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TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA

INCORPORATED

ADELAIDE

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KINTORE AVENUE, ADELAIDE

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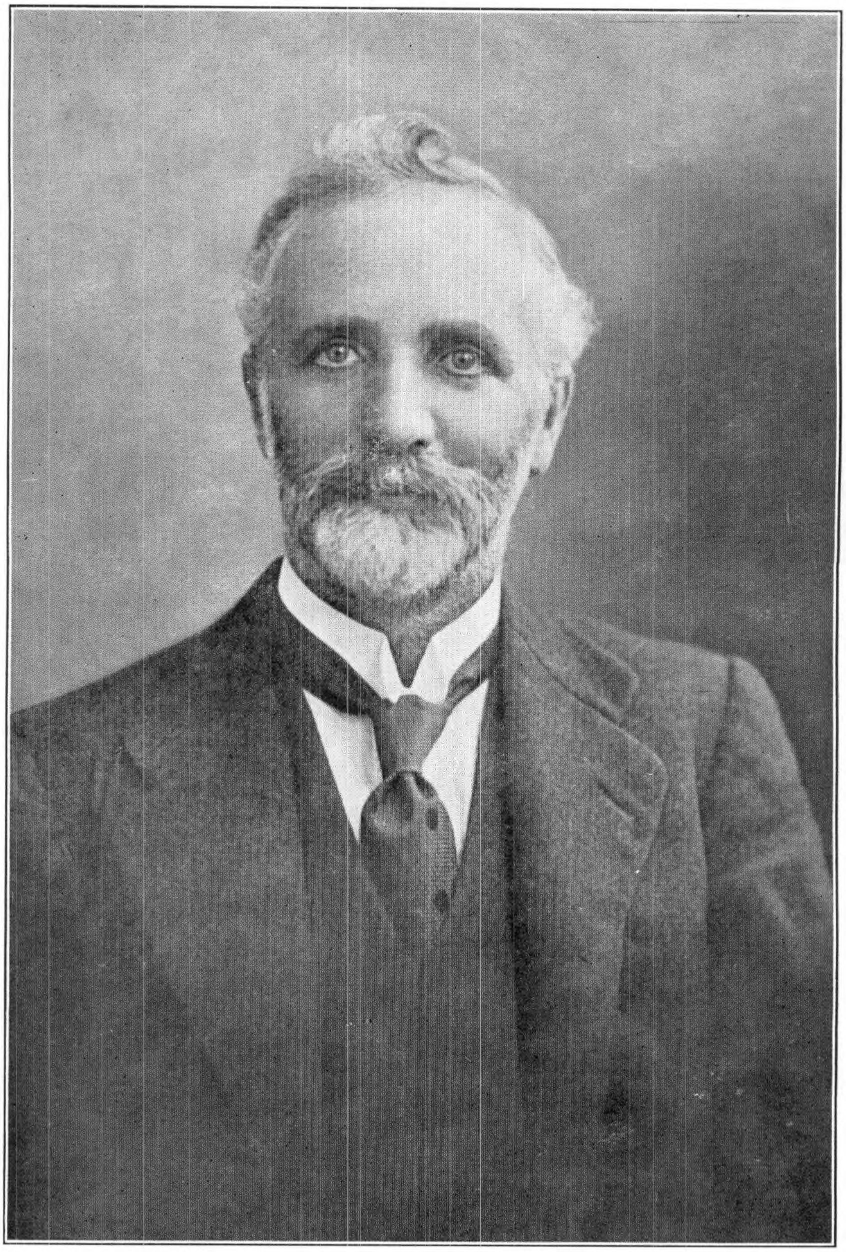
OBITUARY NOTICE

EDWIN ASHBY, 1895-1941

Summary

By the sudden death of Edwin Ashby on 8 January, at his home at Blackwood, South Australia, our Society has lost one of its oldest members. He was a member of Council from 1900 to 1919 and Vice-president from 1919 to 1921. He was a Fellow of the Linnean Society of London, and a Member of the British Ornithologists' Union.



THE LATE EDWIN ASHBY

TRANSACTIONS OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA INCORPORATED

OBITUARY NOTICE

EDWIN ASHBY, 1895-1941

By the sudden death of Edwin Ashby on 8 January, at his home at Blackwood, South Australia, our Society has lost one of its oldest members. He was a member of Council from 1900 to 1919 and Vice-President from 1919 to 1921. He was a Fellow of the Linnean Society of London, and a Member of the British Ornithologists' Union.

Born at Capel, Surrey, England, in 1861, he was a delicate child, and except for a short period at a small Friends' School in Surrey his education was much interrupted by illness.

His intense interest in most branches of Natural History was acquired from his father, who frequently took all his seven children for excursions around their home at Redhill, Surrey, in search of butterflies, plants, etc. On leaving school he travelled the north of England for his father's business of tea merchant of Idol Lane, London. While travelling he again developed pneumonia, and his father shortly afterwards dying of the same complaint, the family became alarmed and, on the doctor's orders, he was sent on a long sea voyage. He came to Australia on the ship "Torrens" in 1885, and after visiting all States, as well as New Zealand, he returned to England in 1888 via America. Having a heavy cold and hay-fever on his return, he was again ordered to leave before the winter. Thereupon, with his eldest sister, he came and settled in Adelaide. On his marriage, in 1890, his sister returned to England.

As a member of the Society of Friends, he attended many conferences in the different States, and it was during such trips, as well as while inspecting properties as a land agent, that he was able to get into the scrub and indulge in his study of bird and plant life. In 1902 he moved to Blackwood. In 1918 he visited America with his eldest son, who required medical help, and was thus able to continue his natural history interests in the neighbourhood of Baltimore. Returning from America, the rest of his life, except for visits to Tasmania and Victoria, was spent at Blackwood.

He was an enthusiastic gardener and paid particular attention to the growing of native shrubs from all States in his garden at Blackwood. Other groups of interesting exotic plants, such as Cactaceae and various succulents, also claimed his attention. Being an ardent supporter of Native Reserves, such as Flinders Chase, he was a prime mover in obtaining the Chauncy's Line Reserve.

His published works have been chiefly concerned with the Chitons, and since Iredale and Hull's "A Monograph of the Australian Loricates" (Roy. Zool. Soc., N.S.W., 1927), which gives a complete bibliography to that date, he has written the following:

1928 The Rediscovery of *Tonicia cuneata* Suter and *Acanthochites thileniusi* Thiele, together with the description of a new genus and short review of the New Zealand Acanthochitonidae. Tr. N.Z. Inst., **58,** 392-407

1928 Notes on a Collection of Chitons from the Capricorn Group, Queensland. Trans. Roy. Soc. S. Aust., **52,** 167-173

1928 Further Notes on Western Australian Chitons. Trans. Roy. Soc. S. Aust., **52**, 174-181

1928 Notes on and Additions to Australian Fossil Polyplacophora. Proc. Roy. Soc. Vict., **41**, (2), (n.s.), 220-230

1928 South African Chitons, being a Description of the Polyplacophora represented in the Turton Collection. Proc. Mal. Soc., **18**, (2), 76-93

1929 Contribution to the Fauna of Rottnest Island, No. 2, Polyplacophora. J. Roy Soc. W. Aust., **15**, 47-54

1929 New Zealand Fossil Polyplacophora. Tr. N.Z. Inst., **60**, 366-378

1929 Notes on the Fauna of Dirk Hartog Island, Western Australia. No. 1, Aves; No. 2, Polyplacophora. Trans. Roy. Soc. S. Aust., **53**, 54-66

1929 Taxonomic Value of Characters in the order Polyplacophora. Proc. Mal. Soc., **18**, (4), 159-164

1929 Monograph of the South African Polyplacophora. Annals S. Afr. Mus., **30**, (1), 1-59

1939 Notes on the Chiton, *Dinoplax gigas,* with descriptions of the Juvenile and various varieties. Annals Durban Mus, **3**, (4), 77-79

1939 Fossil Chitons from Mornington, Victoria. Proc. Linn. Soc., London, pl. iii, 186-189

1940 A New Fossil Cryptoplax from the Pliocene of S. Aust. Trans. Roy. Soc. S. Aust., **64**, (2)

Jointly with B. C. Cotton.

1929 Notes on Australian Polyplacophora. Trans. Roy. Soc. S. Aust., **54**, 57-58

1934 New species of Chitons from Broome, Western Australian. J. Roy. Soc. W. Aust., **20**, 213-219

1936 South Australian Fossil Chitons. Rec. S. Aust. Mus., **5**, (4), 509-512

1937 Descriptions of two New Species of Australian Chitons with additional Notes and Records. Trans. Roy. Soc. S. Aust., **41**, 145-148

1939 New Fossil Chitons from the Miocene and Pliocene of Victoria. Rec. S. Aust. Mus., **6**, (3), 209-242

His ornithological papers have already been listed in the "Emu" for 1 April, 1941. Botanically, he has not published much, but an important paper, "Review of the South Australian representatives of the genus *Correa,* with descriptions of new species," appeared in the Proc. Linnean Soc., London, pt. iii, 214-221, for 1939.

COMPARATIVE VOCABULARIES OF THE NGADJURI AND DIERI TRIBES, SOUTH AUSTRALIA

By R. M. BERNDT and T. VOGELSANG

Summary

In this paper vocabularies of the Ngadjuri ['qad'juri] and Dieri tribes of South Australia are compared. That of the Ngadjuri was compiled from information obtained at intermittent periods from Gunaia ['Gunaia] (third child) while on a visit to Adelaide during February to March 1940; that of the Dieri is by T. Vogelsang who was born in the Dieri country and knows their language. Gunaia was seventy-seven years of age and is ['Waria] of Tindale (1937, p. 149) and [Nadjli'buna] of Berndt (1940, p. 456).

COMPARATIVE VOCABULARIES OF THE NGADJURI AND DIERI TRIBES, SOUTH AUSTRALIA

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[Read 10 April 1941]

In this paper vocabularies of the Ngadjuri [′ŋad′juri] and Dieri tribes of South Australia are compared. That of the Ngadjuri was compiled from information obtained at intermittent periods from Gunaia [′Gunaia] (third child) while on a visit to Adelaide during February to March 1940; that of the Dieri is by T. Vogelsang who was born in the Dieri country and knows their language. Gunaia was seventy-seven years of age and is [′Waria] of Tindale (1937, p. 149) and [Nadjli′buna] of Berndt (1940, p. 456).

Except for a few words by S. Le Brun in E. M. Curr (1886, 2, p. 140) and by N. B. Tindale (1937, pp. 149-153), no vocabularies of the Ngadjuri people have been recorded.

The Ngadjuri language belongs to the "Lakes" or more properly to the "Eastern Group," and the construction of words is similar to that of the Wailpi of the Northern Flinders Ranges. A broad comparison of the two languages (Ngadjuri and Dieri) shows only a slight similarity.

The following table compares several kinship terms of the Wailpi, Pankala (Bangala), Ngadjuri and Dieri, those of the first two tribes after Elkin (1938).

	WAILPI	PANKALA	NGADJURI	DIERI
father - -	bapi	bapi	′vapi	′ŋaperi
mother - -	ŋami	ŋami	′ŋami	′ŋandri
wife - -	atuna	katu	′atu	′noa
sister - -	yakana	yaka	′jaga	′kaku (elder sister)
eldest brother -	naŋana	yuŋa	nuŋa	′neje

Hale and Tindale (1925, pp. 57-60) recorded many words of the Wailpi tribe to some extent similar to those of the Ngadjuri.

Reference to Dieri vocabulary and grammar has been made recently by Berndt and Vogelsang (1941, p. 369).

In the transcription, the alphabet of the International Phonetic Association as modified for Australian languages has been used (Tindale, 1935 and 1940), except in the case of the Wailpi.

The distinct [v] sound occurs, as in [′vapi] (father) and [vad′napa] (circumcision), and is probably the most noticeable. This is often a [bv] sound hard to distinguish from the [b]; it is rare in Australia but occurs in the Flinders Ranges, South Australia (Hale and Tindale, 1925, and Elkin, 1938). Capell also mentions that the bilabial [v] is found in parts of north-west Australia.

A PARTIAL LIST OF PRONOUNS

PERSONAL

	NGADJURI	DIERI
I - -	neiji	′ŋani
we -	′ŋadlu	′ŋaiani
you -	nena	′jidni
he -	nena	nauja, nulu
she -		nania
it - -	gundi′itji	′jenia

POSSESSIVE

	NGADJURI	DIERI
my -	neiji	′ŋakani
mine -	nadju, nuta	′ŋakani
our -	′ŋadlu	′ŋaia′nani
your -	nena	′jinkani

Objective

	NGADJURI	DIERI
me	neiji	'ŋani
myself	nena'idla	'ŋani'mata
own	nena'idla	'ŋakani
your	nena'idla	'jinkani

GENERAL VOCABULARIES

	Ngadjuri	Dieri	Wailpi
abdomen	bunduka	'mandra	
adam's-apple	'judni'muku	'wonkili	
adder, large	'apara	'wiparu	
adder, small wood	munka		
ah!	'wa!		
ancestral being (a giant)	mirlki		
ancestral times (eternal dream-time)	warumata	'warula'mala	
ant, black	'wipa	'mirka	wipa
ant, bull	'ardu		aldu
ant, green	muni		
ant, winged	'wip'a	'katjiriri	
ant-hole, winged	'wip'a'junta, 'wip'a'wadlju	'karjiriri'minka	
anus	mundu'wadlju		
aperture (of the body)	'japa		
arm	'ŋuntu	'ŋura	
arm-pit, hair of	'bidnu'buti	'kapuru'nujdu	
away	'ŋukana		
back, the	'jadna	'tuku	
back-bone of a fish	'jadna'walpu	'tuku'muku'parundru	
barter, or exchange	kopera	'jinki'malina	
bat	mik'a	'pintji'pintjin'dara	
beat, to	dundu	nandrana	
beating on the ground to accompany chants	bun'ba'ta	'kata'nandrana	
bee, stingless, or blowfly	mitji'mitji	'muntju'runtju	
berry, a grey bush with green	'uŋma		
billy-button (a flower)	'wilu		
bird, yellow-breasted	'arku'eta		
blackfellows (or people)	'juru	'kana	
blind	mena'mika	'putju	
blood	garu	'kumari	arti
boomerang	'wadna	'kir:a	wadna
bone, sharpened	'baija	'muku'wutju	
boy (before circumcision)	'mandu	'kanku	
boy (after circumcision)	vad'napa	'karuwali, 'tjutjuru	
branches rustling	inderi		
breasts	ŋama	'ŋama	
breasts, heavy	ŋama'ŋara	'ŋama'madi	
"bruising" (during revenge expedition after a death)	midli'inda		
bullroarer, large	'wetana	'junta	

	Ngadjuri	Dieri	Wailpi
bullroarer, small	muraŋali		
bullroarer design	'ita'malka'na		
bush, green	bundi	'pita'kulja'kulja	
bush, small grey (having medicinal qualities)	'judali		
bustard	'wala	'kala'tura	wal'la
buttocks	bulta	'pit'ti	
camp	'wadli	'ŋura	
camp, men's	meru'wadli	'ŋura'materi	
camp, women's	'atuni'wadli	'ŋura'widla	
camp, young men's	mandu'wadli	'ŋura'materi	
cap, widow's mourning	'wena		
carrots, wild	kaku		
cat, native	'aku'indji	'jikaura	
catch, to	muŋguta	'padana	
caterpillar	'jadna	'kal :i'bil :i'bil :i. 'paŋa	
chest	gundu	munambir :i	
child, male	meru'vapa	'kupa'kanku	
child, female	'atuŋ'vapa	'kupa'mankara	
cicatrise	maŋka		
cicatrisation ceremony	'wil'jaru	'wiljaru	
circumcision	vad'napa	'materi'ŋankana. 'karuwala'ŋankana	
cloud	butji	'palku	wulpi
clouds, heavy white	malku	'talara'palku	
clouds, thunder	gundu'malku	'talaru'palku'pildri'pildri	
clover	'walbula	'kalumba	
club	'wiri		wiri
coccyx	'wadnu		
cockatoo, white	gudaki	'katraŋu	
coition	budlti	'tanina	
coition, act of	'judni		
cooked	'umbata	'pindra	
corpse	indata	'nari	
country, flat (or plain)	bitana	'palara, 'palparu	
country, tribal	buŋari		
covering	'palda	'walpana	
crab	'jilaki	'kuŋ'kutir :i	
creeper (*Clematis*)	'winda'murlku		
creek, or river	bari	'kaijiri	veri
crow	'wakala		wakla
crow, white-eyed	mena'nalkara		
curlew	'wudlaru	'wil'luru	
dance, to	mutaŋa	'kil'lina	
dance, an imitative	guri		
dancing during initiation	'nanbuta		
deaf	uri'mika	'talpakur :u	
dead	indata	'nari	
design or marks	malka	malka	
digging (with yam-stick)	dandura	'wadna	
dingo	'wilka, 'wurdiŋi	'kintala'jampa	wilka
duck	ma :ri	'tau'urla	
eagle-hawk (wedge-tailed), black	'wildu	'kara'wara	wildu
eagle-hawk, red	mura		

