i>Bruguiera gymnorhiza</i> (L.) Lamk.
	<i>Bruguiera parviflora</i> (Roxb.) W & A ex Griff.
	<i>Bruguiera sexangula</i> (Lour.) Poir.
	<i>Ceriops decandra</i> (Griff.) Ding Hou.
	<i>Ceriops tagal</i> (Perr.) C.B. Rob. var. <i>australis</i> C.T. White
	<i>Ceriops tagal</i> (Perr.) C.B. Rob
	<i>Rhizophora apiculata</i> Blume
	<i>Rhizophora lamarckii</i> Montr.
	<i>Rhizophora mucronata</i> Lamk.
	<i>Rhizophora stylosa</i> Griff.
Rubiaceae	<i>Scyphiphora hydrophyllacea</i> Gaertn. f.
Sterculiaceae	<i>Heritiera littoralis</i> (Dryand) Ait.
Sonneratiaceae	<i>Sonneratia alba</i> J.E. Sm.
	<i>Sonneratia caseolaris</i> (L.) Engl.
	<i>Sonneratia</i> spp.

present on most tidal waterways across northern Australia where previously distributions of mangrove species were very imperfectly known. The extreme distributional limits of many species on the east coast of Queensland draw largely on the findings of Jones (1971), Bunt (1978), Duke and Bunt (1979), the latter authors' current research at the Australian Institute of Marine Science and of Dowling at the Queensland Herbarium. For much of the west Australian coastline not surveyed by the author of this article, the findings of Semeniuk et al. (1978) have also proved invaluable.

Table 2. Distribution of mangrove species in Australia in latitudinal subdivisions.

Species	Northern coastline (N.T.)		East Australian coastline																West Australian coastline											
	LAT	10-12° S	10-12° S	12-14°	14-16°	16-18°	18-20°	20-22°	22-24°	24-26°	26-28°	28-30°	30-32°	32-34°	34-36°	36° + 38°	-38°-45°		10-12° S	12-14°	14-16°	16-18°	18-20°	20-22°	22-24°	24-26°	26-28°	28-30°	30-32°	33° 16'
<i>Acanthus ebracteatus</i>			x																		x									
<i>Acanthus ilicifolius</i>		x	x	x	x	x	x	x	x										x	x										
<i>Aegialitis annulata</i>		x	x	x	x	x	x	x	x	x									x	x	x	x	x	x						
<i>Agiceras corniculatum</i>		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x							
<i>Avicennia marina</i>		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		x
<i>Avicennia officinalis</i>		x																												
<i>Bruguiera cylindrica</i>			x	x	x																									
<i>Bruguiera exaristata</i>		x	x	x	x	x	x	x	x										x	x	x	x	x	x						
<i>Bruguiera gymnorhiza</i>		x	x	x	x	x	x	x	x	x	x	x																		
<i>Bruguiera parviflora</i>		x	x	x	x	x	x	x											x	x	x									
<i>Bruguiera sexangula</i>		x	x	x	x	x	x																							
<i>Campostemon schultzei</i>		x	x	x	x														x	x	x	x								
<i>Ceriops decandra</i>		x	x	x	x	x	x																							
<i>Ceriops tagal</i> var. <i>australis</i>		x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x	x						
<i>Ceriops tagal</i>		x	x	x	x	x	x	x	x	x																				
<i>Cynometra ramiflora</i>																														
var. <i>bijuga</i>			x	x	x	x	x	x																						
<i>Dolichandrone spathacea</i>			x																											
<i>Excoecaria agallocha</i>		x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x							
<i>Heritiera littoralis</i>			x	x	x	x	x	x	x																					
<i>Lumnitzera littorea</i>		x	x	x	x	x	x																							
<i>Lumnitzera racemosa</i>		x	x	x	x	x	x	x	x	x	x								x	x	x	x								
<i>Lumnitzera rosea</i>								x																						
<i>Osbornia octodonta</i>		x	x	x	x	x	x	x	x	x									x	x	x	x	x	x						
<i>Nypa fruticans</i>		x		x	x	x	x																							
<i>Rhizophora apiculata</i>		x	x	x	x	x	x	x	x																					
<i>Rhizophora lamarckii</i>		x	x	x	x	x	x	x	x																					
<i>Rhizophora mucronata</i>			x	x	x	x	x																							
<i>Rhizophora stylosa</i>		x	x	x	x	x	x	x	x	x	x	x	x						x	x	x	x	x	x						
<i>Scyphiphora</i>																														
<i>hydrophyllacea</i>		x	x	x	x	x	x												x	x										
<i>Sonneratia alba</i>		x	x	x	x	x	x	x	x										x	x	x	x	x							
<i>Sonneratia caseolaris</i>		x		x	x	x	x																							
<i>Xylocarpus australasicus</i>		x	x	x	x	x	x	x	x										x	x	x	x								
<i>Xylocarpus granatum</i>		x	x	x	x	x	x	x	x	x																				
Totals:		26	29	29	29	27	27	21	18	11	7	6	4	2	2	2	1		15	15	15	12	9	7	2	1	1	1	0	1

Species distributions shown as dot patterns in the ensuing figures are not indicative of a particular locality recorded with a herbarium specimen, although this may be the case, but rather the specific area of the coastline over which the species has been recorded.

Voucher specimens of mangroves from most portions of the coastline have been deposited in the various herbaria throughout Australia.

Results

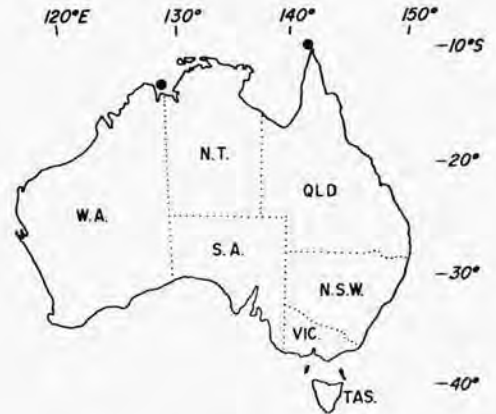
Mangrove species currently recorded in Australia are shown in Table 1 with distributions along the eastern, northern and western coastlines (in latitudinal subdivisions) being provided in Figure 1 and Table 2.

Distributional information for individual species is presented under each species.

ACANTHACEAE

Acanthus ebracteatus

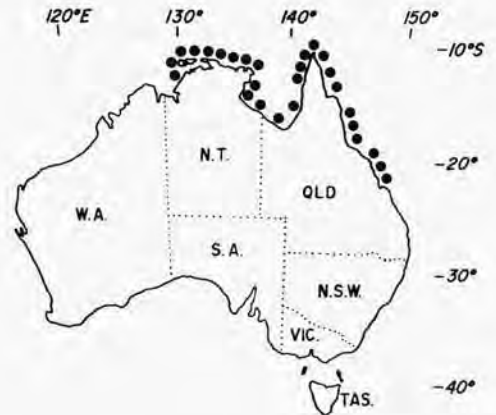
This species has only been recorded from a few localities in Australia – King River near Wyndham ($15^{\circ}30'S$, $128^{\circ}05'E$) in Western Australia (Semeniuk et al., 1978) and in the upper reaches of the Escape River ($10^{\circ}59'S$) on Cape York Peninsula (Duke, pers. comm.).



Acanthus ilicifolius

The southernmost limits of distribution of this species are the Daly River ($13^{\circ}10'S$, $130^{\circ}14'E$) on the west coast of the Northern Territory (Wells, 1981b) and St Lawrence, Qld. ($22^{\circ}15'S$) on the east Australian coastline (Jones, 1971).