	Ngadjuri	Dieri	Wailpi
ear - - -	uri	'talpa	
elbow - - -	'ŋupu	'tinti'pudu	
embers - - -	be:la		
emu - - -	'waridji	'waru'kati	warichi
euro - - -	'juru		manja
evening - - -	'alawara	'kalkaura	
excreta - - -	gudna	'kudna'na	
expectorate, to - -	'ŋalga	'ŋaltja'warana	
eye - - -	mena	milki	
eye-lash - - -	mena'buti	milki'pilpa	
eyed, sharp - -	mena'walpu		
fat (from corpse) -	muŋ'i	mani	
feet or toes - -	tidna	'tidna	
finger or hand - -	mura	'mara	mara
fire - - -	gadla	'turu	ardla
fire, earth-covered -	dunda		
fire-stick - -	gadla'widni	man'ja	
fire-drill (basal stick) -	'watate'widni		
fire-drill (twirling or upright stick) - -	'aru'watuŋ		
fish - - -	guja	'paru	
fish head - -	'akadi'guja	'paru'maŋa'tandra	
fish trap (any kind) -	'witi'wala		
fist - - -	mura'muku	'mara'muku	
flint (for fire-making) -	'judla'gunja	'turu'tula	
flint-knife - -	'judla	'kuku'wanta, 'kandi'muku	yudla
flood - - -	'wunda	'ŋari'mata	
flower - - -	murlku	'tiwi	
fore-head - -	'ŋunta	'milpiri	
fore-skin - -	'wari'bi		
frighten, to - -	'wa:nika, 'weininda	'japali	
frog - - -	'waka	'kalatiri	ngar'na
goanna - - -	budna	'kapiri	
goanna, large (*Varanus gouldii*) - -	'ina'wal:a	'pirinti	radna
go back! - -	'wun'ma'mara!	'tikamai!	
going, I am -	-'wandata	'ŋani'wupai	
grasshopper - -	'pitji'ilki	'pindri	wichirika
grease - - -	maŋ'i	'mani	
ground - - -	'jata	'mita	
grubs - - -	bati		
grubs, sandalwood -	bulkara'bati	'padi	
guard-stick - -	'jadli'gat'ta		
hair, human - -	'akuri	'par:a	
hand, lines on - -	mura'bari		
hawk, sparrow - -	'ŋalulka	'kir'ki	
head - - -	'akadi	'maŋa'tandra	
head-band (of hair string)	muŋa	'jarpu	
heel - - -	maku		
here - - -	'je	'ninkida	
hip - - -	biŋka	'kapa	
hole, a - - -	'japa	'minka	
hollow in a creek's bank	'woŋ'guri	'ŋa'pa'dulkuru	
homicidal native -	'waraŋa		
husband - - -	mani	'noa	

	NGADJURI	DIERI	WAILPI
hut - - -	ganagu	'ŋura	
hymen - - -	mita'japa		
jaw - - -	'ŋilkinja		
kangaroo (general) -	gud'la	'tjukuru	
kangaroo, rock - -	gandu		
kangaroo, red (male) -	'wudlu		wudlu
kangaroo, red (female) -	'waulwi		
kangaroo-skin bag -	'wudli'jakuda	'tjukuru'jakuta	
king-fisher -	'julu		
knee - - -	bura	'pan'tja	
labia minor - -	muniŋi, bimba'kakuti		
lark - - -	dere:lja		
like this - - -	'ŋaru	'jeruja	
lip - - -	'ŋimi	'mana'mim:i	
lizard, frilled - -	gadnu		ardnu
lizard, jew - -	'kudnu	'kadni	'kadni
lizard, sleepy - -	'alda		
lizard, small - -	'iti'iti	'kadiwaru	
look - - -	'nakuka'idla	'najina	
louse - - -	gudlu	'kata	
magpie, small (black-backed) - -	bindi'garu		wurukuli
mallee - - -	gula		yunda
mallee hen - -	budni		
mallee root, water-bearing	guŋa	'ŋapa	
man, a - - -	'juri, meru, 'epa		wulka
man, old - -		'pinaru	
man, young - -		'materi	yongari
medicine-man (male or female) - -	mindaba, mindabi	'kunki	
milk, human - -	'ŋama	'ŋama	
Milky-way - -	'wali'bari	'kadri'pari'wilpa	
moon - - -	bera	'pira	vera
morning - - -	'nupuru	'taŋu'bana	
mouse - - -	muŋu	'punta	
move! do not - -	'panjeli!	'wata'walki'walkiamai!	
mulga - - -	mulka	'malka	
nail, finger - -	beriŋi	'mar:a'pir:i	
nape of neck - -	'ŋundi	'wakura	
native tobacco - -	'pitjuri	'pitjiri	
net, fishing - -	minda, mindi	'jama	
night - - -	'wildja	'tinkani	
nipple (female) - -	'ŋami	'ŋama'tjilpi	
no! (stay) - -	'u'na:!		
no! (refusal) - -	'ne!	'wata	
noise - - -	'walpara	'mir'tja	
nose - -	mudla	'mudla	
nostrils - - -	mudla'wadlju	'mudla'wilpa	
nut grass (tubers) -	'jalka	'jaua	
ochre, black - -	muruŋa	'mita'karku'maru	
ochre, red - -	'jumbura, mildi	'mita'karku'maralji	
opossum - -	bilda	'pildra	
opossum rug - -	bilda'palda		
opossum skin pad -	'walka		
owl, large - -	'winda	'winta	

	Ngadjuri	Dieri	Wailpi
owl, small - -	'ŋani	'munju	
parrot, green grass -	mandelja		
parrot, green tree -	guli		
parrot, grey - -	'wurebu		
parrot, blue mountain -	'walaja		
parrot, mulga - -	gupilja		
parrot, red-backed -			bard'laru
parrot, shell - -	'wulur :i	'katatara	
parrot, blue-bonnet -		'pulanku	
peach, wild - -	'wuti		wulti
pearl-shell - -	makil :a	'kaldrati	
pears, wild - -	'ŋawala		
pears, wild (roots of) -	'ŋandi		
penis - - -	'wari	'kidni	wariardlu
penis, erection of -	'wari'ewaku		
picking up - -	'narinjenara	'manina'kurana	
playstick (knobbed) -	'jakura		
playstick (thrown through a bush or along clay-pan) - - -	'kukuru	'kuku :r :u'pirkina	aya
playstick (plain) -	'waba		
Pleiades - - -	bulali	'mankara'wora	
pointing-bone - -	badnu	'naria'moku	
porcupine grass (*Triodia*)	'nala		
potatoes, wild - -	balku		
pouch (for carrying objects in) - -	'jakuta	'jakuta	
pubic covering - -	'wunari	'ŋampu	
pubic hair - -	'ŋani	'winti	
purulent discharge -	gaba		
quartz, white - -	'judla'gadna		
quandong - -	gu'ti		
rain - - -	galwi	'talara'marda	
rain-maker - -	galwi'jura	'talara'kunki	
rain-stone (gypsum) -	galwi'biki	'talara	
rain-bow - -	guriŋi	'kuri'kir :a	wuranyi
rat - - -	wada	'punta	
reeds (at waterholes) -	'jaki'walala	'wirka, 'wilti	
receptacle or wooden dish	'pitji		wichi
revenge expedition (boning) - - -	badnu	'piŋa	
ribs - - -	'uriŋja	'pankiriri	
robin red-breast - -	'jupi		
round - - -	buri	'dampu'dampuru, 'pira'pira	
sandalwood tree -	bulkara, baru	'kalju'mara	emburu
scapula - - -	'weri	'tuku'muku	
scars (on body) - -	maŋka	'dapa	
scrub land - -	'walpa	'mita'kunari	
seeds, *Acacia* - -	min'ga	'kuntjiripaua	
seeds of the silverwattle -	vaka'mai :		
seeds, ground - -	bulpa	'punpu	
semen - - -	'ŋuru		
shadow - - -	buŋa	'katu	
shaking out dust -	'kunma'rindma	'kanti'kanti'bana	
she-oak tree - -	gudli		

	Ngadjuri	Dieri	Wailpi
shin - - -	'ŋati		
silverwattle - -	vaka		
sing, to - - -	guri'waŋutja	'wankana	
sit, to - - -	ikaŋa	'ŋamana	
sitting down of youth at initiation - -	'nara'daburumbura		
sky - - -	ikara	'pari'wilpa	
sleep - - -	meja'wanti	'muka'turana	
snake, carpet - -	mudlu	'woma	binaru
snake, mythological -	'akaru		
snake, small red (associated with the 'akaru)	babu'lara		
snake, small - -		'wanku	
snake, tiger - -	'arkubi		
snake, whip - -	'wiperu	'wiparu	
Southern Cross (lit. eagle)	'wildu	'paia'tidna	
Southern Triangle -	'winda'gudna	'mankarawara	
sparrow, diamond -	'iti	'tiwilitja	
spear - - -	'winda	'kalti	wadlala
spear-thrower - -	midla		
spider, black - -	'waku	'marankara	
spider, trap-door -	'arambura		
spider's web - -	'waku'ŋuŋura		
spine - - -	bari	'tuku'julkuru, 'tuku'wirdi	
spirits or ancestral beings	liŋjura	'mura'mura	
spirit of deceased -	'wuŋ'japi		
spirits causing heat -	'epa'tura	'kutji	
spirits inhabiting hills -	muŋiura		
spirit-children - -	muri'papa		
spirits that torment -	'wunda'winju		
spirit-men (ancestral or medicine-men) -	mindaba		
spirit-world - -	'kintjura		
star - - -	budli	'pari'tjiwaka	buudli
stick - - -	'widni	'pita	
stone - - -	murku	'marda	miri
stone for grinding seeds -	murku, gunja'buri	'marda'kuparu	mara, wadla
stone, a creek - -	gunja		
stony country - -	'udnamutna	'marda'paltirani	
stone-axe -		'kalara	
stomach - - -	bunduka	'mandra	
string or fibre -	'ita, 'ŋuri	'jinka	
sun - - -	'jandu, 'djendu	'ditji	yuundu
sunrise - - -	'jandu'witjanu	'ditji'dunka	
sunset - - -	'jandu'ŋalpaŋda	'ditji'wiri	
subincision - -	bita		
swelling of penis after circumcision - -	mudjuna		
swelling, body - -		'purulku'tjerina	
swim, to - -	muŋari	'tara'kana	
talk, to - - -	mulka	'jatana	
"talk," by sticks on the ground, or "silent-talk"	'jata'mulka		
teeth - - -	'era	'mana'tandra	
testicles - - -	gadlu	'kadlu'kapi	

	NGADJURI	DIERI	WAILPI
thigh - - -	gunti	'tara	
throat - - -	'judni	'jarkala	
thunder - - -	'kandu, gurini	'pildri'pildri	
tongue - - -	'jali	'tali	
top - - -	'aru'watuŋ	'miri	
totem or "mate" - -	daru, 'ŋumera	'ŋanpu, 'tua	
tree, burnt - -	'kakati	'patara	
tree, ti- - - -	guda		ora
umbilical cord - -	mindati		
umbilical cord, the one who retains it - -	'witjeti		
under - - -	'watate	'ŋarinelu	
urine - - -	'gumbu, 'kumbu	'kipara	
vagina - - -	'aka, mini, wulaka	'kil:a	
virgin - - -	miti		
vulva - - -	'ŋata, mudlju		indi
wagtail, willy - -	'witjililki	'tindri'tindri	
waist - - -	'widli		
waist-band of hair-string	'akuli		
wallaby, rock - -	gandu		andu
wallaby, small - -	gunda		
wallaby, scrub - -	'wadla		
water or rain - -	galwi	'ŋapa	awi
water hen - -	'wuna'djildi		
water-hole - -	'jaki	'ŋapa'kudu	
water from the mallee root - - -	guŋu'galwi		
whale - - -	'ŋakula		
what? - - -	'a ?	'mina ?	
whirl wind - -	'jaru'jaru, 'ŋadla'dara	'watara'watara	
white - - -	'wenda	'waru, 'pulu	
widow - - -	maduku	'ŋamuri	
wind, strong - -	'ŋadlan'dara	'watara'ŋur:u'ŋur:u	
wind, north - -	bakara		
wind, south - -	'wailpi'wari		
woman - - -	'atuni	'widla	adni
wombat - - -	'watu		yalpu
wood-pigeon - -	manbi	'kuru'kuru	
yacca - - -	'wuara		
yam - - -	'ŋumpa		
yam-stick - -	'kata		mungu-wiri
yes! - - -	'em!	'kau	ngaku

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ATMOSPHERIC POLLEN IN THE CITY OF ADELAIDE AND ENVIRONS

By F. V. MERCER, University of Adelaide
(Communicated by J. G. Wood)

Summary

The work described in a previous paper on pollen frequencies (Mercer, 1939, Trans. Roy. Soc. S. Aust., 63, (2) , 372) at Adelaide has been continued for a further year. Certain unknown grains have since been identified, and as a result of the two years' observations it is now possible to present a generalised picture of the pollen grain cycle in Adelaide.

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The sites were the same as before, but vertical as well as horizontal slides were exposed at each tri-weekly period during the year 1 August 1939 – 31 July 1940. At the Town Hall the vertical slides contained 63·7%, and at Croydon 63·5% of the total count, and at each individual count the percentage of each species was approximately the same on both sides. The relative percentages of the different species are shown in the accompanying table, the frequencies and incidence throughout the year being approximately the same as previously reported.

	Ash	Pine	Elm	Plane	Cupressus	Acacia
Town Hall	5·9	25·8	7·1	11·3	3·9	0·2
Croydon	4·6	2·6	0·1	1·0	1·9	0·6

	Casuarina	Grass	Dock	Chenopods	Unknown Group	Araucaria
Town Hall	1·8	11·7	0·8	5·1	9·9	0·4
Croydon	1·4	28·2	0·9	13·7	10·8	—

	Echium	Compositae	Sisymbrium	Walnut	Conifer	Plantain
Town Hall	0·6	2·1	0·8	0·1	1·4	3·9
Croydon	0·3	4·4	0·3	—	0·1	3·5

	Almond	Tamarix	No. 4	Olea
Town Hall	—	—	0·8	6·4
Croydon	14·0	4·5	1·5	3·2

Species not previously identified

Dock (*Rumex* spp.) occurred in very small quantities from September-December, probably from plants commonly growing on wasteland.

Salvation Jane (*Echium plantagineum* L.) occurred sporadically from October-November. The species is normally insect-pollinated and rarely becomes atmospheric.

Walnut (*Juglans regia* L.)—A few grains regularly from mid-October to mid-November.

Sisymbrium spp.—Occasionally present in September-October.

Olive (*Olea europea* L.)—Common in many areas, especially in the foothills. Grains occurred from end of October to end of November. At the Waite Research Institute, Glen Osmond, counts rose from one or two grains at the end of October to 2,200 per unit area on 13-15 November, and thereafter fell to zero at end of November. At other sites a similar incidence but smaller numbers was observed.