Acanthus ilicifolius, although often locally abundant, is discontinuous in occurrence on tidal waterways of the Northern Territory eastwards of the Daly River. The species is particularly uncommon on tidal waterways entering the Gulf of Carpentaria but is more abundant (although still discontinuous in occurrence) along the north-eastern Australian coastline (Bunt, 1978; Duke and Bunt, Dowling, pers. comm.).



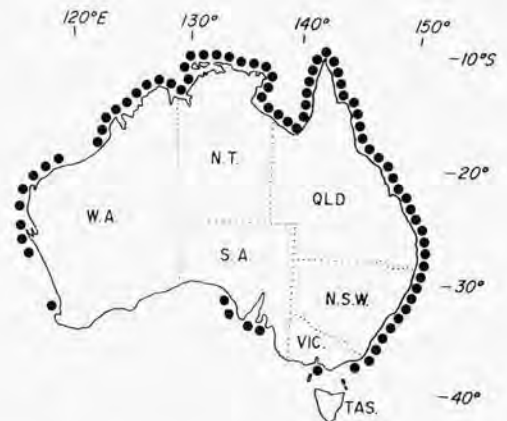
AVICENNIACEAE

Avicennia marina

The southernmost limits of distribution of this species are Leschenault Inlet, Bunbury ($33^{\circ}16'S$, $115^{\circ}42'E$) on the west Australian coast and at Corner Inlet, Victoria ($38^{\circ}45'S$, $146^{\circ}42'E$) on the south-east Australian coast.

Avicennia marina at Corner Inlet is the southernmost occurrence of any mangrove species in the world.

The occurrence of *Avicennia marina* at Bunbury is considered by Semeniuk et al., 1978, to be an outlier as the species does not reappear to the north along the west Australian coastline until the Abrolhos Islands are reached. Northwards from this point *Avicennia marina* is common at suitable sites around the entire coastline to Corner Inlet in



Victoria. Isolated pockets of this species also occur in protected coastal pockets throughout South Australia (Butler et al., 1977).

Avicennia officinalis

The restricted distribution of this species could be a result of its being at the edge of its geographical range in northern Australia.

Avicennia officinalis has not been recorded west of Buffalo Creek, Darwin, NT ($12^{\circ}20'S$, $130^{\circ}57'E$) or east of the Glyde River ($12^{\circ}16'S$, $135^{\circ}03'E$) in eastern Arnhem Land (Wells, 1981b). That *Avicennia officinalis* does not occur in rivers entering the north coast of Melville Island is most unusual as this species is quite widely distributed throughout southeast Asia (Chai, 1973; Chapman, 1975).

BIGNONIACEAE

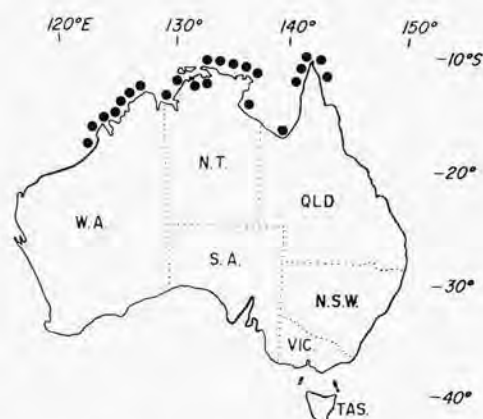
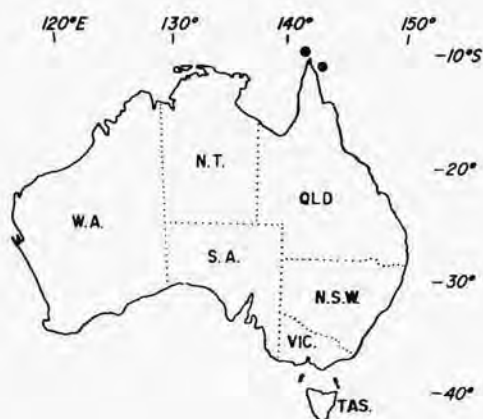
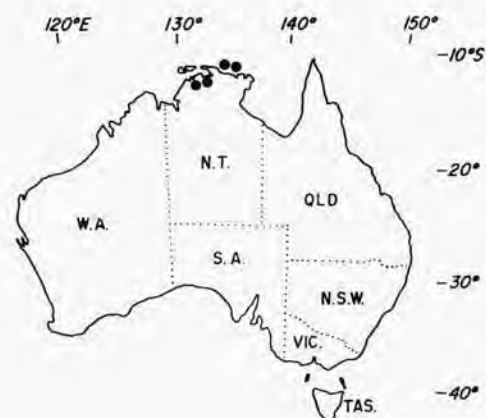
Dolichandrone spathacea

This species is currently recorded from only two sites in north-east Queensland – Cowal Creek ($10^{\circ}54'S$) and the Olive River ($12^{\circ}10'S$) on Cape York Peninsula (Duke, pers. comm.).

BOMBACACEAE

Campostemon schultzei

The southernmost limits of distribution of *Campostemon schultzei* are Cape Bossut ($18^{\circ}43'S$, $121^{\circ}38'E$) on the west Australian coastline (Semeniuk et al., 1978) and the Pascoe River, Qld ($12^{\circ}31'S$) on the east Australian coastline (Duke, pers. comm.). The species is common from Cape Bossut to Gove ($12^{\circ}13'S$, $136^{\circ}42'E$) in the Northern Territory, excluding the Joseph Bonaparte Gulf region where it is uncommon and the north coast of Melville Island, where it is unrecorded (Wells, 1981b). *Campostemon schultzei* has not been recorded on any tidal waterway entering the western shores of the Gulf of Carpentaria although isolated trees of this species were collected on the Limmen Bight River ($15^{\circ}06'S$, $135^{\circ}42'E$), which enters into the southern portion of the Gulf of Carpentaria. The species is unknown on any other tidal water-



way entering the southern shoreline of the Gulf of Carpentaria across to Karumba (Saenger and Hopkins, 1975; Wells, 1981b).

Along the eastern shores of the Gulf of Carpentaria this species occurs at least as far south as Weipa Qld. ($12^{\circ}40'S$, $141^{\circ}50'E$) (Specht et al.,

1977). Bunt (1978) describes the distribution of *Camptostemon schultzei* down the east Australian coast as being discontinuous in occurrence down Cape York.

Camptostemon schultzei is one of the few mangrove species that comes close to being endemic to

Australia. As well as its wide distribution across northern Australia, the species also occurs in tidal waterways entering the Gulf of Papua (Percival and Womersley, 1975; Floyd, 1977) and Ambon Island in the Moluccas (Chapman, 1976).

EUPHORBIACEAE

Excoecaria agallocha

The southernmost limits of distribution of *Excoecaria agallocha* are at Thangoo Station (18°16'S, 122°10'E) on the west Australian coast (Semeniuk et al., 1978) and the Hastings River, NSW (31°26'S, 152°26'E) on the east Australian coast (Floyd, 1980). *Excoecaria agallocha* is reasonably abundant throughout its range except at sites along the NSW coastline, where it is discontinuous in occurrence.

It occurs on most tidal waterways particularly in association with *Avicennia marina*, *Ceriops tagal* var. *australis* and *Lumnitzera racemosa* on consolidated muds in the more landward, less frequently inundated zones.

LEGUMINOSAE

Cynometra ramiflora var. *bijuga*

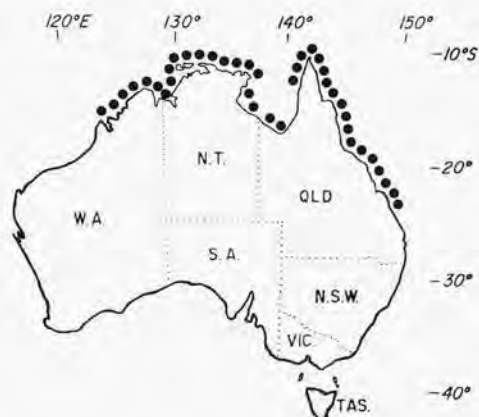
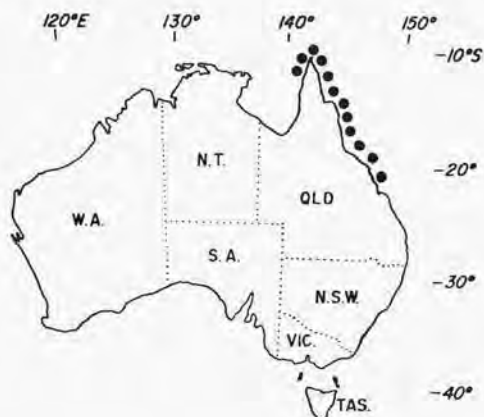
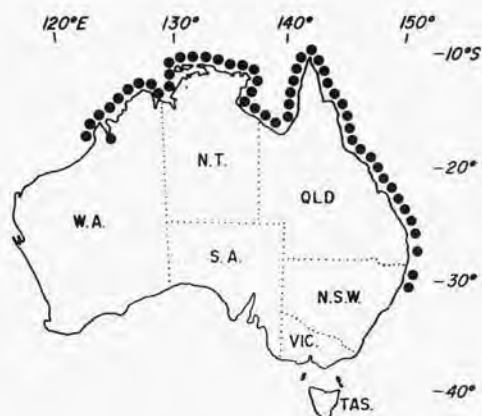
This species has not been recorded in either Western Australia nor the Northern Territory. It is first recorded at Port Musgrave, Qld (12°00'S, 141°54'E) on the eastern shores of the Gulf of Carpentaria (pers. obs.) and extends around Cape York and down the east Australian coastline (Bunt, 1978) to Mackay, Qld. (21°08'S) (Jones, 1971).

MELIACEAE (cont. on p. 64)

Xylocarpus australasicus

The southernmost limits of distribution of *Xylocarpus australasicus* are King Sound, Derby (17°19'S, 123°38'E) on the west Australian coast (Semeniuk et al., 1978) and Gladstone, Qld. (23°50'S) on the east Australian coast (Saenger and Robson, 1977).

Throughout this area *Xylocarpus australasicus* commonly occurs as isolated trees amongst the



fringing vegetation along tidal waterways. In portions of tidal waterways of the Northern Territory that remain brackish for long periods, *Xylocarpus australasicus* may occur as a dominant tree species

typically in association with *Diospyros ferrea* var. *humilis*, *Bruguiera parviflora* and *Rhizophora stylosa* on suitable substrates.

COMBRETACEAE

Lumnitzera littorea

Lumnitzera littorea has not been recorded west of the Johnston River (11° 18'S, 131° 10'E) on Melville Island. Distribution of the species across the northern portion of Arnhem Land is discontinuous and it has not been recorded south of the Rose River (14° 17'S, 135° 44'E) on the western shore of the Gulf of Carpentaria (Wells, 1981b).

Saenger and Hopkins (1975) record *Lumnitzera littorea* at Tarrant Point (17° 23'S, 139° 25'E) in the south-eastern portion of the Gulf of Carpentaria and Woolston (1973) also records the species at Mornington Island.

Along the eastern shore of the Gulf of Carpentaria, *Lumnitzera littorea* occurs at least as far south as Weipa (Love, pers. comm.). On the east Australian coast this species is recorded south to the Herbert River, Qld. (18° 32'S) (Jones, 1971), although it has a discontinuous distribution through-

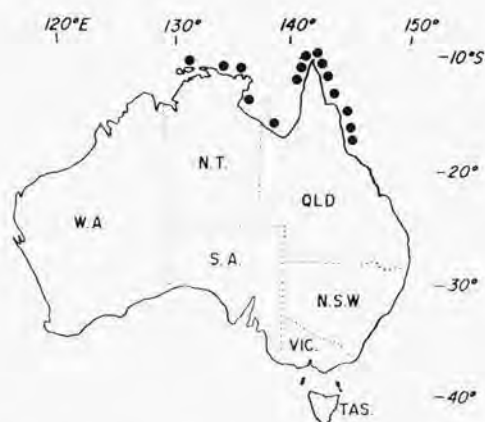
out this area (Bunt, 1978; Duke and Bunt pers. comm.).

Lumnitzera littorea only occurs as a shrub to small tree (<6 m) in the Northern Territory (Wells, 1981b). On Cape York Peninsula this species often attains tree heights to 25 m (Bunt, 1978; pers. obs.).

Lumnitzera racemosa

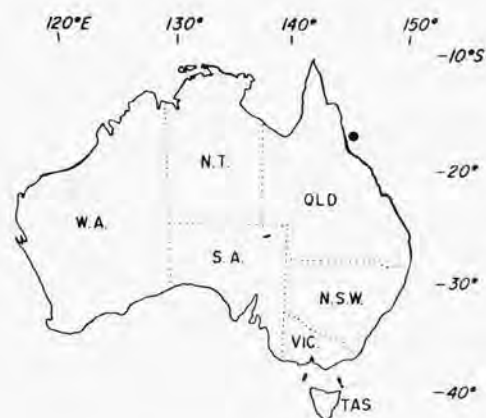
The southernmost limits of distribution of *Lumnitzera racemosa* are Beagle Bay (16° 56'S, 122° 32'E) on the west Australian coast (Semeniuk et al., 1978) and Moreton Bay, Qld. (27° 30'S) on the east Australian coast (Dowling, 1979).

Excluding the Kimberley area of Western Australia, where the species is uncommon, *Lumnitzera racemosa* is widespread throughout the remainder of its range.



Lumnitzera rosea

This species is only known in Australia from Missionary Bay, Hinchinbrook Island, (18°15'S), (Tomlinson et al., 1978.)



MELIACEAE

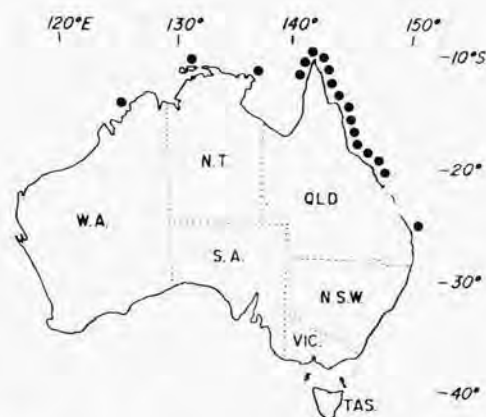
Xylocarpus granatum

The southernmost limits of distribution of *Xylocarpus granatum* are the Prince Regent River (15°27'S, 125°03'E) on the west Australian coast (Wells, 1981a) and Frazer Island, Qld. (25°30'S) on the east Australian coast (Dowling, pers. comm.).