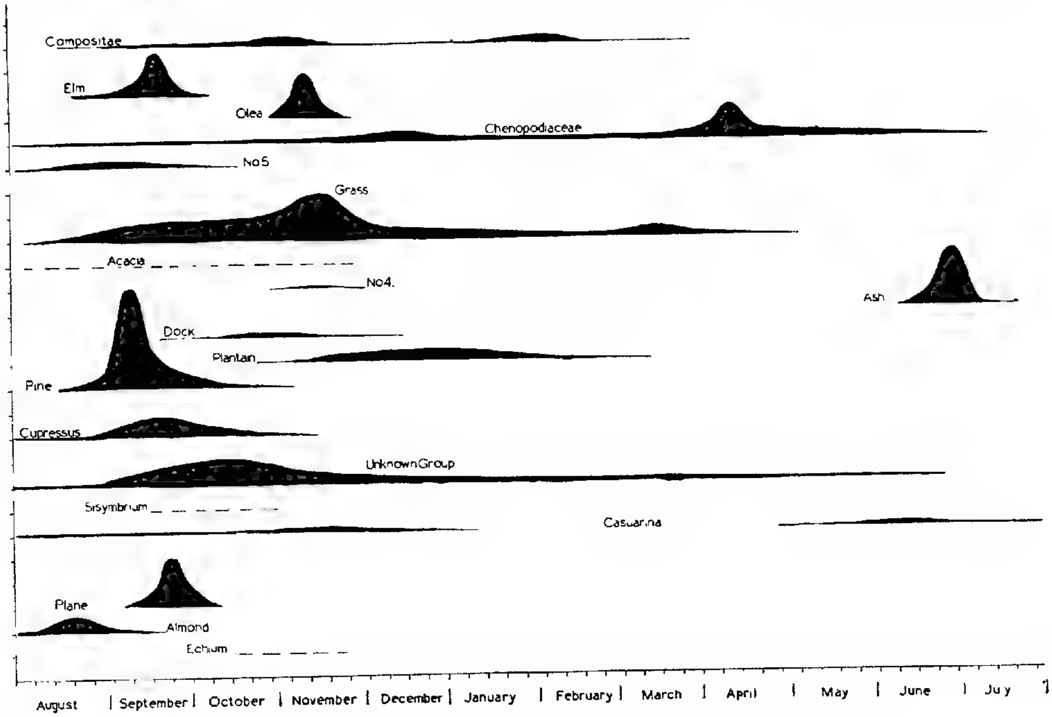
She-oak (*Casuarina* spp.), reported as No. 3 in the previous communication; it occurred over extended periods May-July and August-December but never more than 2% of the total. Native she-oaks common in the Mount Lofty Ranges have following flowering periods: *C. stricta,* summer; *C. striata,* June-December; *C. Muelleriana,* May-December.

"Unknown group"—This is a residue of grains of doubtful origin. It reaches a maximum in early spring when counts are high and doubtless includes some already known tree pollens which are variable and difficult to identify at the magnifications used for counting. The individual members of the group are never present in large amounts nor for any length of time, and not therefore likely to be of importance from a hay-fever aspect at Adelaide.

The Generalised Pollen Cycle

This is shown graphically, utilising the data accumulated over two years. The incidence and maximum for any species is the same for any part of the Adelaide area, although the actual number of grains present depends on the composition of adjacent vegetation.

All species listed produce pollen over long periods and can be regarded as suspects in causing hay-fever. It is noteworthy that wild oats (*Avena fatua*), still one of the commonest grasses around Adelaide in August-September with large pollen grains is rarely found on the slides. Pollens found occasionally or



General Pollen Chart in the City of Adelaide.

Each vertical division equals five grains per day per four square centimetres.

locally but not listed include: *Eucalyptus* spp. (September-April); *Tamarix* (January-February); *Malvaceae* (probably *Lagunaria*), Spring.

In Spring, at higher levels, such as at the Town Hall, Adelaide, the grass pollen consists mainly of smaller grains, whereas at the lower levels of the University and Croydon, both large and small grains are about equal.

The outstanding features of the cycle are:

June-July: Ash;

August-September: chiefly exotic trees, notably pines, elms, plane, *Cupressus*, and occasionally *Acacia* and *Casuarina;*

August-April: annual and herbaceous plants, notably grasses.

The above cycle applies only to Adelaide and its environs. At increasing distances from the city the prominence of pollen from introduced species is probably replaced by that from indigenous species.

Identification of Common Pollens

The following key permits practical identification of the prominent pollens likely to cause hay-fever in Adelaide. It does not pretend to be a systematic classification but is arranged for practical convenience.

Bladders present.	*Pinus* spp.
Grains spherical—	
(*a*) starch grains prominent	size 70 μ *Araucaria*
	„ 30 μ *Rumex* spp.
(*b*) exine reticulate	
June—furrows vague, reticulations small.	*Fraxinus*
September—grains irregular.	*Platanus*
October—exine thick between furrows and stains deeply.	No. 4
October—reticulations prominent and fine.	*Sisymbrium*
November—reticulations prominent and coarse.	*Olea*
January.	*Tamarix*
(c) exine pored.	
pores single.	Graminae
pores sunken.	Chenopodiaceae
pores papilliform.	*Plantago*
(*d*) intine star-shaped.	*Cupressus*
Grains aspidate—	
pores 3.	*Casuarina*
pores 3-7.	*Ulmus*
pores ∞.	*Juglans*
Grains compound.	*Acacia*
Grains triangular-spherical—	
Furrows conspicuous.	*Amygdalus*
„ inconspicuous, exine rigid.	*Eucalyptus*
„ „ grains irregular.	*Echium*

A REVISION OF THE AUSTRALIAN HELIODINIDAE (LEPIDOPTERA)

By A. JEFFERIS TURNER, M.D., F.R.E.S.

Summary

This family is a modern conception, which we owe to Meyrick. I cannot do better than to commence by quoting his description from the Genera Insectorum (1914).

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[Read 10 April 1941]

This family is a modern conception, which we owe to Meyrick. I cannot do better than to commence by quoting his description from the Genera Insectorum (1914).

"Head smooth; ocelli usually present; tongue usually developed. Antennae one-half to over 1, often strongly ciliated in male or fringed with long rough projecting scales, basal joint without pecten. Labial palpi slender with appressed scales, pointed, usually long, recurved, often diverging, sometimes short, porrected. Maxillary palpi short or usually very short, filiform; scaled, appressed to tongue, or often obsolete. Posterior tibiae hairy, bristly, or smooth, with more or less developed whorls of bristles or scales at origin of spurs, tarsi always with more or less developed bristles at apices of joints; in repose habitually erected over back or projecting laterally (in *Vanicela* appressed to abdomen without touching ground). Forewings narrow or very narrow, often widest near base, costa usually rather strongly arched towards apex, tornus obsolete; 1b furcate or simple, 2 from towards angle, 7 and 8 separate or stalked, 7 to termen or costa, 11 from about middle. Hindwings 1 or under 1, from narrowly elongate-ovate to lanceolate or linear, cilia 1 to 6; 3-7 normally separate, 3 and 4 seldom stalked, 6 and 7 sometimes stalked. Larvae with prolegs on segments 7-10 and 13, feeding externally or mining in leaves, stems, galls, or fruits, or on scale insects (*Coccidae*)."

He adds that the family "is specially characterised by the singular habit of erecting the posterior legs in repose, for which, as in the case of the peculiar attitude of the Gracilariadae, it is difficult to imagine any adequate explanation; associated with this habit is the invariable presence of apical bristles (sometimes very short) on the joints of the posterior tarsi, often more conspicuously developed on the tibiae also."

In the Genera Insectorum Meyrick recorded 41 genera and 227 species, but in his revised Handbook of British Lepidoptera (1927) he states that the number had risen to about 70 genera and 350 species. Since then many have been described in his Exotic Microlepidoptera, and there is no doubt many more will be discovered. The family is mainly tropical, but is well represented in Australia by 22 genera and 118 species.

KEY TO GENERA

1	Hindwings linear-lanceolate or linear		2
	Hindwings more broadly lanceolate or narrowly elongate-ovate		13
2	Forewings smooth		3
	Forewings with tufts of raised scales	*Trychnopepla*	
3	Palpi short, drooping	*Actinoscelis*	
	Palpi long, curved, ascending		4
4	Antennae with basal segment dilated to form an eyecap		5
	Antennae without eyecap		7
5	Anterior tibiae and tarsi much thickened with smooth scales	*Vanicela*	
	Anterior tibiae and tarsi not dilated		6
6	Antennae in male simple	*Calicotis*	
	Antennae in male with long ciliations	*Hieromantis*	
7	Tongue with long hairs on base	*Idioglossa*	
	Tongue without basal hairs		8
8	Antennae much longer than forewings	*Zaratha*	
	Antennae not longer than forewings		9
9	Antennae nearly as long as forewings	*Ethirastis*	
	Antennae not exceeding four-fifths		10
10	Forewings with 6 and 7 out of 8	*Isorrhoa*	
	Forewings with 6 separate		11

11	Hindwings with 4 absent, male antennae simple	*Pachyrhabda*	
	Hindwings with 4 present, male antennae ciliated		12
12	Antennae of male shortly or minutely ciliated	*Aeoloscelis*	
	Antennae of male with very long cilia towards base	*Stathmopoda*	
13	Palpi short, drooping	*Heliodinides*	
	Palpi moderate or long, curved, ascending		14
14	Forewings smooth		15
	Forewings with tufts of raised scales	*Coracistis*	
15	Palpi very long, much exceeding vertex		16
	Palpi moderate, not exceeding vertex		18
16	Antennae with a ridge of raised scales on dorsum		17
	Antennae without dorsal ridge	*Lissocarena*	
17	Hindwings with 6 and 7 connate or stalked	*Pseudaegeria*	
	Hindwings with 6 and 7 separate, parallel	*Snellenia*	
18	Tongue absent	*Aenicteria*	
	Tongue present		19
19	Forewings with 7 absent		20
	Forewings with 7 present		21
20	Antennae less than one-half	*Agiton*	
	Antennae four-fifths	*Molybdurga*	
21	Forewings with 7 absent	*Eretmocera*	
	Forewings with 7 and 8 stalked	*Dolophrosyne*	

1 Gen. Actinoscelis

Meyr., Exot. Micro., i, p. 24.

Tongue rudimentary. Palpi short, slender, drooping. Antennae in male ciliated. Posterior tibiae and tarsi with whorls of very long bristles; inner median spurs ending in whorls of short bristles. Forewings very narrow. Hindwings linear. Type, *A. irina* Meyr., from India. Only two species have been described.

1 *A. astricta* Turn., P.R.S.Vict., 1923, p. 80. (Qld.: Caloundra.)

2 Gen. Idioglossa

Wals., Tr. E. S., 1881, p. 273.

Tongue with long hair-scales on base. Palpi long, recurved, diverging. Antennae in male simple with a deep notch near base covered by a projection beneath. Forewings with 6 and 7 out of 8. Hindwings linear-lanceolate; 4 present. Type, *I. miraculosa* Frey, from North America. Two species are recorded from India and one from Africa.

According to Meyrick the larvae feed in a silken tube on the underside of grass leaves. Pupae within the tube.

2 *I. metallochrysa* Turn., P.R.S.Q., 1917, p. 84. (Cairns, Innisfail, Eungella, Nambour, Mount Tamborine, Macpherson Range 2,000 ft.)

3 Gen. Zaratha

Wlk., xxix, p. 789; Meyr., Exot. Micro., i, p. 335.

Tongue present. Palpi very long, slender, recurved, ascending. Antennae much longer than forewings; in male simple. Posterior tibiae with long hairs on dorsum; tarsi with very short or minute whorls of bristles. Forewings with 7 and 8 stalked. Hindwings linear-lanceolate.; 4 present. Type, *Z. pterodactylella* Wlk. from South America.

3 *Z. trisecta* Meyr., Exot. Micro., i, p. 335. (Darwin, Cairns.)

4 *Z. crotolitha* Meyr., Exot. Micro., i, p. 336. (Darwin, Cairns.)

4 Gen. Ethirastis

Meyr., Exot. Micro., ii, p. 462.

Tongue present. Palpi very long, slender, recurved, ascending. Antennae nearly as long as forewings; in male ciliated. Posterior tibiae with long hairs on dorsum and with apical whorls of bristles; tarsi with minute whorls of scales. Forewings with 7 and 8 stalked. Hindwings linear-lanceolate; 4 present. Type, *E. sideraula* Meyr. Monotypic.

5 *E. sideraula* Meyr., Exot. Micro., i, p. 315. (Cairns.)

5 Gen. Vanicela

Wlk., xxx, p. 1,039; Meyr., P.L.S.N.S.W., 1897, p. 314.

Tongue present. Palpi long, curved, diverging, slightly thickened with appressed scales. Antennae with basal segment dilated to form an eyecap; in male with long ciliations. Anterior tibiae and tarsi thickened with appressed scales. Posterior tibiae with rough bristly hairs on dorsum. Forewings with 7 and 8 separate. Hindwings linear-lanceolate; 4 present. Type, *V. disjunctella* Wlk., from New Zealand. Four species.

6 *V. xenadelpha* Meyr., *ibid.*, 1897, p. 315. Gen. Insect., pl. i, fig. 7. (Yeppoon, Bundaberg, Noosa, Brisbane, Stradbroke Island, Mount Tamborine, Rosewood, Toowoomba, Lismore, Sydney.)

7 *V. dentigera* Meyr., Exot. Micro., i, p. 81. (Herberton.)

8 *V. tricolona* Meyr., *ibid.*, i, p. 81. (Cairns.)

6 Gen. Hieromantis

Meyr., P.L.S.N.S.W., 1897, p. 315.

Tongue present. Palpi long, recurved, diverging. Antennae with basal segment expanded to form an eyecap; in male with long ciliations. Forewings with 7 and 8 stalked. Hindwings linear-lanceolate; 4 present. Type, *H. ephodophora* Meyr. There are four Indian species and three from Fiji.

9 *H. ephodophora* Meyr., *ibid.*, 1897, p. 315. (Cairns, Cardwell, Brisbane, Esk, Tweed Hds., Warwick, Sydney.)

10 *H. albata* Meyr., Exot., Micro., i, p. 94. (Dunk Island, Stradbroke Island. Also from New Guinea.)

7 Gen. Calicotis

Meyr., Tr. N.Z. Inst., 1889, p. 170; P.L.S.N.S.W., 1897, p. 313.

Tongue present. Palpi long, recurved, diverging. Antennae with basal segment dilated and hollowed to form an eyecap; in male simple. Forewings with 7 and 8 stalked. Hindwings linear-lanceolate; 4 absent. Type, *C. crucifera* Meyr. Besides the Australian species two have been described from Fiji, and one from the Seychelles.

Larvae feeding in galleries of loose refuse among the sporangia of ferns.

11 *C. microgalopsis* Low., Trans. Roy. Soc. S. Aust., 1904, p. 171. (Cairns, Mackay.)

12 *C. sialota* Turn., P.R.S.Q., 1917, p. 87. (Nambour, Brisbane, Stradbroke Island, Mount Tamborine, Tweed Hds., Toowoomba.)

13 *C. crucifera* Meyr., Trans. N.Z. Inst., 1888, p. 170; P.L.S.N.S.W., 1897, p. 313. Gen. Insect., pl. i, fig. 5. (Brisbane, Mount Tamborine, Macpherson Range 2,500-3,000 ft., Bunya Mountains 3,500 ft., Sydney. Also from New Zealand.)

14 *C. triploësta* Turn., P.R.S.Vict., 1923, p. 78. (Brisbane.)

8 Gen. Pachyrhabda

Meyr., P.L.S.N.S.W., 1897, p. 312.

Tongue present. Palpi long, recurved, divergent. Antennae in male simple. Forewings with 7 and 8 separate or stalked. Hindwings linear-lanceolate; 4 absent. Type, *P. steropodes* Meyr. The number of described species is now 22, of which four are from Ceylon and India, two from Africa, twelve from Australia, one from New Zealand, three from Fiji, and one from the Seychelles. One of the Australian species is recorded also from India, Ceylon and Kermadec Island, and another from Ceylon. This, however, does not give a correct idea of its real distribution, for there can be little doubt that the genus is of Indo-Malayan origin, and will be found most plentiful in that region. With only two exceptions the Australian species are confined to the coast of Queensland.

15 **Pachyrhabda punctifera** n. sp.

punctiferus, spotted.

♂, 10 mm. Head, palpi, antennae, and thorax grey-whitish. (Abdomen missing.) Legs white; posterior pair with fuscous rings on apices of tibiae and on tarsi. Forewings moderate, apex pointed; 7 and 8 separate; grey-whitish; costal edge fuscous towards base; fuscous dots on fold at one-eighth and one-fourth, a third subcostal at two-fifths, a fourth on costa at two-thirds, and a fifth beneath it; cilia grey-whitish, on apex fuscous. Hindwings one-half; grey; cilia 4, grey. Queensland: Bundaberg in August; one specimen.