In the Northern Territory *Xylocarpus granatum* occurs on Andranangoo Creek, Melville Island (11°21'S, 130°51'E) and on the Gove Peninsula (Yirrkala) (Specht, 1958).

The species has not been recorded on any other tidal waterway in the Northern Territory (Wells, 1981b). Saenger and Hopkins (1975) have reported the species at Tarrant Point, Qld (17°23'S, 139°25'E) in the southeastern portion of the Gulf of Carpentaria. The writer considers that this record is most probably *Xylocarpus australasicus* as this species has been observed growing at Karumba (17°28'S, 140°50'E) a little distance away from Tarrant Point under an equally arid climate.

Specht et al. (1977) record *Xylocarpus granatum*



at Weipa and the species is reasonably abundant in the Port Musgrave area north of Weipa (pers. obs.).

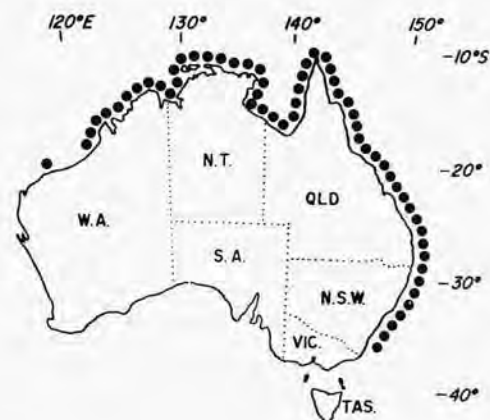
Distribution of this species along the remainder of the western shores of Cape York Peninsula is unknown. *Xylocarpus granatum* is particularly common amongst fringing vegetation in tidal waterways down the east Australian coastline (Bunt, 1978; Duke and Bunt, pers. comm.).

MYRSINACEAE

Aegiceras corniculatum

The southernmost limits of distribution of *Aegiceras corniculatum* are at Cossack (20°41'S, 117°12'E) on the west Australian coast (Semeniuk et al., 1978) and Merimbula, NSW (36°53'S, 149°55'E) on the south-east coast of NSW (Weate, pers. comm.).

Throughout this area *Aegiceras corniculatum* is reasonably abundant, particularly as a shrub understory to fringing vegetation along tidal waterways.

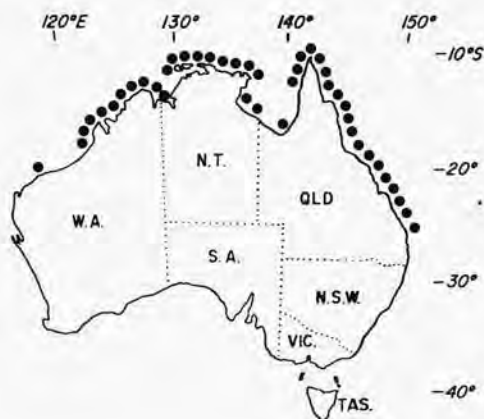


MYRTACEAE

Osbornia octodonta

The southernmost limits of distribution of *Osbornia octodonta* are at Cossack (20°41'S, 117°11'E) on the west Australian coast (Semeniuk et al., 1978) and Tin Can Bay, Qld. (25°30'S) on the east Australian coast (Dowling and McDonald, 1981).

Distribution of *Osbornia octodonta* is discontinuous around the coastline, particularly in the Gulf of Carpentaria. Specht et al. (1977) record this species at Weipa, Qld. (12°40'S, 141°50'E), although Saenger and Hopkins (1975) did not record it at Tarrant Point in the south-eastern portion of the Gulf of Carpentaria. Wells (1981b) records *Osbornia octodonta* from over half the tidal waterways of the Kimberley region of Western Australia and the Northern Territory and Bunt (1978) and



Dowling (pers. comm.) record this species as being reasonably common at sites along the east coast of Queensland.

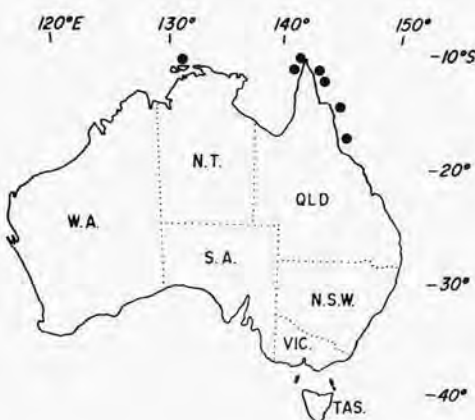
NYPACEAE

Nypa fruticans

Nypa fruticans has been recorded at only one locality, Maxwell Creek, Melville Island in the Northern Territory.

Nypa fruticans has been recorded by Messel et al. 1981a at Port Musgrave, Qld. (12°00'S, 141°54'E) on the eastern shores of the Gulf of Carpentaria. It is also known to occur on the Jardine river (10°55'S) and Cowal Creek (10°54'S). (Duke and Bunt, pers. comm.).

On the east Australian coast, *Nypa fruticans* occurs in a discontinuous distribution from the Olive River, Qld. (12°10'S) (Bunt, 1978) to the southern end of Hinchinbrook channel, Qld. (18°31'S) (Duke and Bunt, pers. comm.).

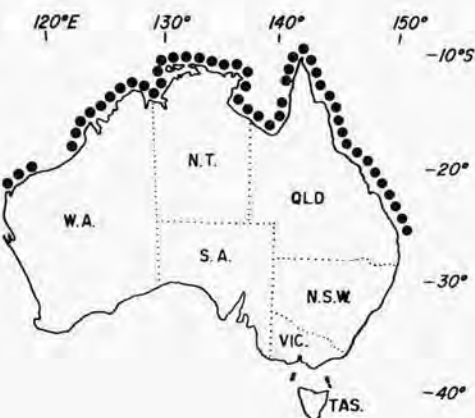


PLUMBAGINACEAE

Aegialitis annulata

The southernmost limits of distribution of *Aegialitis annulata* are at Exmouth Gulf (21°53'S, 114°22'E) on the west Australian coast (Semeniuk et al., 1978) and Frazer Island, Qld. (25°30'S) on the east Australian coast (Jones, 1971).

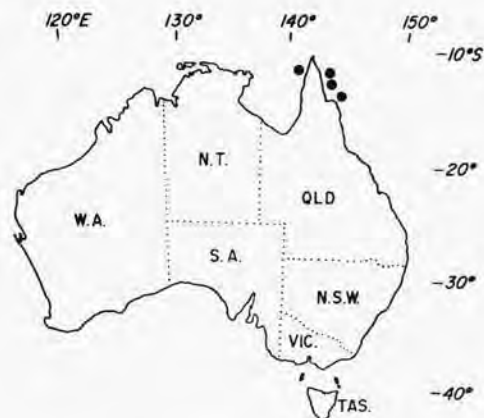
Throughout its range *Aegialitis annulata* is reasonably abundant.



RHIZOPHORACEAE

Bruguiera cylindrica

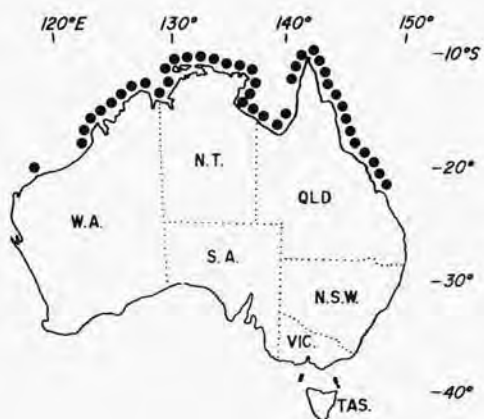
This species has a very restricted distribution in Australia. It is not recorded from either Western Australia (Semeniuk et al., 1978) or the Northern Territory (Wells, 1981b). *Bruguiera cylindrica* was not recorded by Specht et al., (1977) at Weipa, Qld. ($12^{\circ}40'S$, $141^{\circ}50'E$) but occurs at Port Musgrave, 65 km north of Weipa (Messel et al., 1981a). On the east Australian coast Jones (1971) originally recorded the species only at Cape Sidmouth ($13^{\circ}25'S$, $143^{\circ}36'E$), although more detailed studies now show that although the distribution of this species is discontinuous; it occurs at several mainland and island localities north of the Normanby River ($14^{\circ}25'S$) and at localities around the tip of Cape



York (Bunt, 1978; Duke and Bunt, pers. comm.; Saenger, pers. comm.).

Bruguiera exaristata

The southernmost limits of distribution of *Bruguiera exaristata* are at Cossack ($20^{\circ}41'S$, $117^{\circ}11'E$) on the west Australian coast (Semeniuk et al., 1978) and Port Clinton, Qld. ($22^{\circ}30'S$) on the east Australian coast (Saenger, pers. comm.). The species is reasonably well represented amongst fringing vegetation along tidal waterways throughout these limits except along the west Australian coastline where it is infrequently observed.

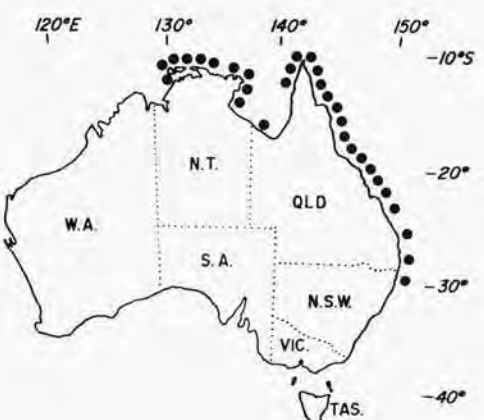


Bruguiera gymnorhiza

Bruguiera gymnorhiza has not been recorded west of Darwin, NT ($12^{\circ}25'S$, $130^{\circ}48'E$) (Wells, 1981b).

Although discontinuous in occurrence the species occurs eastwards of this point as far south as the Roper River, NT ($14^{\circ}17'S$, $135^{\circ}44'E$) in the Gulf of Carpentaria. *Bruguiera gymnorhiza* has not been observed on any other tidal waterway of the Northern Territory entering into the southern portion of the Gulf of Carpentaria.

Saenger and Hopkins (1975) have recorded the species as present but uncommon at Tarrant Point ($17^{\circ}23'S$, $139^{\circ}25'E$) in the south-eastern portion of the Gulf of Carpentaria. On the eastern shores of the Gulf of Carpentaria the species occurs at least as far south as Weipa ($12^{\circ}40'S$, $141^{\circ}50'E$) (Love, pers.



comm.). Its distribution along the remainder of the tidal waterways entering the Gulf of Carpentaria

from Weipa to Karumba is unknown. On the east Australian coastline, *Bruguiera gymnorhiza* has been recorded south to the Clarence River, N.S.W.

Bruguiera parviflora

The southernmost limits of distribution of *Bruguiera parviflora* are the Sale River (15°57'S, 124°33'E) on the west Australian coast (Wells, 1981b) and Proserpine, Qld. (20°30'S) on the east Australian coast (Jones, 1971).

The species is uncommon throughout the Kimberleys and the Joseph Bonaparte Gulf region of Western Australia and the Northern Territory. Distribution of the species is continuous across the northern coastline of the Northern Territory.

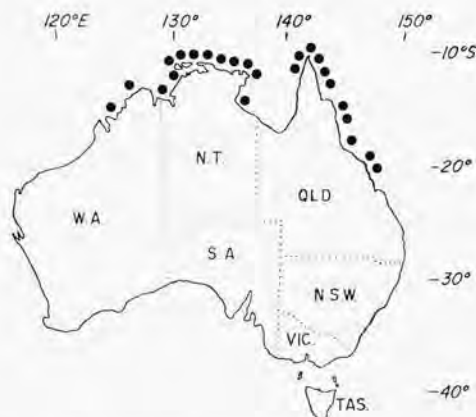
Bruguiera parviflora is rare on tidal waterways entering the western shores of the Gulf of Carpentaria and has not been recorded eastwards of the Limmen Bight River (15°06'S, 135°42'E) in the Northern Territory. *Bruguiera parviflora* recently has been recorded at Port Musgrave Qld. (12°00'S, 141°54'E) (Messel et al., 1981a). The species is

Bruguiera sexangula

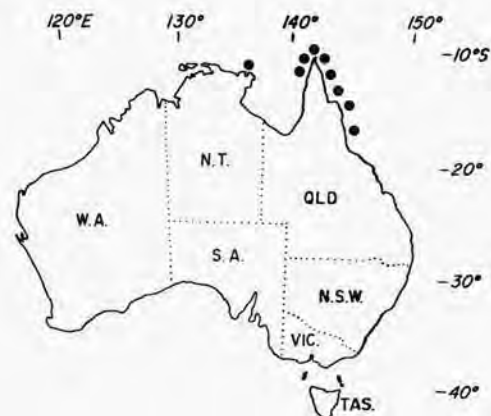
Bruguiera sexangula has not been recorded previously from the Northern Territory. It is known from only the Cato and Peter John Rivers in Arnhem Bay, NT (12°15'S, 136°21'E) (Wells, 1981b).

On the eastern shores of the Gulf of Carpentaria, *Bruguiera sexangula* has been recorded south to Port Musgrave, Qld. (12°00'S, 141°54'E) (pers. obs.) while on the east Australian coastline, this species has been recorded south to Missionary Bay, Hinchinbrook Island, Qld. (18°15'S) (Duke and Bunt, pers. comm.). The distribution of *Bruguiera sexangula* down the east Australian coastline is discontinuous.

(29°25'S, 153°21'E) (McCormick, pers. comm.; Floyd, pers. comm.), although this species only occurs as isolated trees in northern N.S.W.



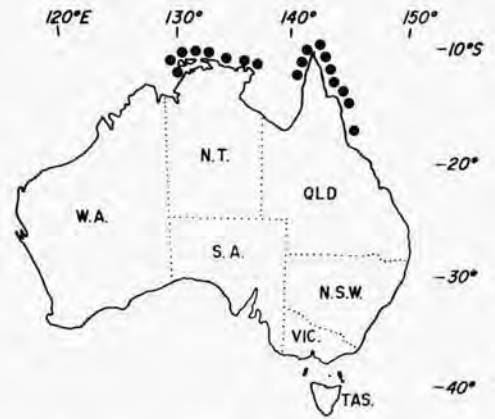
reasonably common along tidal waterways over the northern portion of the east Australian coast (Bunt, 1978) although it becomes discontinuous in occurrence towards the southern limit of distribution at Proserpine.



Cerriops decandra

Cerriops decandra has not been recorded west of Darwin, NT ($12^{\circ}25'S$, $130^{\circ}48'E$) (Wells, 1981b). Its distribution across the northern coastline of the Northern Territory is discontinuous and it has not been recorded on any tidal waterway entering the western or southern shores of the Gulf of Carpentaria. Occurrence of *Cerriops decandra* throughout the Queensland portion of the Gulf of Carpentaria is largely unknown. It may occur at Weipa (Love, pers. comm.). It occurs at least as far south as Port Musgrave ($12^{\circ}00'S$, $141^{\circ}54'E$) (pers. obs.).