16 **Pachyrhabda campylosticha** n. sp.

καμπυλοστιχος, with zig-zag lines.

♂, 8 mm. Head fuscous; face glossy ochreous-whitish. Palpi fuscous, inner surface ochreous-whitish. Antennae grey. Thorax fuscous. Abdomen fuscous, towards base brassy. Legs ochreous-whitish; anterior pair fuscous (posterior pair missing). Forewings narrow, apex pointed; pale yellow with blackish markings; a costal streak from base to three fourths; two closely appressed longitudinal lines on middle of fold; two zig-zag fasciae, broadest on costa, slender in middle, composed of coalesced longitudinal lines; first from mid-costa to before tornus; second from three-fourths costa to termen; an apical dot; cilia grey, on apex blackish. Hindwings over one-half; fuscous with brassy lustre; cilia 3, grey. Queensland: Bunya Mountains in January; two specimens.

17 *P. hygrophaes* Turn., P.R.S.Vict., 1923, p. 79. (Gympie, Brisbane.)

18 *P. adela* Turn., *ibid.*, 1923, p. 79. (Macpherson Range, 2,500-3,000 ft.)

19 *P. capnoscia* Turn., *ibid.*, 1923, p. 80. (Macpherson Range, 3,000 ft.)

20 *P. xanthoscia* Turn., *ibid.*, 1923, p. 80. (Cairns.)

21 *P. steropodes* Meyr., P.L.S.N.S.W., 1897, p. 312. (Toowoomba, Katoomba, Mount Wilson, Warragul, Mount Wellington 2,500 ft.)

22 *P. antinoma* Meyr., Trans. N.Z. Inst., 1910, p. 72 = *cryerodes* Turn., P.L.S.N.S.W., 1915, p. 195. (Macpherson Range 2,500-3,000 ft., Ebor. Also from Kermadec Island, Ceylon, and India.)

23 **Pachyrhabda argyritis** n. sp.

ἀργυριτις, silvery.

♂, 12 mm. Head and thorax shining white. Palpi grey-whitish, inner surface white. Antennae dark grey. Abdomen grey. Legs dark grey; tarsi, rings on posterior tibiae, and anterior coxae white. Forewings narrow, apex pointed; 7 and 8 stalked; shining silvery-grey; a narrow whitish fascia from one-third costa to one-third dorsum; a transverse whitish fascia from two-thirds costa to tornus, not reaching margins; cilia grey, on apex fuscous. Hindwings one-half; cilia 5, grey. North Queensland: Dunk Island, in May; one specimen.

24 **Pachyrhabda acroscia** n. sp.

ἀκροσκιος, shaded at the apex.

♂, ♀, 8-11 mm. Head and palpi white. Antennae grey. Thorax and abdomen grey-whitish. Legs white; posterior pair with tibiae broadly fuscous at apices. Forewings narrow, apex obtuse; 7 and 8 stalked, whitish-grey; apical area suffusedly fuscous; cilia fuscous, on dorsum and tornus grey. Hindwings one-half; grey; cilia 4, grey. Queensland: Mount Tamborine in March; Macpherson Range (3,000 ft.) in November; Bunya Mountains (3,500 ft.) in October; three specimens.

25 *P. bacterias* Meyr., Exot. Micro., i, p. 95. (Cairns, Tweed Hds. Also from Ceylon.)

26 **Pachyrhabda liriopis** n. sp.

λιριωπις, white as a lily.

♀, 8-9 mm. Head, palpi, antennae, thorax, and abdomen white. Legs white; posterior pair with a dark fuscous ring at origin of terminal spurs. Forewings narrow, apex acute; 7 and 8 stalked; shining white; cilia white. Hindwings one-third; pale grey; cilia 8, pale grey. Queensland: Macpherson Range (2,500 ft.) in November; two specimens.

9 Gen. Isorrhoa

Meyr., Exot. Micro., i, p. 79.

Tongue present. Palpi very long, slender, recurved, diverging. Antennae of male simple towards base, towards apex with segments triangularly dilated and minutely but interruptedly ciliated. Forewings with 7 and 8 out of 6. Hindwings linear-lanceolate; 4 present. Type: *I. antimetra* Meyr., from India. There have been described four species from Ceylon and India, one from North and one from South Africa.

27 *I. atmozona* Turn., P.R.S.Q., 1917, p. 85. (Cairns, Cardwell.)

28 *I. pandani* Turn., P.R.S.Vict., 1923, p. 76. Larvae feeding on *Pandanus* in oval cases made of two conjoined segments each of the whole thickness of the leaf, leaving oval perforations in the leaves. (Darwin, Palm Island, Magnetic Island.)

29 *I. ancistrota* Turn., *ibid.*, 1923, p. 77. (Macpherson Range, 3,000 ft.)

30 *I. emplecta* Turn., Trans. Roy. Soc. S. Aust., 1926, p. 142. (Bunya Mountains, 3,000 ft.)

31 *I aetheria* Meyr., P.L.S.N.S.W., 1897, p. 327; Gen. Insect., pl. i, fig. 4 = *hydrographa* Meyr., *ibid.*, 1897, p. 327 = *implicata* Meyr., Exot. Micro., ii, p. 324 = *loxoschema* Turn., P.R.S.Vict., 1923, p. 97. In this species the markings on the forewings vary much in detail. In 13 examples I have found scarcely any two alike. The black scales on the forewings and cilia are inconstant, frequently absent in the male, more developed in the female. (Cairns, Yeppoon, Gympie, Brisbane, Tweed Hds., Mount Tamborine, Macpherson Range 2,500 ft., Sydney.)

32 *I. ochrochyta* Turn., Trans. Roy. Soc. S.A., 1926, p. 143. (Bunya Mountains, 3,000 ft.)

33 *I. euzona* Turn., *ibid.*, 1926, p. 143. (Macpherson Range, at the foot.)

10 Gen. Aeoloscelis

Meyr., P.L.S.N.S.W., 1897, p. 326.

Tongue present. Palpi very long, slender, recurved, diverging. Antennae of male shortly or minutely ciliated. Forewings with 7 and 8 stalked. Hindwings linear-lanceolate; 4 present. Type, *A. hipparcha* Meyr. At present known only from Australia.

34 *A. chrysophoenicea* Meyr., *ibid.*, 1897, p. 328. (Gympie, Brisbane, Stradbroke Island, Tweed Hds., Rosewood.)

35 *A. hipparcha* Meyr., *ibid.*, 1897, p. 328. (Geraldton.)

36 *A. sphragidota* Meyr., *ibid.*, 1897, p. 329. (Geraldton, Carnarvon.)

37 *A. thiostola* Turn., P.R.S.Vict., 1923, p. 77. (Charleville.)

38 **Aeoloscelis pachyceros** n. sp.

παχυκερως, thick-horned.

♂, ♀, 12-14 mm. Head pale ochreous or ochreous-grey; face and palpi ochreous-whitish. Antennae grey with obscure fuscous annulations; in male thickened, ciliations one-half. Thorax ochreous-grey. Abdomen grey; in male bases of segments and tuft ochreous-whitish. Legs grey; posterior pair ochreous-tinged. Forewings narrow, apex pointed; pale ochreous; costal edge fuscous towards base; markings variable, sometimes some median fuscous irroration, or a fuscous subdorsal median spot; cilia grey, on apex fuscous. Hindwings one-fourth, grey; cilia 8, grey. North Queensland: Palm Island in May, Mackay in October; four specimens.

11 Gen. Stathmopoda

Sttn., Brit. Tineina, p. 227; Meyr., P.L.S.N.S.W., 1897, p. 316.

Tongue present. Palpi very long, slender, recurved, diverging. Antennae in male with very long fine ciliations (3-7), sometimes with a short series also. Forewings with 7 and 8 stalked. Hindwings linear-lanceolate; 4 present. Type, *S. pedella* Lin., from Europe. By far the largest genus in the family, more than 150 species have already been described. It is most abundant in the Indo-Malayan region and in Australia and well represented in New Zealand and oceanic islands, but no continent is without at least one or two representatives. The Australian species known at present number 61.

The larvae vary much in habit. Some feed in galls or fruits; some on scale insects; and one on spider's eggs.

39 *S. melanochra* Meyr., *ibid.*, 1897, p. 321, Gen. Insect., pl. i, fig. 11. (Brisbane, Toowoomba, Glen Innes, Armidale, Ebor, Gosford, Sydney, Katoomba, Bathurst, Mittagong, Canberra, Adaminaby, Gisborne, Casterton, Melbourne, Launceston, Deloraine, Campbelltown, Hobart, Mount Gambier, Victor Harbour, Adelaide, Mount Lofty.) Larvae feeding on *Eriococcus* sp. (L. Tonnoir).

40 *S. desmoteles* Meyr., *ibid.*, 1897, p. 322 (Bathurst).

41 *S. lethonoa* Meyr., *ibid.*, 1897, p. 322 = *acromolybda* Turn., P.R.S.Vict., 1923, p. 78. (Brisbane, Bunya Mountains, Tabulam, Gosford, Sydney, Melbourne, Hobart.)

42 *S. chalybeis* Meyr., *ibid.*, 1897, p. 322. (Hobart, Port Lincoln, Albany.)

43 *S. acontias* Meyr., *ibid.*, 1897, p. 318. (Fernshaw, Launceston, Deloraine, Strahan, Russell Falls, Hobart.)

44 *S. chalchotypa* Meyr., *ibid.*, 1897, p. 318. Larvae feeding in galls on *Acacia decurrens*. (Brisbane, Warwick, Sydney, Melbourne, Hobart.)

45 *S. cyanopla* Meyr., *ibid.*, 1897, p. 319. (Mount Kosciusko, Deloraine.)

46 *S. sphendonita* Meyr., Exot. Micro., ii, p. 461. (Cairns.)

47 *S. holobapta* Low., Trans. Roy. Soc. S. Aust., 1904, p. 171. (Melbourne.)

48 **Stathmopoda castanodes** n. sp.

καστανωδης, chestnut-coloured.

♂, ♀, 12-18 mm. Head with crown reddish-brown, fillet leaden-fuscous, face shining white. Palpi pale brownish; internal surface white. Antennae pale grey, base and apex darker; ciliations in male 7. Thorax brown; tegulae except bases white. Abdomen brown; tuft whitish-ochreous. Legs white; posterior pair brownish, apices of tibiae and last two tarsal segments white, tarsi with fuscous rings. Forewings narrow, broadest near base, diminishing at first rapidly, then gradually to an acute apex; costal edge fuscous to a variable extent; a brown-whitish costal streak throughout; a reddish-brown median streak interrupted in middle, with a rounded basal expansion reaching dorsum and containing a leaden-fuscous spot; a brown-whitish streak along dorsum and termen interrupted beyond tornus by a leaden-fuscous spot; cilia grey, bases ochreous-whitish, on apex wholly fuscous. Hindwings one-fourth, almost linear; cilia 10, grey. North Queensland: Atherton Plateau (Lake Barrine). I bred from an unidentified rain-forest fruit 14 examples, of which only one was a male, in August. I also took a female example in June.

49 *S. cephalaea* Meyr., P.L.S.N.S.W., 1897, p. 319. Bred from galls on *Acacia decurrens* and another *Acacia*. (Bunya Mountains, Guyra, Hobart, Mount Wellington 1,500 ft.)

50 **Stathmopoda amathodes** n. sp.

ἀμαθώδης, sandy.

♀, 14 mm. Head and thorax pale ochreous-brown; face and palpi white. Antennae grey with fuscous annulations. (Abdomen missing.) Legs white. Forewings moderate, apex rather obtusely pointed; pale ochreous-brown; an ill-defined fuscous dot before midtermen; cilia grey, on apex pale ochreous-brown. Hindwings one-half; grey; cilia 5, grey. West Australia: Merredin in September; one specimen.

51 *S. astrapeis* Meyr., *ibid.*, 1897, p. 320. (Campbelltown, Tasmania; Adelaide.)

52 *S. mesombra* Meyr., *ibid.*, 1897, p. 320. (Hobart.)

53 *S. hyposcia* Meyr., *ibid.*, 1897, p. 320. (Warwick, Sydney, Mount Wilson, Bathurst, Hobart, Albany.)

54 **Stathmopoda notosticha** n. sp.

νωτοστιχος, with dorsal lines.

♀, 13 mm. Head with crown dark fuscous; face shining white. Palpi white. Antennae pale grey. Thorax white. Abdomen whitish; apices of segments fuscous; posterior pair with fuscous rings on apices of tibiae and on tarsi. Forewings narrow; white with slight costal fuscous suffusion; markings dark fuscous; a broad dorsal patch extending from base to one-third; a short median dorsal line almost confluent with it; a short longitudinal line above tornus; cilia grey. Hindwings one-half; grey; cilia 5, grey. New South Wales: Mount Wilson in November; one specimen.

55 *S. iodes* Meyr., *ibid*, 1897, p. 323. (Sydney, Fernshaw, Deloraine.)

56 *S. doratias* Meyr., *ibid.*, 1897, p. 323. (Albany.)

57 *S. sentica* Low., *ibid.*, 1899, p. 114. (Broken Hill.)

58 *S. xanthoma* Meyr., *ibid.*, 1897, p. 323. (Brisbane, Sydney.)

59 *S. metopias* Meyr., Exot. Micro., ii, p. 324. (Melbourne.)

60 *S. isoclera* Meyr., *ibid.*, 1897, p. 328. (Brisbane, Macpherson Range, 2,500 ft.)

61 *S. callichrysa* Low., Trans., Roy. Soc. S. Aust., 1893, p. 184, Meyr., *ibid.*, 1897, p. 325. Bred from *Acacia* sp. (Brisbane, Stanthorpe, Sydney, Melbourne, Port Lincoln, W.A., York, Northampton.)

62 *S. ischnotis* Meyr., *ibid.*, 1897, p. 324. (Carnarvon.)

63 *S. crocophanes* Meyr., *ibid.*, 1897, p. 324. One example has been bred from the fruit of the loquat (*Photinia japonica*). (Townsville, Yeppoon, Duaringa, Gladstone, Gayndah, Noosa, Brisbane, Stradbroke Island, Tweed Hds., Rosewood, Toowoomba, Bunya Mountains, Charleville, Milmerran, Warwick, Killarney, Glen Innes, Newcastle, Sydney, Cooma, St. Helens, Hobart, Adelaide, Hoyleton, Perth, Mogumber, Geraldton.)

64 **Stathmopoda ptycholampra** n. sp.

πτυχολαμπρος, with shining fold.

♀, 10 mm. Head yellow; face glossy whitish. Palpi whitish. Antennae grey. Thorax yellow. Abdomen grey. Legs whitish. Forewings rather narrow; yellow, towards apex with some brownish suffusion; costal edge fuscous from base to one-third; a fuscous costal dot near base; a fine silvery metallic line on fold; cilia grey. Hindwings one-half; grey; cilia 3, grey. Queenland: Noosa in May; one specimen.

65 **Stathmopoda marmarosticha** n. sp.

μαρμαροστιχος, with shining lines.

♂, ♀, 14-15 mm. Head ochreous-yellow; face whitish. Palpi ochreous-whitish. Antennae grey; ciliations in male 3 near base only, together with a short series from base to apex. Thorax ochreous in male; ochreous-fuscous in female. Abdomen grey; apices of segments grey-whitish. Legs fuscous; posterior pair ochreous. Forewings moderate, apex obtuse; ochreous-yellow, paler towards apex; costal edge fuscous towards base; markings lustrous silvery; a narrow subcostal line from base to midcosta; a narrow line on fold from base to dorsum; an oval spot on base of dorsum and another at one-fourth; cilia pale ochreous-grey. Hindwings one-half; grey; cilia 4, pale ochreous-grey. North Queensland: Townsville and Bowen in June; five specimens.

66 *S. bathrodelta* Meyr., Exot. Micro., ii, p. 461. (Cairns.)

67 **Stathmopoda citroptila** n. sp.

κιτροπτιλος, citron winged.

♀, 13 mm. Head and palpi whitish-ochreous. Antennae and thorax pale fuscous. Abdomen and legs whitish-ochreous. Forewings rather broad towards base, gradually narrowing towards apex, which is acute, costa moderately arched; very pale yellow; a moderately broad fuscous fascia from costa beyond middle to dorsum before tornus, its edges somewhat suffused; cilia grey. Hindwings one-half; grey; cilia 3, grey. North Queensland: Bowen in June; one specimen.