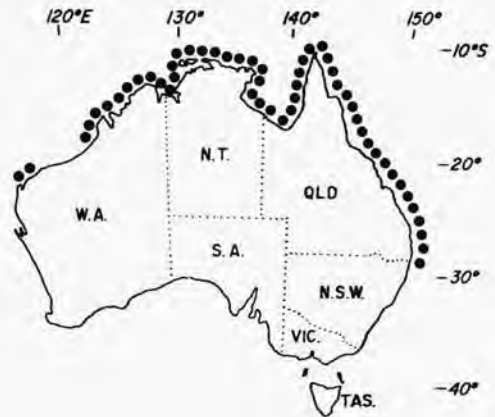
On the east Australian coastline the species has been recorded south to Missionary Bay, Hinchinbrook Island, Qld. ($18^{\circ}15'S$) (Duke and Bunt, pers.



comm.) and is common between Cape York and Cooktown (Bunt, 1978), and south to Cairns, Qld. ($16^{\circ}55'S$) (Dowling and McDonald 1981).

Cerriops tagal var. *australis*

The southernmost limits of distribution of *Cerriops tagal* var. *australis* are at Exmouth Gulf ($21^{\circ}53'S$, $114^{\circ}22'E$) on the west Australian coast (Semeniuk et al., 1978) and the Tweed River, NSW ($28^{\circ}11'S$, $153^{\circ}32'E$) on the east Australian coast (Lear and Turner, 1977). Throughout its range the distribution of this variety is continuous.



Cerriops tagal

Distribution of the species across the northern coastline of the Northern Territory is extremely discontinuous. It has neither been recorded west of Tinganoo Creek, Melville Island, NT ($11^{\circ}24'S$, $131^{\circ}29'E$) nor east of the Cato River, NT ($12^{\circ}16'S$, $136^{\circ}21'E$) (Wells, 1981b) nor on any tidal waterway within the Gulf of Carpentaria.

In eastern Australia, the species is quite abundant south from Cape York to Cooktown (Bunt, 1978) and becomes progressively rarer as it approaches the southernmost limit of its distribution at Bustard Head, Qld. ($24^{\circ}01'S$) (Dowling and McDonald, 1981).



Rhizophora apiculata

Rhizophora apiculata has not been recorded west of Andranangoo Creek, Melville Island ($11^{\circ}21'S$, $130^{\circ}51'E$) or east of Gove ($12^{\circ}13'S$, $136^{\circ}43'E$) in the Northern Territory (Wells, 1981b). The species is absent from the greater portion of tidal waterways entering into the Gulf of Carpentaria. Specht et al. (1977) did not record *Rhizophora apiculata* at Weipa ($12^{\circ}40'S$, $141^{\circ}50'E$) although this writer found this species to be common within Port Musgrave ($12^{\circ}00'S$, $141^{\circ}54'E$) just 65 km north of Weipa.

On the east Australian coastline *Rhizophora apiculata* has been recorded south to Port Clinton, Qld ($22^{\circ}30'S$) (Duke and Bunt, 1979); these authors suggest that this species may occur further south.

Rhizophora lamareckii

Rhizophora lamareckii has been recorded from the Alligator Rivers region of the Northern Territory (Hegerl, pers. comm.). It has not been recorded within any other tidal waterway of the Northern Territory although it could occur in Arnhem Bay.

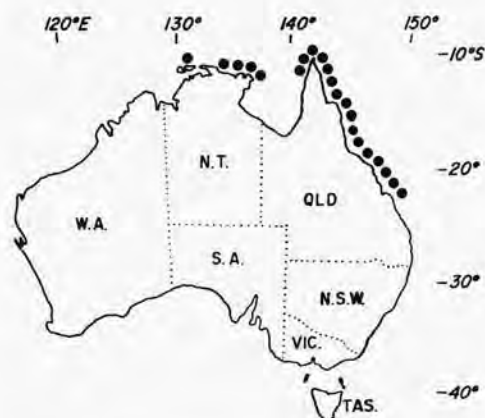
This species has not been recorded in the Gulf of Carpentaria although it could occur in low numbers on the Jardine River (Duke and Bunt, 1979). Although not recorded by this writer on tidal rivers entering Port Musgrave, it may be present here also.

Along the east Australian coastline *Rhizophora lamareckii* shows a discontinuous distribution from Cape York to Port Clinton, Qld. ($22^{\circ}30'S$) (Duke and Bunt, 1979). It is probable that this species occurs south of this given limit at Port Clinton.

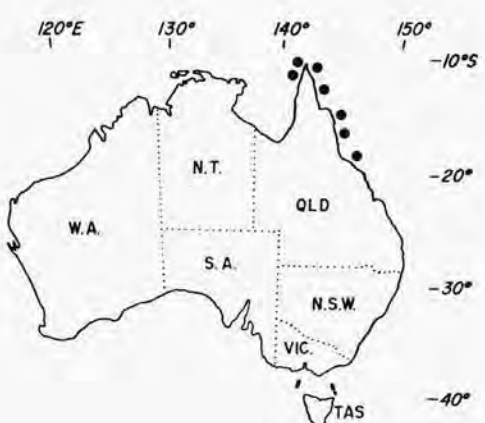
Rhizophora mucronata

Rhizophora mucronata has not been recorded on any tidal waterway in Western Australia (Semeniuk et al., 1978) or the Northern Territory (Wells, 1981b).

Rhizophora mucronata has been recorded from Port Musgrave, Qld. ($12^{\circ}00'S$, $141^{\circ}54'E$) (pers. obs.) and appears to be discontinuous in occurrence in tidal waterways from this point to Deluge Inlet, Qld ($18^{\circ}25'S$) (Duke and Bunt, 1979).



Duke and Bunt (1979) show that throughout its range along the east Australian coast, *Rhizophora apiculata* is continuous in occurrence.



Rhizophora stylosa

The southernmost limits of distribution of *Rhizophora stylosa* in Australia are at Yardie Creek (22°20'S, 113°51'E) on the west Australian coast (Semeniuk et al., 1978) and the Corindi Creek, NSW (30°03'S, 153°12'E) on the east Australian coast (Floyd, pers. comm.). Floyd notes that this species was previously recorded as far south as the Richmond River, NSW (28°31'S) (Jones 1971); however, this record referred to an old Herbarium specimen. *Rhizophora stylosa* does not occur on the Richmond River now and except for the collection made at Corindi Creek in 1979, the species was not known to have occurred in recent times south of Cudgera Creek on the Tweed River, NSW (Floyd, pers. comm.).

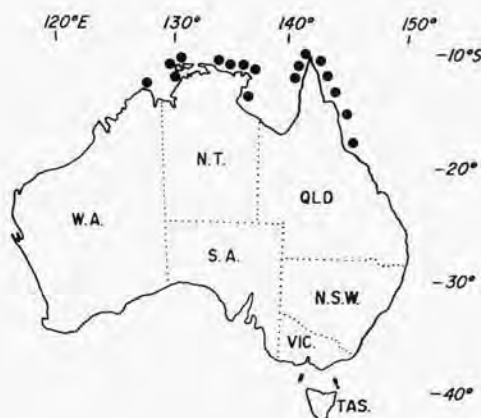


RUBIACEAE

Scyphiphora hydrophyllacea

To the west in its Australian distribution, *Scyphiphora hydrophyllacea* occurs at Cape Londonderry (13°48'S, 126°46'E), the most northerly point of Western Australia (Semeniuk et al., 1978). It is surprisingly, not recorded from tidal waterways of the Kimberley region immediately westward (Wells, 1981a).