68 *S. trichopeda* Low., Trans. Roy. Soc. S. Aust., 1904, p. 171. (Cairns, Townsville.)

69 *S. arachnophthora* Turn., P.R.S.Q., 1917, p. 86. Larvae feeding in the egg capsules of an unidentified spider. (Eidsvold.)

70 *S. basixantha* Turn., *ibid.*, 1917, p. 85. (Rosewood.)

71 *S. tritophaea* Turn., *ibid.*, 1917, p. 86. (Cairns, Brisbane.)

72 *S. mimantha* Meyr., Exot. Micro., i, p. 92. (Cape York, Cairns, Yeppoon, Bundaberg.)

73 *S. xanthocrana* Turn., Trans. Roy. Soc. S. Aust., 1933, p. 179. (Macpherson Range, 3,000 ft.)

74 *S. triselena* Meyr., P.L.S.N.S.W., 1897, p. 318. (Cairns, Nambour, Caloundra, Brisbane.)

75 **Stathmopoda trimochla** n. sp.

τριμοχλος, three-barred.

♂, 12 mm. Head white; fillet narrowly fuscous. Palpi white. Antennae grey; ciliations in male 4. Thorax white. Abdomen grey; tuft white. Legs white; posterior pair with pale fuscous rings on apices of tibiae and on tarsi. Forewings narrow, apex acute; white with fuscous markings; an oval subdorsal spot at one-fifth; a moderate somewhat oblique fascia from two-fifths costa to mid-dorsum, expanded on dorsum; an ill-defined fascia from four-fifths costa to tornus; a subapical fascia leaving extreme apex white; cilia grey. Hindwings one-half; grey; cilia 6, grey. Queensland: Brisbane in September; one specimen.

76 *S. platynipha* Turn., P.R.S.Vict., 1923, p. 78. (Townsville.)

77 *S. diclidias* Meyr., Exot. Micro., ii, p. 462. (Cairns.)

78 *S. pantarches* Meyr., P.L.S.N.S.W., 1897, p. 321. (Brisbane, Sydney, Melbourne.)

79 *S. mannophora* Turn., Trans. Roy. Soc. S. Aust., 1900, p. 23. (Nambour, Brisbane.)

80 *S. nitida* Meyr., Exot. Micro., i, p. 93. (Darwin.)

81 *S. grammatopis* Meyr., *ibid.*, ii, p. 462. (Cairns.)

82 *S. rhythmota* Meyr., *ibid.*, ii, p. 324. (Brisbane.)

83 **Stathmopoda dimochla** n. sp.

διμοχλος, twice-barred.

♀, 9 mm. Head, palpi, antennae, and thorax white. Abdomen pale grey. Legs white; posterior pair with two broad tibial and three narrow tarsal fuscous rings. Forewings narrow, apex pointed; white; markings and some irroration fuscous; a broad submedian fascia, its outer edge angled beneath costa; a second somewhat suffused postmedian fascia not reaching costa, the two separated by a narrow white inwardly oblique line, a median spot above tornus and another at apex; cilia whitish-grey, on apex fuscous. Hindwings one-half; pale grey; cilia 5, whitish-grey. North Queensland: Cairns in August; one specimen.

84 *S. canonica* Meyr., P.L.S.N.S.W., 1897, p. 326. (Yeppoon, Stradbroke Island, Sydney, Katoomba.)
85 *S. megathyma* Meyr., *ibid.*, 1897, p. 325. (Brisbane, Stradbroke Island, Mount Tamborine, Tweed Hds., Rosewood, Lismore, Glen Innes, Gosford, Sydney, Wollongong.)
86 *S. liporrhoa* Meyr., *ibid.*, 1897, p. 326. (Toowoomba, Chinchilla, Newcastle, Sydney, Launceston.)
87 *S. rubripicta* Meyr., Exot. Micro., ii, p. 490. (Cairns, Innisfail, Nambour, Tweed Hds.)
88 *S. zalodes* Meyr., *ibid.*, i, p. 93. (Cairns.)
89 *S. effossa* Meyr., *ibid.*, ii, p. 460. (Adelaide.)
90 *S. nephocentra* Meyr., *ibid.*, ii, p. 461. (Broken Hill, Adelaide.)
91 *S. aphanosema* Turn., P.R.S.Vict., 1923, p. 78. (Stanthorpe.)
92 *S. trifida* Meyr., *ibid.*, ii, p. 462. (Cairns.)
93 *S. pampolia* Turn., *ibid.*, 1923, p. 79. (Tweed Hds.)
94 *S. ceramoptila* Turn., *ibid.*, 1923, p. 79. (Cairns.)

95 **Stathmopoda zophoptila** n. sp.

ζοφοπτιλος, dark-winged.

♂, 10 mm. Head with crown fuscous, fillet and face shining whitish; fillet prominent. Palpi whitish. Antennae whitish; ciliations in male 8; there is also a series of shirt ciliations. Thorax and abdomen fuscous. Legs whitish; posterior pair with dark fuscous rings on apices of tibiae and on tarsi. Forewings moderate, apex rather obtusely pointed; fuscous; a darker fuscous spot on costa at one-third and another above tornus; small areas of whitish-ochreous irroration on costa at middle and three-fourths; a small whitish-ochreous crescent at apex; cilia fuscous. Hindwings one-third; fuscous; cilia 6, fuscous. Queensland: Bundaberg in September; one specimen.

96 **Stathmopoda recondita** n. sp.

reconditus, concealed, obscure.

♂, ♀, 12-16 mm. Head glossy ochreous-grey-whitish; in female fuscous. Palpi ochreous-grey-whitish or grey. Antennae grey or grey-whitish; ciliations in male 5 towards base, but with a continuous series of shorter ciliations. Thorax ochreous-grey; in female fuscous. Abdomen grey; in female fuscous; tuft in male whitish-ochreous. Legs ochreous-grey or grey; anterior pair fuscous. Forewings broadest near base, gradually narrowing to an acute apex; grey-whitish or ochreous-grey-whitish with usually a variable degree of fuscous irroration; this may form inconstant basal, tornal, and subapical spots; cilia grey, on apex fuscous. Hindwings one-half; grey; cilia 4, grey. Tasmania: Burnie in December and January; Hobart, Strahan and Deloraine in February; six specimens.

97 **Stathmopoda rhodocosma** n. sp.

ῥοδοκοσμος, with rosy ornament.

♀, 13 mm. Head, palpi, and antennae white. Thorax white, in centre densely sprinkled with crimson. Abdomen and legs white. Forewings narrow, broadest at base, gradually attenuated to an acute apex; white; a few crimson scales close to base; termen from tornus to apex edged with crimson; cilia white. Hindwings one-half; whitish-grey; cilia 4, whitish. North Queensland: Dunk Island in May; one specimen.

98 **Stathmopoda nympheuteria** n. sp.

νυμφευτηριος, bridal.

♂, 13 mm. Head, palpi, antennae, and thorax white. Abdomen grey; tuft whitish. Legs white; posterior pair with fuscous rings on apices of tibiae and on tarsi. Forewings moderate; shining white; cilia grey. Hindwings two-thirds; grey; cilia 3 and a half, grey. Tasmania: Mount Wellington (1,500 ft.) in January; one specimen.

12 Gen. **Trychnopepla** nov.

τρυκνοπεπλος, rough-coated.

Head smooth; face retreating. Tongue present. Palpi moderately long, diverging, thickened with loosely appressed scales, slightly rough anteriorly; terminal segment shorter than second, equally stout, obtusely pointed. Antennae with basal segment elongate. Posterior tibiae with long hairs on dorsum; tarsi with whorls of short scales on apices of segments. Forewings with tufts of raised scales, of even width with rounded apex; 7 and 8 separate; 11 from before middle. Hindwings almost linear. The palpi and shape of forewings are distinctive.

99 **Trychnopepla discors** n. sp.

discors, unlike.

♀, 10 mm. Head white. Palpi whitish-brown with two fuscous bars on terminal segment, inner surface white. Antennae whitish-brown with dark fuscous annulations. Thorax pale ochreous-brown sprinkled with dark fuscous. (Abdomen missing.) Legs whitish; tarsi with dark fuscous rings. Forewings with costa straight to near apex; pale ochreous-brown unevenly suffused with pale crimson; markings and some irroration dark fuscous; a slender median line from one-third to two-thirds; a subdorsal tuft of raised scales at one-fourth; a transverse ridge of raised dark fuscous scales in disc at three-fourths; a spot between this and apex; a slender terminal line; cilia pale ochreous, on costa fuscous, on dorsum grey. Hindwings one-fifth; grey; cilia 6, grey. North Queensland: Kuranda; one specimen received from F. P. Dodd.

13 Gen. Aenicteria

Turn., Trans. Roy. Soc. S. Aust., 1926, p. 143.

Tongue absent. Palpi moderately long, smooth, recurved, ascending; second segment slightly thickened. Antennae in male very minutely ciliated. Posterior tibiae with dense long hairs on dorsum and with a terminal whorl of short scales; tarsi with whorls of very short scales. Forewings with rounded apex. Hindwings lanceolate; 2 and 3 connate, 4 absent. Monotypic.

100 *A. termiticola* Turn., *ibid.*, 1926, p. 143. Probably associated with termites. (Cairns.)

14 Gen. Lissocarena

Turn., P.R.S.Vict., 1923, p. 80.

Palpi long, smooth, recurved, diverging; terminal segment broadly dilated but laterally compressed. Antennae nearly 1; in male simple. Posterior tibiae and first tarsal segment clothed with short bristly hairs, whorls of short scales on apices of tibiae and first three tarsal segments. Forewings with 7 and 8 stalked. Hindwings lanceolate; 4 absent. Monotypic.

101 *L. semicuprea* Turn., *ibid.*, 1923, p. 81. (Cairns.)

15 Gen. HELIODINIDES

Sttn., Brit. Tin., p. 243; Meyr., Trans. Roy. Soc. S. Aust., 1906, p. 54.

Tongue present. Palpi short, filiform, porrect or drooping. Antennae in male thickened, simple. Posterior tibiae smooth with whorls of short bristles at apices; tarsi with short bristles at apices of segments. Forewings with 7 absent, 6 and 8 sometimes stalked. Hindwings lanceolate; 4 absent. Type, *H. roesella* Lin., from Europe. There are also nine species recorded from North America and four from the West Indies.

102 *H. princeps* Meyr., *ibid.*, 1906, p. 54. (Cairns, Brisbane.)

16 Gen. AGITON

Turn., *ibid.*, 1926, p. 145.

Tongue present. Palpi moderately long, recurved, ascending, divergent; second segment thickened towards apex with loosely appressed scales; terminal segment stout, rather obtuse. Antennae short (less than one-half); in male thickened and minutely ciliated. Posterior tibiae hairy on dorsum, with a terminal whorl of bristles; tarsi with whorls of short bristles on apices of segments. Forewings elongate-triangular; 7 absent (coincident with 8). Hindwings spathulate-lanceolate; 2 and 3 stalked, 4 absent, 6 absent. Monotypic. A curious and isolated genus.

103 *A. idioptila* Turn., *ibid.*, 1926, p. 145. (Macpherson Range, 2,500-3,000 ft.)

17 Gen. PSEUDAEGERIA

Wals., Tr. E. S., 1889, p. 17; Meyr., P.L.S.N.S.W., 1907, p. 133.

Tongue present. Palpi long, smooth, recurved, ascending; second segment thickened with appressed scales. Antennae with dorsal ridge of scales; in male ciliated. Abdomen with terminal tuft of laterally projecting scales. Posterior tibiae with dense whorls of long scales at apices; tarsi with spines at apices of segments. Forewings with 7 and 8 stalked. Hindwings narrowly elongate-ovate; 3 and 4 connate or stalked, 6 and 7 connate or stalked. Type, *P. squamicornis* Feld. The genus appears to be confined to Australia.

104 **Pseudaegeria phlogina** n. sp.

φλογινος, fiery.

♂, ♀, 23-28 mm. Head brilliant red; eyes white-edged beneath. Palpi moderately long, recurved, ascending, second segment moderately thickened, rough anteriorly; terminal segment ½, slender, acute; black, apex and anterior margin of second segment white. Antennae about 4/5, with a ridge of dense scales on dorsum from ¼ to near apex, ciliations in male (2/3); black, apex of dorsal ridge white. Thorax black, posterior and sometimes anterior margin red. Abdomen expanded towards apex with projecting lateral scales; bright red, transversely barred with black on two basal and three terminal segments. Legs black; middle and posterior tibiae with median part red, spurs white; posterior tarsi much longer than tibiae. Forewings elongate, narrow, posteriorly dilated so as to be somewhat spathulate, costa sinuate, apex rounded, termen and dorsum not differentiated; black with red markings; a narrow line on costa from base almost to apex; a similar line on dorsum from 1/5 to tornus; these are connected by an inwardly curved transverse line shortly before middle; a spot in disc at 2/3 beneath or touching costal line; cilia purple, bases narrowly white. Hindwings narrow;

6 and 7 short-stalked or approximated; basal area in male scaleless and transparent in costal half, bright red in dorsal half in male, orange in female; apical area black; cilia as forewings.

The larvae of this remarkable species feed on the bark of the woody stems of a climber locally known as "Supplejack," making small tunnels in its nodes and spinning a covering of silk and sawdust as is done by some *Xyloryctidae*. Mr. H. Francis has identified the food plant as *Ventilago viminalis* (Rhamneae). Queensland: Injune in March; four specimens received from W. B. Barnard. Type in Queensland Museum.

105 *P. squamicornis* Feld., pl. cxxxix, fig. 6; Meyr., P.L.S.N.S.W., 1907, p. 134, Gen. Insect., pl. i, fig. 15. (Sydney.)
106 *P. polytita* Turn., *ibid.*, 1913, p. 221. (Townsville.)
107 *P. hyalina* Turn., *ibid.*, 1913, p. 222. (Birchip.)

18 Gen. Snellenia

Wals., Tr. E. S., 1889, p. 13; Meyr., P.L.S.N.S.W., 1907, p. 132.

Tongue present. Palpi extremely long, slender, recurved, ascending, slightly rough anteriorly. Antennae with a dorsal ridge of rough scales; in male ciliated. Abdomen margined with rough scales; in male with a large posterior tuft. Posterior tibiae smooth with whorls of large scales on origin of spurs; tarsi with short spines on apices of segments. Forewings with 7 and 8 stalked. Hindwings very narrowly elongate-ovate; 3 and 4 connate, 6 and 7 separate, parallel. Type, *S. coccinea* Wals., from India. Besides the Australian there are two Indian and one South American species.

108 *S. lineata* Wlk., viii, p. 261; Meyr., P.L.S.N.S.W., 1907, p. 132, Gen. Insect., pl. ii, fig. 16 = *sesioides* Feld., pl. cxl, fig. 22. (Nambour, Brisbane, Tweed Hds., Tabulam, Sydney, Gisborne.)
109 *S. hylaea* Turn., *ibid.*, 1913, p. 221. (Mount Tamborine, Macpherson Range 2,500-3,500 ft.)
110 *S. miltocrossa* Turn., P.R.S.Vict., 1923, p. 81. (Bulli.)
111 *S. capnora* Turn., P.L.S.N.S.W., 1913, p. 221. (Herberton.)

19 Gen. Dolophrosyne

Drnt., Novit. Zool., 1919, p. 120.

Tongue present. Palpi moderate, recurved, ascending; second segment thickened and somewhat rough anteriorly; terminal segment short. Antennae in male thickened and slightly laminate with fascicles of cilia. Posterior tibiae with dense scale-tufts at origin of spurs; tarsi with whorls of short scales at apices of segments. Forewings narrow; 7 and 8 stalked. Hindwings narrowly elongate-ovate; 3 and 4 connate or stalked, 5 remote, 6 and 7 stalked. Monotypic.

112 *D. balteata* Drnt., *ibid.*, 1919, p. 121. (Yeppoon, Duaringa.)

20 Gen. Eretmocera

Zel., Micr. Caffr., p. 96; Meyr., P.L.S.N.S.W., 1897, p. 420.