The species has not been recorded throughout the remainder of the Joseph Bonaparte Gulf and reappears again in Bynoe Harbour (12°34'S, 130°31'E) near Darwin in the Northern Territory. *Scyphiphora hydrophyllacea* has a discontinuous distribution across the remainder of the northern coastline of the Northern Territory and has been recorded as far south as the Rose River, N.T. (14°17'S, 135°44'E) on the western shores of the Gulf of Carpentaria (Wells, 1981b). The species has not been observed on any other tidal waterway of the Northern Territory entering into the southern portion of the Gulf of Carpentaria. Saenger and Hopkins (1975) likewise do not record this species at Tarrant Point (17°23'S, 139°25'E) in the south-



eastern portion of the Gulf of Carpentaria.

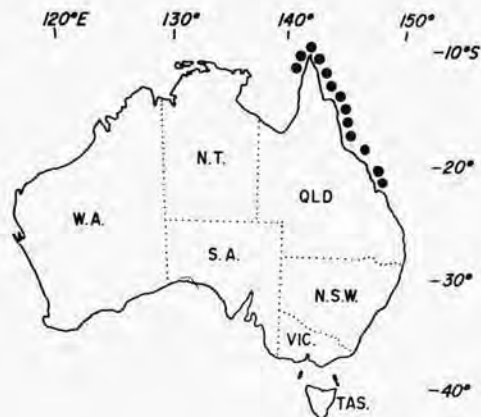
Specht et al., (1977) record the species as far south as Weipa, Qld. (12°40'S, 141°50'E) on the eastern shore of the Gulf of Carpentaria. However, its occurrence down the remainder of this shore to Karumba is unknown. On the east Australian coast this species occurs as far south as Townsville, Qld. (19°12'S) (Jones, 1971), although again it is discontinuous throughout this region.

STERCULIACEAE

Heritiera littoralis

Heritiera littoralis has not been recorded from Western Australia nor from the Northern Territory.

The species is first recorded at Port Musgrave, Qld. (Messel et al., 1981a) and thence forms a fairly continuous distribution around Cape York and down the east Australian coastline to Cooktown (Bunt, 1978) and Cairns Qld. ($16^{\circ}55'S$) (Dowling and McDonald, 1981). the species is common along the upstream portions of many tidal waterways down the east coast to Hinchinbrook Island. The southernmost limit of distribution of *Heritiera littoralis* is St Lawrence, Qld. ($22^{\circ}15'S$) (Jones, 1971).



SONNERATIACEAE

Sonneratia alba

The southernmost limit of distribution of *Sonneratia alba* on the west Australian coast is at Cape Bossut ($18^{\circ}43'S$, $121^{\circ}38'E$) (Semeniuk et al., 1978). The species is common throughout the estuaries of tidal waterways in the Kimberleys W.A. (Wells, 1981a) but is largely absent from tidal waterways draining into Joseph Bonaparte Gulf.

The species is nearly continuous in occurrence from Port Paterson, N.T. ($12^{\circ}34'S$, $130^{\circ}31'E$) around the northern coastline to Gove ($12^{\circ}13'S$, $136^{\circ}42'E$) in the Northern Territory. The species has not been recorded on any tidal waterway entering the western or southern shores of the Gulf of Carpentaria (Wells, 1981b). *Sonneratia alba* occurs at least as far south as Weipa, Qld. ($12^{\circ}40'S$, $141^{\circ}50'E$) on the eastern shores of the Gulf of Carpentaria (Love, pers. comm.). On the east Aus-



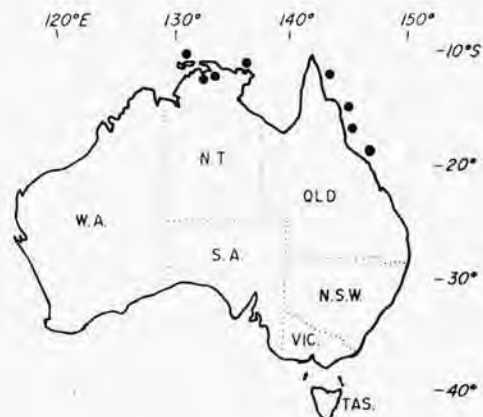
tralian coast this species occurs as far south as Port Clinton, Qld. ($22^{\circ}30'S$) (Duke and Bunt, pers. comm.). Work in progress at the Australian Institute of Marine Science suggests that a range of *Sonneratia* spp. occur along the east Australian coast (Duke and Bunt, pers. comm.).

Sonneratia caseolaris

The most westerly occurrence of this species is on Andranangoo Creek, Melville Island, NT (11°21'S, 130°51'E) (Wells, 1981b). It is abundant on tidal waterways entering Van Diemen Gulf and also occurs on certain rivers within Arnhem Bay (N.T.). Its distribution is discontinuous along the northern coastline of the Northern Territory and the species has not been recorded east of the Peter John River in Arnhem Bay, N.T. (12°15'S, 136°21'E). It also has not been recorded on tidal waterways within the Gulf of Carpentaria. On the east Australian coast it occurs from the Olive River, Qld. (12°10'S) to the Murray River, Qld. (18°05'S) (Duke and Bunt, pers. comm.) although its distribution here is again discontinuous.

Discussion

Many species of mangroves that are widespread throughout the Indo-Malaysian region, as discussed in particular by Chapman (1975, 1976), possess quite restricted distributions in Australia. These conclude *Acanthus ebracteatus*, *Avicennia officinalis*, *Dolichandrone spathacea*, *Cynometra ramiflora* var. *bijuga*, *Nypa fruticans*, *Bruguiera cylindrica*, *Bruguiera sexangula*, *Rhizophora mucronata*, *Heritiera littoralis* and *Sonneratia caseolaris*. Species that show considerable latitudinal extension down the east as opposed to the west Australian coast include *Acanthus ilicifolius*, *Lumnitzera littorea*, *Lumnitzera racemosa*, *Excoecaria agallocha*, *Xylocarpus australasicus*, *Xylocarpus granatum*, *Aegiceras corniculatum*, *Bruguiera gymnorhiza*, *Ceriops decandra*, *Ceriops tagal* var. *australis*, *Ceriops tagal*, *Rhizophora apiculata*, *Rhizophora stylosa*, *Scyphiphora hydrophyllacea* and *Bruguiera parviflora*; while still other species *Aegialitis annulata*, *Bruguiera exaristata*, *Osbornia octodonta* and *Sonneratia alba* show no such uneven latitudinal extension between the eastern and western extremities of their distributions and occur at similar latitudes on both east and west coastlines. Only one species, *Camptostemon schultzei*, occurs at a higher latitude on the west as opposed to the east coast of the continent.



Considerable variation exists in species occurrences throughout their respective geographic ranges in Australia. Many species, *Acanthus ilicifolius*, *Aegialitis annulata*, *Aegiceras corniculatum*, *Avicennia marina*, *Bruguiera exaristata*, *Ceriops tagal* var. *australis*, *Excoecaria agallocha*, *Rhizophora stylosa* and *Xylocarpus australasicus*, are considered as having continuous distributions throughout their ranges. Other species, in particular *Bruguiera parviflora*, *Camptostemon schultzei* and *Ceriops decandra*, while reasonably continuous in occurrence around the north Australian coastline, are entirely absent from those regions within their geographic ranges that are subjected to high levels of seasonal aridity (i.e. Cambridge/Joseph Bonaparte Gulf; Gulf of Carpentaria). Additional species which are quite discontinuous in occurrence at sites across the Northern Territory – *Bruguiera sexangula*, *Ceriops tagal*, *Lumnitzera littorea*, *Nypa fruticans*, *Rhizophora apiculata*, *Rhizophora lamarckii*, *Scyphiphora hydrophyllacea* and *Xylocarpus granatum* – also are not recorded from sites in these gulfs but occur more frequently at localities along the north Queensland coastline.

Several species only recorded in Australia from north-east Queensland – *Bruguiera cylindrica*, *Cynometra ramiflora* var. *bijuga*, *Heritiera littoralis* and *Rhizophora mucronata* – shown reasonably continuous distributions throughout their Aus-

tralian ranges, although *Dolichandrone spathacea* and *Lumnitzera rosea* present extremely restrictive distributions. However, this usual trend of uncommonly recorded mangrove species occurring in north-east Queensland does not include *Avicennia officinalis*, which is wholly limited in its Australian distribution to sites along the northern coastline of the Northern Territory.

Macnae (1966), Jones (1971), Gill (1975), Lear and Turner (1977), Saenger et al. (1977) and Semeniuk et al. (1978) all show that a gradual reduction in species number occurs with increasing latitude down both the east and west coasts of the continent from tropical to temperate regions. However, presence of species at sites within their geographic ranges depends on an interacting complex of factors. Many are discussed by Clark and Hannon (1969) in relation to zonation at a particular site whilst others, e.g. Thom et al. (1975), stress that the pool of species available are influenced by local environmental conditions which in turn are affected by geomorphic processes.

In this regard, in Australia, within the geographic range of a species, although edaphic and physiographic conditions of a site may be favourable for its occurrence, local climatic conditions may prevent establishment. Fosberg (1961), Zahran (1975) and Cintron et al. (1978) have observed this phenomenon elsewhere in the world.

Species distributions in northern Australia show certain trends. *Bruguiera sexangula*, *Ceriops decandra*, *Ceriops tagal*, *Nypa fruticans*, *Rhizophora apiculata*, *Rhizophora lamareckii*, *Sonneratia alba* and *Sonneratia caseolaris* all occur at sites across the northern coastline of the Northern Territory and down the east Queensland coastline, but remain unrecorded at any site within the larger portion of the Gulf of Carpentaria.

In addition, *Bruguiera gymnorhiza*, *Bruguiera parviflora*, *Camptostemon schultzei*, *Lumnitzera littorea*, *Scyphiphora hydrophyllacea* and possibly *Xylocarpus granatum* are represented only by straggly trees/shrubs at few sites within this Gulf.

Such a reduction in floristic diversity is not attributable to 'latitudinal sifting' of species as the Gulf of Carpentaria lies within the geographic ranges of all these species. Wells (1981b) has shown

that the Arnhem Bay/Gove region at the north-western extremity of the Gulf with twenty-two species recorded, has the most diverse mangrove flora of any region in the Northern Territory. Likewise, the Port Musgrave region on the north-eastern shores of the Gulf of Carpentaria with twenty-seven recorded species (pers. obs.) is also particularly diverse in species when compared to other sites detailed by Bunt and Williams (1980) in north-eastern Queensland.

Such high levels of species numbers for mangroves at sites near the northern limits of the Gulf of Carpentaria and the extremely low numbers of species recorded from sites further within this Gulf, frequently only eight to eleven species (Wells, 1981b), pose a number of problems.

The prevailing sea currents flow east along the northern coastline of the Northern Territory into and around the Gulf of Carpentaria during the 'wet' season (Australia Pilot, Vol. 5, 1972), when most fruiting of mangroves occurs. Such currents thus pass the Arnhem Bay/Gove region, deflect across the Gulf entrance to the Port Musgrave region in Queensland and then move southwards in a clockwise direction around the Gulf. Floating disseminules of the various mangrove species should then retain viability over such small sea journeys (when contrasted to the distributional spread of many of the species throughout islands in the Pacific Ocean), and should have little difficulty in reaching all sites within the Gulf of Carpentaria.

In this regard, throughout the southern portion of the Gulf, restricted sporadic occurrences of species like *Acanthus ilicifolius*, *Bruguiera parviflora*, *Camptostemon schultzei* and *Lumnitzera littorea* in extremely sheltered habitats and the absence of many other species that would have little difficulty in reaching these shores, appears to be largely attributable to the considerable climatic aridity experienced in this region during the 'dry' season (Climatic Averages, Qld., N.T., 1975).

In an analogous situation involving waterways entering into Cambridge and Joseph Bonaparte Gulfs on the north-west coast of Australia, only between seven to thirteen species are commonly recorded (Thom et al., 1975; Wells, 1981b) even though Semeniuk et al. (1978) and Wells (1981a)

show that between thirteen to fifteen mangrove species are frequently recorded further south at sites throughout the Kimberley region of Western Australia.

Of the thirteen species occurring in these two gulfs, *Camptostemon schultzei*, *Rhizophora stylosa* and *Sonneratia alba* are infrequently encountered and then only as straggly trees or shrubs in contrast to their considerable abundance in adjacent tidal waterways of the Kimberleys (Wells, 1981a). An additional species, *Bruguiera parviflora*, is also uncommonly recorded at sites along this portion of the north-west coastline where it is at the southern end of its geographic range. However, both *Bruguiera parviflora* and *Bruguiera exaristata* are still less frequently encountered amongst the mangrove vegetation around Cambridge or Joseph Bonaparte Gulfs than at localities further south in the Kimberleys.

It might be expected that there would be fewer mangrove species in the Kimberley region, lying at higher latitudes than the Cambridge and Joseph Bonaparte Gulf regions. Such is not the case. The increase in number and abundance of species in the Kimberleys and the floristically and structurally depauperate mangrove scrubs fringing waterways entering the two latter mentioned gulfs may relate to subtle differences in seasonal aridity as shown in the Climatic Averages, N.T., W.A. (1975).

The south-east trade winds that blow rather consistently across the hot, dry interior of the continent during the 'dry' season (Gentilli, 1971) are considered by this writer to be most important in their effects on species numbers and structure of the mangrove vegetation along both the north-west coast of Australia and throughout the lower portions of the Gulf of Carpentaria. These drying winds blow straight into the mangrove scrubs fringing the low level plains abutting these gulfs and many species of mangroves with more humid climatic requirements are thus excluded from establishment in such seasonally arid regions. For the Kimberley region, which also receives considerable climatic aridity, the more diverse mangrove flora occurs in scattered pockets beneath cliffs of drowned river valleys. Such vegetation is often shielded from the sun's direct rays for a larger portion of the

day (particularly during the winter, dry season months) due to the aspect of the overhead cliffs and is also protected from the desiccating effects of the south-east trade winds by the Mitchell Plateau.

Overall, distributions of the various mangrove species around the continent are considered to be the cumulative result of complex interactions of the biological, chemical and physical environments now and in the past. However, increased seasonal aridity on the west, compared with the east, Australian coast is considered as a major factor resulting in mangrove swamps on the west coast having only half the number of species present as have swamps at similar latitudes on the east Australian coastline.

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