Tongue strongly developed. Palpi rather short, curved, ascending; second segment somewhat thickened and rough anteriorly. Antennae with some long loose scales on dorsum; in male simple or very minutely ciliated. Abdomen broad, flattened, with laterally projecting scales. Posterior tibiae smooth with whorls of short scales at apices; tarsi with short spines at apices of segments. Forewings narrow; 7 absent, 6 and 8 stalked. Hindwings lanceolate. Type, *E. fuscipennis* Zel., from Africa. Most numerous in species from Africa, from which 13 species have been described, together with three from China and India, one from Europe, and four from the Archipelago.

113 *E. chrysias* Meyr., P.L.S.N.S.W., 1896, p. 1,047, *ibid.*, 1897, p. 421. (Palm Island, Townsville, Duaringa, Maryborough, N.W.A., Noonkambah.)

114 *E. cyanauges* Turn., *ibid.*, 1913, p. 220. (Townsville.)

115 *E. dioctis* Meyr., *ibid.*, 1897, p. 370 = *flavicincta* Turn., *ibid.*, 1913, p. 219. (Banana, Brisbane, Rosewood, Toowoomba, Dalby, Bunya Mountains, Injune, Milmerran, Warwick, Killarney, Geraldton (W.A.))

116 *E. coracopis* Turn., P.R.S.Tas., 1926, p. 155. (Cradle Mount, 2,000 ft.)

21 Gen. MOLYBDURGA

Meyr., P.L.S.N.S.W., 1897, p. 369.

Tongue present. Palpi moderately long, curved, ascending; second segment thickened with appressed scales. Posterior tibiae rough-haired; tarsi with short bristles at apices of segments. Forewings with 4 absent, 6 and 7 stalked. Hindwings lanceolate; 2 to 7 separate, nearly parallel. Monotypic.

117 *M. metallophora* Meyr., *ibid.*, 1897, p. 369, Gen. Insect., pl. ii, fig. 20. (Melbourne.)

22 Gen CORACISTIS

Meyr., *ibid.*, 1897, p. 370.

Tongue present. Palpi very long, recurved, ascending; second segment rough-scaled anteriorly towards apex. Antennae over 1; in male simple; in female with tuft of scales on mid-dorsum. Posterior tibiae long-haired on dorsum with slight whorls on origin of spurs; tarsi with short bristles on apices of segments. Forewings with tufts of raised scales; 7 and 8 out of 6. Hindwings lanceolate; 4 present, 6 and 7 parallel. Monotypic.

118 *C. erythrocosma* Meyr., *ibid.*, 1897, p. 370. Gen. Insect., pl. ii, fig. 26. (Melbourne, Gisborne.) Mr. Geo. Lyell, who has captured a specimen, says that it simulated a wasp both in appearance and poise.

INDEX TO GENERA

INDEX TO SPECIES

Synonyms in Italics

Erratum

By an unfortunate accident one of the best known species of *Gracilaria* was omitted from my revision of the Gracilariidae in these Transactions published last year.

169A *G. xanthopharella* Meyr., P.L.S.N.S.W., 1881, p. 141. N. Qld.: Atherton Tableland. Qld.: Brisbane, Mount Tamborine, Tweed Hds., Toowoomba. N.S.W.: Lismore, Sydney.

In the same paper the food plants of *Lithocolletis aglaozona* Meyr. were by an error of copying transferred to *L. stephanota* Meyr.

Phyllocnistis enchalcoa (Proc. Roy. Soc. Tas., 1938, p. 100) is a misprint for *P. enchalca*. This is plainly indicated by the derivation given from εγχαλκος, brassy.

REDISCOVERY OF ONE OF CANESTRINI'S AUSTRALIAN ACARIDS

By H. WOMERSLEY, F.R.E.S., A.L.S., South Australian Museum

Summary

In 1884, "Atti Ist Veneto," ser. vi, vol. 2, 705-728, Canestrini described and figured a number of species of Acarina from Australia, many of which were new. Of these none have hitherto been recognised since Canestrini's publication. His figures were reasonably good and well enable the species to be recognised; his descriptions, however, were inadequate.

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[Read 10 April 1941]

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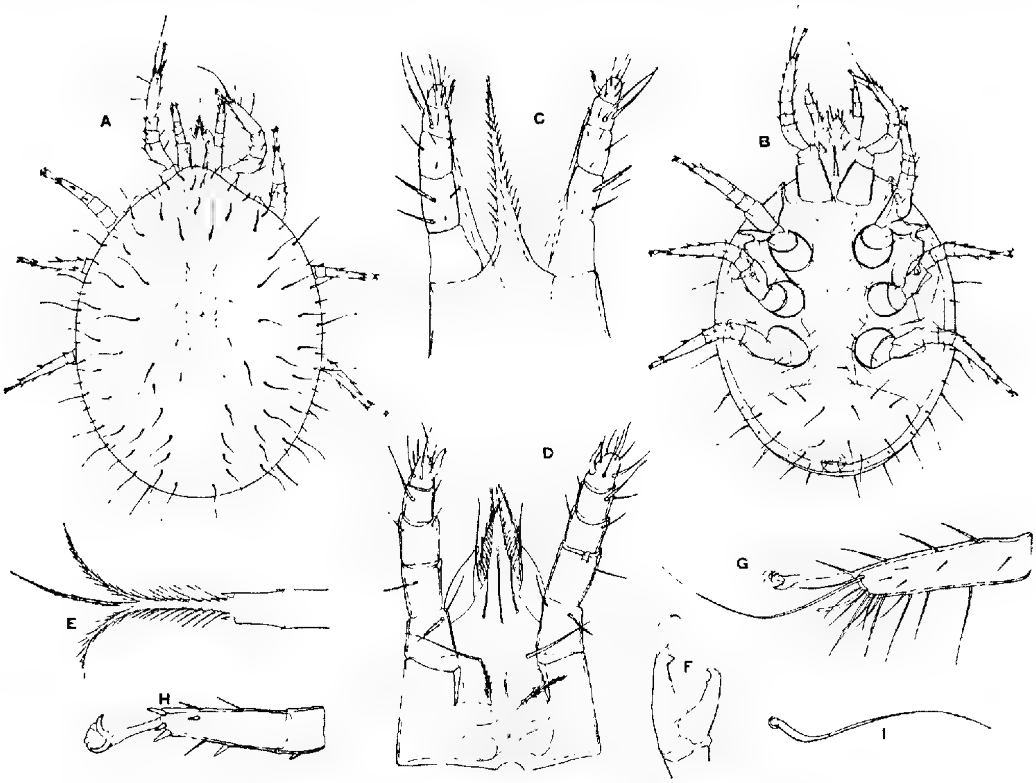
Amongst the new species described was the deutonymph of *Uropoda spinulipes,* from specimens found on a beetle, said to be allied to the European *Geotrupes.* It was illustrated by a figure of the ventral surface and of the tarsus.

Recently I have received from Dr. J. W. Evans; of Hobart, a specimen of an earwig killed by an overwhelming number of deutonymphal Uropodid Mites which



Uropoda spinulipes Canestrini (deutonymph)
A, dorsal view; B, ventral view; C, epistome and palpi; D, gnathosoma from below; E, tritosternum; F, mandible; G, tarsus I; H, tarsus II; I, dorsal seta

are undoubtedly the same as Canestrini's *U. spinulipes.* The locality was Hobart, Tasmania, September 1940. When received, all the mites were alive and, although in the deutonymphal stage, were very active and the adhesive vesicle had disappeared.

The purpose of this paper is to redescribe and refigure the species.

UROPODA SPINULIPES Canestrini 1884

Fig. A-I

Deutonymph

Shape broadly oval, slightly tapering apically. Length, 835 μ, width 610 μ (*i.e.*, rather greater than dimensions given by Canestrini—720 μ and 500 μ, respectively).

Dorsal surface with an entire shield which is coarsely and sparsely pitted or pored. Clothing as figured, mainly of long (90 μ) strong setae, which basally are strongly bent (fig. I); medially the two longitudinal rows are of much shorter fine setae. There are also a few large pores in the middle field (not figured).

Ventral surface—Tritosternum (fig. E) apparently trifurcate apically, the base longer than wide, the furcae with ciliations. Sternal-metasternal-genital shield long and roughly 4-sided with eight pairs of short, fine setae and two pairs of pores. Posterior shield roughly elliptical with the anus at the apex; it carries 14 long setae similar to those on the dorsum. The extreme edge of the venter outside of the plates carries some short, fine setae.

Gnathosoma-epistoma as in fig. C. Ventral view as in fig. D. Palpi as in fig. C and D, 5-segmented, segment II ventrally with a stout apical tooth. Mandibles as in fig. F.

Legs short and stout, tarsi with claws at the apex of a long caruncle, I apically with a number of long setae, one of which over-reaches the claws, and another which is stout, blunt and rod-like, II-IV with a number of short, stout spines.

SOME NEMATODES FROM AUSTRALIAN BIRDS OF PREY

By T. HARVEY JOHNSTON and PATRICIA M. MAWSON, University of Adelaide

Summary

This paper is based on material collected over a period of years from different parts of Australia. We are indebted to the late Dr. T. L. Bancroft (Eidsvold, Burnett River, Queensland), the late Dr. MacGillivray, Professor J. B. Cleland, Dr. A. Randall, Mr. J. T. Gray (Orroroo, S.A.), and the Queensland Museum for some of the parasites examined. Most of the remainder where collected by the senior author. The work was made possible by the Commonwealth Research Grant to the University of Adelaide. Types of the new species described have been deposited in the South Australian Museum. The following is a list of parasites arranged under their hosts:

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Falco longipennis Swainson (Orroroo, Gawler, and Lake Alexandrina, S. Aust.; Burracoppin, W. Aust.), *Serratospiculum guttatum* (Schneider).

Falco peregrinus Tunstall (Moorook, S. Aust.), *Serratospiculum guttatum* (Schneider).

Falco melanogenys Gould (Macdonald Downs, Central Aust.), *Serratospiculum guttatum* (Schneider).

Nisaetus morphnoides Gould (Lake Frome, S. Aust.), *Porrocaecum circinum* n. sp.

Circus assimilis Jardine (Orroroo, S. Aust.), *Porrocaecum circinum* n. sp.

Astur novae-hollandiae Gmelin (North Queensland), *Thelazia aquilina* Baylis; (Brisbane), *Porrocaecum circinum* n. sp.

Accipiter cirrhocephalus Vieill. (Eidsvold), *Hamatospiculum* sp. (? *mcneilli*).

Hieracidea berigora Vig. and Horsf. (Eidsvold), *Bancroftinema dentatum*, n. g., n. sp.

Hieracidea orientalis Schlegel (Flinders Is., Bass Strait), *Acuaria flindersi*, n. sp., *Physaloptera hieracideae* n. sp.

Cerchneis cenchroides Vig. and Horsf. (West Burleigh, South Queensland), *Habronema paraleptoptera* n. sp.

Ninox connivens Lath. (Eidsvold), *Seuratinema brevicaudatum* n. g., n. sp.

Ninox rufa Gould (North Queensland), *Hamatospiculum mcneilli* J. & M.

Ninox boobook Lath. (Burnett River, Queensland), *Hamatospiculum mcneilli* J. & M.

Ninox strenua Gould (Burnett River, Queensland), *Subulura* sp.

Porrocaecum circinum n. sp.

(Fig. 1)

From the spotted harrier, *Circus assimilis* (type host), (Orroroo; coll., J. T. Gray), the little eagle, *Nisaetus morphnoides* (Lake Frome, S. Aust.), and the white goshawk, *Astur novae-hollandiae* (Brisbane—Queensland Museum). Complete specimens not present. Material consisting of anterior parts of females up to 100 mm. long, posterior parts of females up to 20 mm.; and the anterior parts of narrower worms, either males or immature females, without genital organs. Maximum width 1·5 mm. Head narrower than succeeding body. Dentigerous ridge on anterior inner surface of each lip continuing along edge of cuticular wing-like expansion on each side of lip, and extending nearly to its base. Interlabia less than half length of lips, each joined anteriorly on its inner surface to adjacent lips; two papillae on dorsal lip, one on each ventral. Oesophagus 3·7-4·3 mm. long, including ventriculus ·32 mm. long. Intestinal caecum wide, half to two-thirds oesophageal length. Nerve ring about ·7-·8 mm. from head end. Vulva not observed, only female fragment long enough to be likely to include it being very much coiled and twisted. Eggs subglobular, about 90-100 μ in diameter.

These worms differ from *P. angusticolle* in total length, in the relative length of oesophagus, and the size and shape of the eggs. The absence of males in our material, and of measurements of the oesophagus and intestinal caecum in accounts of previously described species, makes comparison with other forms difficult.

Physaloptera hieracideae n. sp.

(Fig. 2-3)

From the brown hawk, *Hieracidea orientalis,* from Flinders Island, Bass Strait. Several poorly preserved females; only external features distinguishable. Length 17-18 mm., maximum breadth ·8 mm. Cuticular collar barely covering

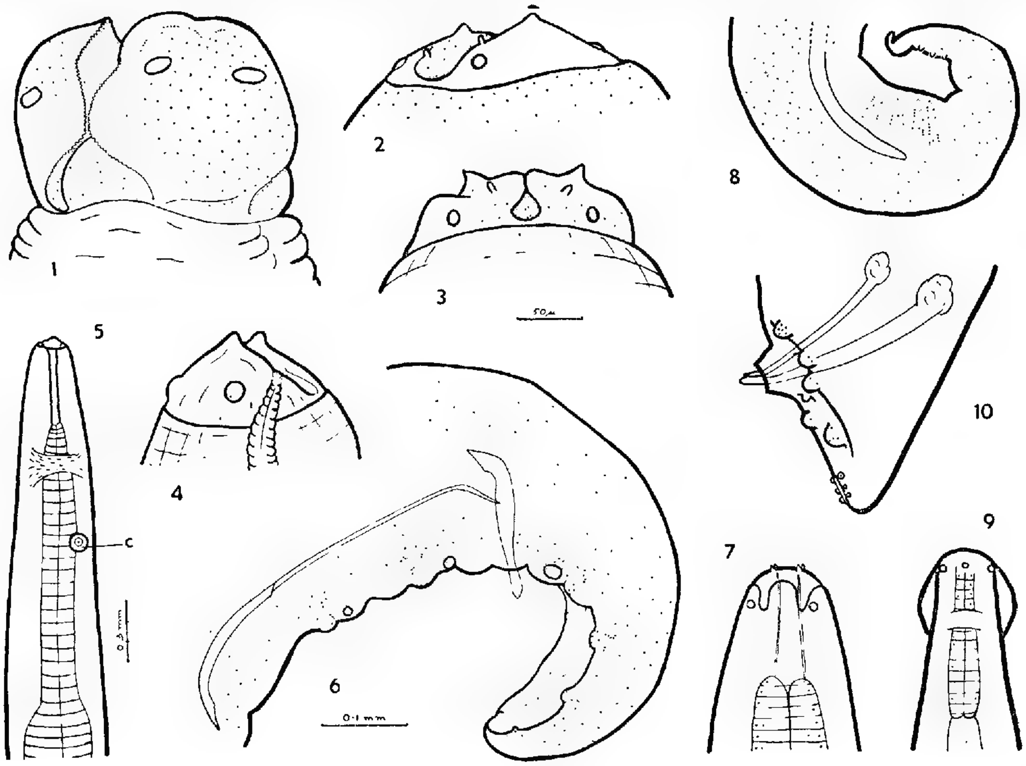

Fig 1, *Porrocaecum circinum:* head. Fig. 2-3, *Physaloptera hieracideae:* sublateral and ventral views of head. Fig. 4-6, *Acuaria flindersi:* 4, head; 5, anterior end; 6, male tail. Fig. 7-8, *Habronema paraleptoptera:* 7, head; 8, male tail. Fig. 9-10, *Seuratinema brevicaudatum:* 9, head; 10, male tail. Fig. 1, 6, and 10 to same scale; fig. 2, 3, 4, and 8. C, cervical papilla.

base of lips. Each lateral lip with one median conical tooth, two smaller lateral stylet-shaped teeth on inner border, and two papillae externally. Median teeth apparently not meeting in midline when head seen in dorsal or ventral view (fig. 3). Oesophagus 2·8 mm. long. Tail pointed, ·3 mm. long. The arrangement of the teeth distinguishes this species from other Physalopterids known from birds.

Acuaria flindersi n. sp.

(Fig. 4-6)

From *Hieracidea orientalis,* Flinders Island. Male 14·5 mm., female 16·9 to 18 mm. long; maximum breadth ·5 mm. Cordons rather faint, disappearing beyond 4 mm. from head. Lips each with two large papillae. Mouth leads to vestibule ·25 mm. long, ·03 mm. wide; anterior part of oesophagus ·9 mm., posterior part 4·3 mm. in length; nerve ring ·4 mm. from head. Measurements from female.

Male: longer spicule ·51 mm. in length, tubular proximally, narrowed distally; shorter spicule ·18 mm. long, spatulate with blunt tip. Caudal alae narrow, extending ·7 mm. in front of posterior end; on each side two large and two smaller precloacal, four postcloacal, and near posterior end of ala one small rounded papilla.

Female: tail ·15 mm. long. Vulva 5·5 mm. in front of posterior end, a third of body length from tail. Eggs, 36-38 μ by 25-26 μ.

Differs from *A. indica* Maplestone and *A. corvicola* J. & M. in length of cordons and position of vulva.

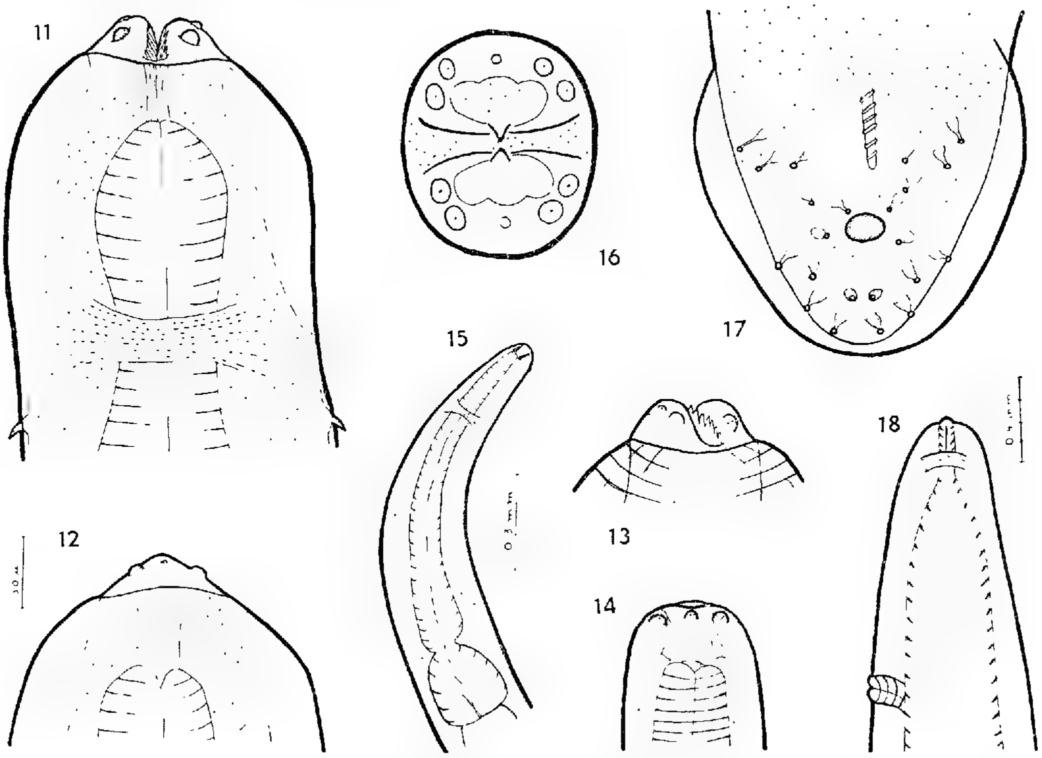

Fig. 11-13, *Bancroftinema dentatum:* ventral, lateral and sub-lateral views of head. Fig. 14-15, *Subulura* sp.: 14, head; 15, anterior end. Fig. 16-17, *Serratospiculum guttatum:* 16, head, anterior view; 17, male tail. Fig. 18, *Hamatospiculum* sp. from *Accipiter cirrhocephalus*, anterior end. All fig. except 15 and 18 to same scale.

Habronema paraleptoptera n. sp.

(Fig. 7-8)

From stomach of the kestrel, *Cerchneis cenchroides*, from West Burleigh, South Queensland. Material consisting of two males 10 mm. and 6·3 mm. long, their widths ·21 and ·1 mm. respectively; and posterior 9·8 mm. of a female. Specimens so slender and fragile that only a lateral view of head could be obtained. At least two, possibly three, teeth on each lateral lip; median of the three external lobes of each lateral lip slightly larger, the two outer each with large papilla; dorsal and ventral lips not visible from lateral aspect. Vestibule

12 μ wide; oesophagus commencing 38 μ from top of lips. In male 10 mm. in length, oesophagus 1·8 mm. long, nerve ring ·2 mm., and cervical papillae ·17 mm. from head end. Lateral alae about a quarter body length.

Male: tail with caudal alae about ·2 mm. long, reaching to within ·05 mm. of bluntly rounded tip. At least four pairs pedunculated preanal papillae, and three pairs small sessile postanal papillae. Tail 1·2 mm. long. Spicules in longer male ·35 mm. and 1·1 mm. in length; in shorter male shorter spicule ·3 mm., longer spicule very fine and its termination not observed.

Female: Vulva not present in only available piece. Tail ·31 mm. long, pointed. Eggs, thick-shelled, 25-30 μ by 12-15 μ.

The species closely resembles *H. leptoptera* (Rud.), but differs in the relative sizes of the lobes of the lips, the position of the nerve ring and excretory pore, and the size of the eggs. In spite of our inadequate study, these differences suggest that we are dealing with a new species.

Seuratinema brevicaudatum n. g., n.sp.

(Fig. 9-10)

From the winking owl, *Ninox connivens*, from the Burnett River (coll., Dr. Bancroft). One male present, 18 mm. long, ·5 mm. wide. Head rounded, with a pair lateral and two pairs larger submedian papillae; cuticle behind these inflated for distance of ·25 mm. Oesophagus ·5 mm. long, widening at base; nerve ring ·25 mm. from head. Posterior end bluntly pointed. Cloaca ·16 mm. from tip of tail, on prominence with four pairs pericloacal papillae at its base; posterior to these are one median and two lateral papillae; near tip of tail three pairs smaller papillae. Spicules subequal, about ·22-·25 mm. long, both tapering, shorter slightly thinner.

The combined characters of the head, tail and oesophagus suggest a new genus, diagnosed as follows:

Seuratinae: head rounded, cuticle behind head inflated for short distance. Buccal capsule absent; oesophagus short, muscular. Male: tail short, conical, with papillae not in linear row; no caudal alae; spicules subequal, short. Female unknown. Parasites of birds. Type species, *Seuratinema brevicaudatum* n. sp.

The genus appears to be nearest *Seuratum*, from which it differs in the absence of longitudinal bands on the cuticle, in the presence of inflated cervical cuticle, and in possessing a shorter male tail. It differs from genera of Thelaziidae in the absence of a buccal capsule, the presence of cervical inflation, the shortness of the male tail, the arrangement of the caudal papillae, and the length of the oesophagus.

Bancroftinema dentatum n. g., n. sp.

(Fig. 11-13)

From *Hieracidea berigora* from Eidsvold, Queensland (coll., Dr. Bancroft). Two females present, 2-2·5 cm. long, ·13-·15 mm. wide; body tapering anteriorly; tail rounded. Two more or less crescentic lateral lips, each with a small median and two large lateral papillae. Oesophagus commencing 70 μ from front of lips. From this level numerous (20-30 ?) chitinised rods extend forwards along inner surface of each lip to terminate in tooth-like points. These form a sort of buccal capsule, of which the dorso-ventral diameter is much greater than that from side to side, and of which the walls are longer in the centre than dorsally and ventrally. Cuticle inflated behind lips and extending backwards for about ·25 mm. Two parts of oesophagus not readily distinguishable, total length 2·5 mm.; nerve ring ·25 mm. from head, surrounding a constriction in oesophagus. Cervical papillae hook-like, posteriorly directed, small, ·1 mm. behind posterior end of cuticular inflation. Vulva just anterior to middle of oesophagus; two uteri filled with thick-shelled eggs about 50 μ by 25-30 μ, each containing a coiled larva.

Owing to the absence of males we have been compelled to depend mainly on the characters of the head and oesophagus to determine the systematic position of this genus. The presence of two well-marked lateral "pseudolabia" suggests the Physalopteridae, but it differs from members of that family in having a well-developed stoma. The Spiruridae have a well-developed stoma but the pseudolabia are usually small, and cephalic papillae are situated posterior to them. Our genus then appears to lie between the Spiruridae and the Physalopteridae as outlined by Chitwood and Wehr (1934). The genus *Bancroftinema* is diagnosed as follows:

Spiruroidea: with two lateral lips, each with three papillae. Buccal capsule present, narrower laterally than dorso-ventrally, its walls formed of rods arranged vertically side by side each ending in a tooth-like point on inner margin of lips. Cervical cuticle inflated. Oesophagus long, two parts not distinct. Vulva oesophageal. Parasites of birds. Type species *Bancroftinema dentatum* n. sp.

The genus differs from *Seuratinema* in the presence of lips and in the possession of an armed stoma.

Thelazia aquilina Baylis

From *Astur novae-hollandiae*, collected by Dr. MacGillivray in North Queensland. Several specimens of both sexes were examined. They agree essentially with Baylis' description (1934). Our specimens are shorter and stouter; the males show only three pairs of post-anal papillae. the third however is indistinct and large, and may comprise two small ones close together.

Subulura sp.

(Fig. 14-15)

From *Ninox strenua*, Eidsvold, Queensland. One poorly preserved female present, 9·5 mm. long. Vestibule 49 μ long, 29 μ wide; oesophagus 1·2 mm. long, its terminal bulb ·25 mm. long, ·2 mm. wide. Nerve ring ·28 mm., and excretory pore ·34 mm. from head end. Tail ·755 mm. long; vulva at mid-body; eggs 30-32 μ by 22 μ. Possibly owing to the density of the worm, teeth were not observed in buccal cavity. In the absence of males this species cannot be compared satisfactorily with recognised species.

Serratospiculum guttatum (Schneider)

(Fig. 20-21)

Specimens were obtained from *Falco longipennis*, from Orroroo, S. Aust. (coll., F. T. Gray and S. Aust. Museum), Lake Alexandrina, S. Aust. (coll., Dr. A. S. Randall), Burracoppin, W. Aust. (coll. Dr. Cleland), and Gawler, S. Aust.; *Falco peregrinus* from Moorook, S. Aust.; and from *Falco melanogenys* from Macdonald Downs, Central Australia. All the specimens examined appear to belong to the same species, although those from *F. peregrinus* are larger. The measurements given are, unless otherwise stated, of males and females from *F. longipennis*.

Males 80 mm. long, females 100-200 mm., maximum width 1 mm. (Males and females from *F. peregrinus* 160 mm. and 290 mm. long respectively, 2 mm. maximum width.) Epaulette structures on head poorly developed; four pairs submedian papillae large; laterals very small. Median anterior projection on each lip short. Narrow anterior part of oesophagus ·35 mm. long in female, ·32 mm. in male; posterior part 10 mm. in female 200 mm. long; nerve ring around anterior part, about its middle.

Male: spicules of typical shape, longer ·62 mm., shorter ·3 mm. in length (1·13 mm. and ·5 mm. in specimens from *F. peregrinus*), *i.e.*, shorter spicule about half length of longer. Caudal alae ·22 mm. long; cloaca 90 μ from tip of tail. Caudal papillae pedunculate, five pairs preanal, six pairs postanal, their arrangement being remarkably constant in all specimens examined.

Female: anus 60 μ in front of tip of rounded tail. Vulva near beginning of glandular part of oesophagus, ·8 mm. from head in 200 mm. long worm. All females except those from *F. peregrinus* covered with small cuticular bosses. Eggs, 50 μ by 30-25 μ.

The worms differ from *Filaria attenuata* Rud., 1819, as described by Seurat 1915, in being longer, in having a relatively shorter oesophagus, a pair of lateral cephalic papillae, and in the arrangement of the postanal papillae in the male. It agrees with Schneider's *Filaria guttata,* described in 1866 from *Falco berigora* from Adelaide. Seurat placed the species as a synonym of Rudolphi's *F. attenuata* (from *Falco peregrinus*), in spite of the fact that Schneider re-described Rudolphi's material at the same time as he published his own account of *F. guttata.* Baylis (1925, 112) recorded *S. attenuatum* from *Falco longipennis* from St. George, Southern Queensland, quoting as a synonym *Filaria guttata* Schneider.

Hamatospiculum mcneilli J. & M.

This species, originally described from *Ninox boobook,* from Hayman Island, Queensland, is now recorded from the same host from the Burnett River, Queensland, and from *Ninox rufa,* collected by Dr. MacGillivray in North Queensland.

Hamatospiculum sp.

(Fig. 18)

Part of a female worm probably referable to this genus was obtained from *Accipiter cirrhocephalus* at Eidsvold by Dr. Bancroft. Such features as can be made out, suggest *H. mcneilli* J. & M.

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Note—To bring our host names into line with those given in the "Official checklist of the birds of Australia" (1926), the following alterations are necessary: *Falco melanogenys* = *F. peregrinus; Nisaetus morphnoides* = *Hieraaetus m.; Hieracidea berigora* (syn. *H. orientalis*) = *Falco b.; Cerchneis cenchroides* = *Falco c.*

NEW AUSTRALIAN LEAF-HOPPERS

By J. W. EVANS, M.A., D.Sc., F.R.E.S.

Summary

The classification adopted in this paper is based on the system proposed in an earlier publication (Evans. 1939). No excuse is offered for considering the principal jassoid groups as families, as they are certainly as distinct as well established families in several other Orders of insects. As long as jassoid classification rests, to such a large extent, on the position of the ocelli, little progress will be made, and genera such as *Xerophloca* Germ. which on basic head structure and accessory characters clearly belongs to the Ledridae, will continue to be misplaced.

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BYTHOSCOPIDAE

Parablocratus australis sp. nov. (Fig. 13)

Length, 6 mm. General coloration, pale yellowish-green; eyes reddish-brown. *Head,* ante-clypeus parallel-sided, projecting beyond the maxillary plates. Apex of head consisting of a white apical band, of even width throughout, bounded on each side by a narrow brown line. The ocelli on this band are in contact with the eyes on each side. Crown flat, coronal suture extending a little beyond the ocelli. *Pronotum,* more or less parallel-sided. *Tegmen* hyaline, very pale green, appendix wide. *Legs* flattened, and with a development of minute spines between each of the spines in the row of the shortest but strongest spines.

Type ♂, from Gregory Downs, North Queensland (T. G. Campbell, May 1931), in the collection of the C.S.I.R, Division of Entomology at Canberra.

Parablocratus citrinus sp. nov. (Fig. 14-16)

Length, 6 mm. *Head* pale brown, ante-clypeus parallel-sided but not projecting beyond the maxillary plates; fronto-clypeus convex. Apical vertical margin of the head wider against the eyes than in the centre, white bounded on each side by a faint brown line. Ocelli on the apical margin, close to but not touching the eyes, visible from above. Crown concave, white with orange markings, coronal suture extending to between the ocelli. *Pronotum,* anteriorly white, posteriorly brown with orange markings as indicated in fig. 16. *Tegmen* pale hyaline brown, appendix narrow. Hind tibia flat with minute spines between each short spine.

Type ♀, from Cairns, North Queensland (A. M. Lea), in the collection of the South Australian Museum.

The genera *Parablocratus* Fieber and *Spanbergiella* Sign. are more closely related to *Bythoscopus* Germ. than to genera in the family Euscelidae. Accordingly they are added to the list of those genera, which in the opinion of the present author, comprises the family Bythoscopidae (Evans, 1939). It is recognised that although they are not extremely close to *Bythoscopus* and *Eurinoscopus* Kirk., they are more closely related to them than are such genera as *Macropsis* Lewis, *Idiocerus* Lewis and *Agallia* Curtis. With regard to the head, in *Parablocratus* and *Spanbergiella* the ocelli are marginal, in *Bythoscopus* they are ventral. The ante-clypeus is rectangular in all three genera, the maxillary plate wide and the labium short. The crown in *Bythoscopus* consists entirely of the vertex; in the other two genera it is made up of the vertex and part of the fronto-clypeus. The pronotum in all is wide and more or less parallel-sided, the tegmina have all similar venation, and the hind tibiae are flattened and slightly curved. A change in head shape from an evenly rounded head with ventral or marginal ocelli to one that is flattened or even spatulate with marginal or dorsal ocelli has occurred independently in several groups of leaf-hoppers. A series of figures illustrating such a change and the transition stages, has been given in an earlier paper (Evans, 1937).

IDIOCERIDAE

Idiocerus swani sp. nov. (Fig. 4)

Length, 6 mm. (♀), 4·5 mm. (♂). *Head* biscuit-coloured suffused with pink posteriorly; ocelli red; eyes, dark reddish-brown. Face of the head in two distinct planes which are separated by a line joining the antennae. Fronto-clypeus anteriorly convex, posteriorly flat. Crown of even width throughout, pink with two small black spots close to the eyes on each side. *Pronotum,* finely transversely striated, yellowish-pink with two large black spots in a line with the internal margin of the eyes on each side. *Scutellum,* wide and long with a median transverse depression, marked with a variable pattern of black, yellow and pinkish-brown. *Tegmen* hyaline brown, veins pink excepting for the first anal vein which is white. *Thorax* and *abdomen,* ventral surface pale biscuit colour; ovipositor, black.

Type, ♀, from Flinders Chase, Kangaroo Island (D. C. Swan, February 1940), in the collection of the South Australian Museum.

Idiocerus flindersi sp. nov. (Fig. 1)

Length, 4·5 mm. *Head,* ventral surface pale biscuit-colour, eyes dull red. Ante-clypeus medially depressed, lora swollen; fronto-clypeus anteriorly medially convex, posteriorly flat. Crown of even width throughout, slightly produced anteriorly. *Pronotum* and *scutellum* pale biscuit-colour. *Tegmen,* transparent, colourless, veins apically pale brown.

Type, ♀, from Flinders Chase, Kangaroo Island (D. C. Swan, February, 1940), in the collection of the South Australian Museum.

Idiocerus macropensis sp. nov. (Fig. 2 and 3)

Length, 3 mm. *Head,* ventral surface almost flat, pale biscuit-colour, with a rectangular grey area lying against the posterior margin; ocelli brown, eyes black, Crown wide, pale brown and pale yellowish-brown with two small black spots close to the anterior margin. *Pronotum* concolorous with the crown. *Tegmen,* dull whitish-grey with several scattered brown spots, apical cells hyaline, veins white. *Thorax,* ventral surface black. *Abdomen,* ventral surface pale biscuit-colour.

Type, ♀, from Flinders Chase, Kangaroo Island (D. C. Swan, February, 1940), in the collection of the South Australian Museum.

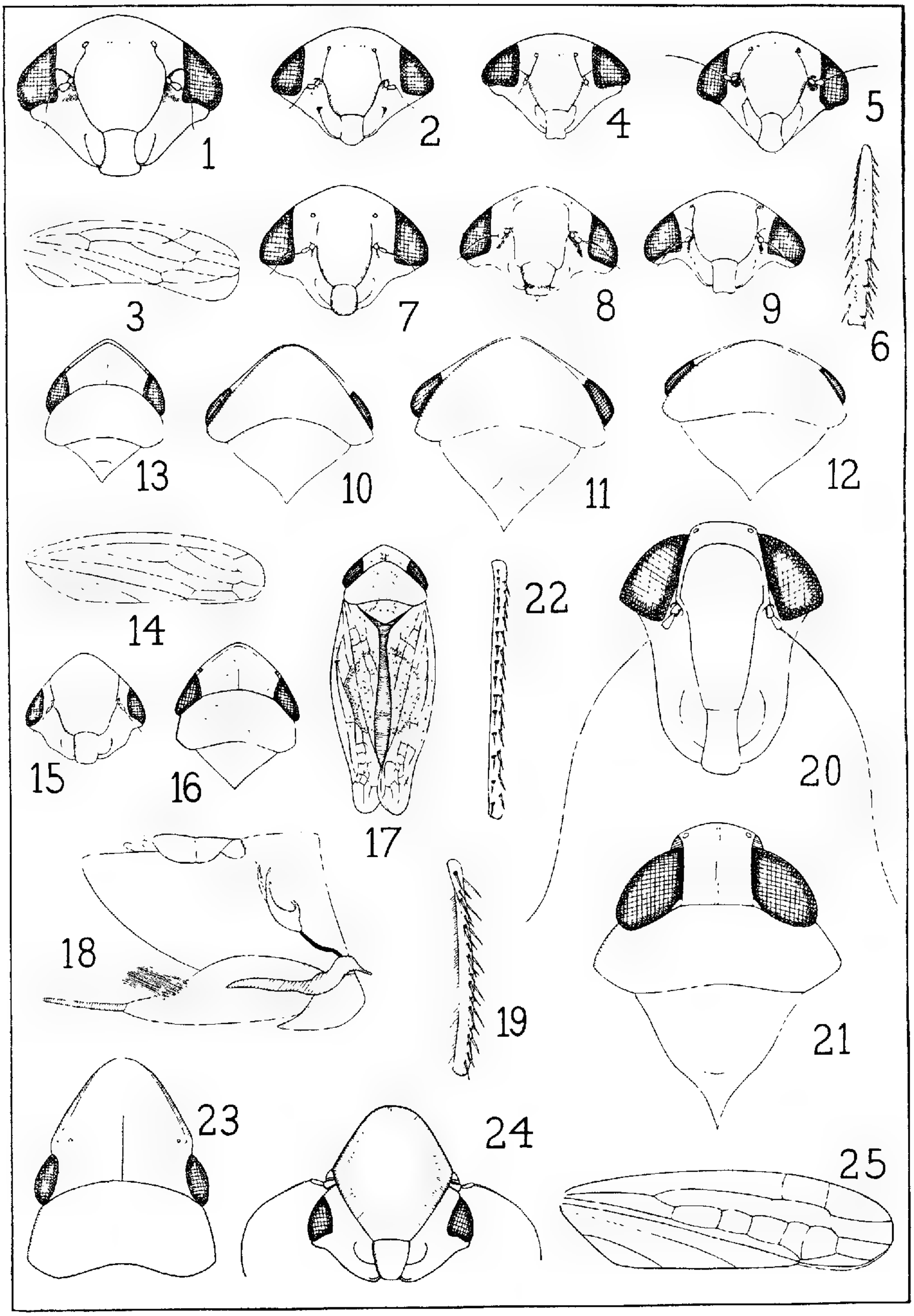
Idiocerus insularis sp. nov. (Fig 5 and 6)

Length, 2·5 mm. *Head,* ventral surface evenly convex, ante- and fronto-clypeus apricot-colour; eyes purplish-brown, ocelli black; an oval area against the posterior margin of the face, purplish-brown; lora and maxillary plates biscuit-coloured. Crown medially pale purplish-brown, laterally apricot, slightly wider in the centre than against the eyes. *Pronotum* and *scutellum* golden-yellow. *Tegmen,* golden-yellow, apically hyaline. *Thorax* and *abdomen,* ventral surface pale biscuit-colour.

Type, ♂, from Flinders Chase, Kangaroo Island (D. C. Swan, February 1940), in the collection of the South Australian Museum.

Austrocerus gen. nov.

The ante-clypeus is flat anteriorly and steeply convex posteriorly. The fronto-clypeus is narrow and convex anterior to the antennae; posterior to the antennae the face is evenly rounded. The maxillary plates are narrow and emarginate, the eyes large and the apices of the frontal sutures directed inwards. The crown is wide and the coronal suture distinct. The hind tibia has one spine set on a prominent base in a row containing four other spines.



Austrocerus emarginatus sp. nov. (Genotype) (Fig. 8)

Length, 3 mm. *Head,* ventral surface biscuit-colour, eyes lemon. Crown wider in the centre than against the eyes, medially apricot-colour, laterally biscuit-colour. *Pronotum, scutellum* and *tegmen,* apricot. *Thorax* and *abdomen,* ventral surface biscuit-colour.

Type, 1♀, from Flinders Chase, Kangaroo Island (D. C. Swan, February 1940), in the collection of the South Australian Museum.

Macrocerus gen. nov.

The ante-clypeus and the fronto-clypeus are wide and almost flat, and the maxillary plates are narrow and depressed below the level of the lora. The frontal sutures are directed outwards apically and the ocelli are sunk in slight depressions. The crown is wide and the coronal suture very short. The hind tibia has two spines set on prominent bases in a row containing four other spines.

Macrocerus minutus sp. nov. (Genotype) (Fig. 9)

Length, 3 mm. *Head,* ventral surface lemon-yellow; eyes, greenish-yellow. Crown slightly wider in the centre than against the eyes. *Pronotum, scutellum* and *tegmen,* pale buff. *Thorax* and *abdomen,* ventral surface pale biscuit-colour.

Type, ♂, from Flinders Chase, Kangaroo Island (D. C. Swan, February 1940), in the collection of the South Australian Museum.

Idiocerella gen. nov.

The ante-clypeus is swollen and declivous anteriorly and narrow posteriorly. The fronto-clypeus is evenly rounded and narrow, and the frontal sutures are parallel. The crown is wide and the coronal suture short. The hind tibia has two spines set on prominent bases in a row containing four other spines.

Idiocerella obscura sp. nov. (Genotype) (Fig. 7)

Length, 3·5 mm. *Head,* ventral surface pale buff, eyes lemon-yellow. Crown slightly anteriorly produced, wider in the centre than against the eyes. *Pronotum* wide, hind border medially emarginate, dull buff. *Scutellum* and *tegmen* dull buff.

Type, ♀, from Flinders Chase, Kangaroo Island (D. C. Swan, February 1940), in the collection of the South Australian Museum.

Nineteen species of *Idiocerus* Lewis have been described previously from Australia. Of these twelve occur in Queensland and two in Western Australia. Two of the remaining species, *I. seckeri* Ev. and *I. kirkaldyi* Ev., are abundant and widespread in South-Eastern Australia and Tasmania, whilst three are apparently rare insects. It is of particular interest to be able to record four new

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DESCRIPTION OF FIGURES

Fig. 1-25

1, *Idiocerus flindersi,* head, ventral aspect; 2, *Idiocerus macropensis,* head, ventral aspect; 3, *Idiocerus macropensis,* tegmen; 4, *Idiocerus swani,* head, ventral aspect; 5, *Idiocerus insularis,* head, ventral aspect; 6, *Idiocerus insularis,* hind tibia; 7, *Idiocerella obscura,* head, ventral aspect; 8, *Austrocerus emarginatus,* head, ventral aspect; 9, *Macrocerus minutus,* head, ventral aspect; 10, *Macropsis viridiceps,* head and thorax, dorsal aspect; 11, *Macropsis variabilis,* head and thorax, dorsal aspect; 12, *Macropsis norrisi,* head and thorax, dorsal aspect; 13, *Parablocratus australis,* head and thorax, dorsal aspect; 14, *Parablocratus citrinus,* tegmen; 15, *Parablocratus citrinus,* head, ventral aspect; 16, *Parablocratus citrinus,* head and thorax, dorsal aspect; 17, *Eutettix passiflorae;* 18, *Eutettix passiflorae,* male genitalia; 19, *Eutettix passiflorae,* hind tibia; 20, *Tharra leai,* head, ventral aspect; 21, *Tharra leai,* head and thorax, dorsal aspect; 22, *Tharra leai,* hind tibia; 23, *Austronirvana flavus,* head and thorax, dorsal aspect; 24, *Austronirvana flavus,* head, ventral aspect; 25, *Austronirvana flavus,* tegmen.

species of *Idiocerus* and three new species in allied genera, collected in a restricted area on Kangaroo Island during the same month.

MACROPSIDAE

Macropsis viridiceps sp. nov. (Fig. 10)

Length, 4 mm. *Head*, ventral surface emerald green, longer than wide; eyes reddish-brown. Crown visible above as a very narrow border, widest against the eyes. *Pronotum* emerald green, steeply declivous anteriorly. *Scutellum* yellow with two dark brown triangular markings against the anterior margin. *Tegmen* transparent, colourless, pale grey apically; a black spot at the apex of the claval suture, and the costal border proximally black. *Thorax* and *abdomen,* ventral surface green. The bases of the spines on the hind tibiae, dark brown.

Type, ♀, from Hobart, Tasmania (J. W. E., February 1936), in the collection of the South Australian Museum.

Macropsis variabilis sp. nov. (Fig. 11)

Length, 4 mm. *Head,* ventral surface wider than long, sordid yellow, eyes red. Crown narrowly visible from above, widest against the eyes. *Pronotum* dull brown flecked with black, declivous anteriorly. *Scutellum* brownish-yellow with dark brown punctures. *Tegmen* smoky-hyaline, clavus and costal margin green. *Wing* with R_{2+3} not fully developed. *Thorax* and *abdomen,* ventral surface, pale greenish-yellow.

Type, ♂, from New Norfolk, Tasmania (J. W. E., November 1938), in the collection of the South Australian Museum.

NOTE—This is a variable species, and the general coloration may be pale yellowish-green.

Oncopsis norrisi sp. nov. (Fig. 12)

Length, 4 mm. *Head,* ventral surface, ante-clypeus, lora and maxillary plates, buff; fronto clypeus reddish-brown, vertex posteriorly dark brown; eyes red. *Pronotum* declivous, red. *Scutellum* dull brown. *Tegmen* proximally pale yellow, distally testaceous; a wide red area between the costal border and the radius and a transverse median dark brown fascia; clavus yellow, anal margin dark brown; veins distally red. *Thorax* and *abdomen,* ventral surface pale yellow. *Legs* pale yellow, bases of spurs on hind tibia, black.

Type, ♀, from Guildford, Western Australia (K. R. Norris, September 1935), in the collection of the South Australian Museum.

EUSCELIDAE

Eutettix passiflorae sp. nov. (Fig. 17-19)

Length, 3·8 mm. *Head,* ventral surface buff with irregular yellowish-brown markings, eyes dark brown. Crown buff mottled with yellowish-brown. *Pronotum* anteriorly yellowish-brown, posteriorly grey mottled with brown. *Scutellum* apically, and anterior lateral angles, yellowish-brown, the remainder buff. *Tegmen* whitish-hyaline with an irregular pattern of light and dark brown spots; veins light and dark brown. An irregular dark grey median fascia extends from the anal border to half-way towards the costal border. *Thorax* and *abdomen,* ventral surface pale grey and buff. *Legs,* anterior two pairs buff with very dark brown markings on the femora and tibiae. Hind legs buff, bases of the spines dark brown.

Male Genitalia, as in fig. 18.

Type, ♂, from Sydney, N.S.W. (N. S. Noble on *Passiflora edulis,* August 1937), in the collection of the Australian Museum.

JASSIDAE

Tharra leai sp. nov. (Fig. 20-22)

Length, 6 mm. *Head,* ventral surface coffee-colour, eyes black. Ante-clypeus, fronto-clypeus and lora smooth, maxillary plates with marginal, and vertex with transverse striations. Ocelli distant from the fronto-clypeus which is raised above the level of the eyes; antennae very long. Crown wide consisting entirely of the vertex, the sides of which are at right-angles to the central portion. A median carina marks the position of the coronal suture. *Pronotum* and *scutellum,* dark brown. *Tegmen,* brownish-yellow, veins brown. *Thorax* and *abdomen,* ventral surface pale brown.

Type, ♀, from Cairns, North Queensland (A. M. Lea), in the collection of the South Australian Museum.

Kirkaldy (1906) in describing the genus *Tharra* stated that it differed from *Jassus* Fabr. by the possession of two sub-apical cells and the absence of transverse veins in the clavus. Later (1907) he was of the opinion that this venational difference was unreliable, and separated the two genera in a key in which *Jassus* was stated to have a flat frons and antennae situated near the intero-posterior angles of the eyes, whilst in *Tharra* the frons was raised and the antennae situated near the intero-anterior angles of the eyes. The species described above has been placed in Kirkaldy's genus as the fronto-clypeus is raised, although in the position of the insertion of the antennae it resembles *Jassus* rather than *Tharra.*

NIRVANIIDAE

Austronirvana gen. nov.

The ante-clypeus, which is slightly convex, is narrower anteriorly than posteriorly. The fronto-clypeus is concave, especially apically, and the labium is short, reaching only a little beyond the fore-coxae. The head has an apical flattened margin which is wider against the antennae on each side than in the centre, and the muscle impressions of the sucking-pump extend onto this margin. The crown is evenly convex and declivous, and the coronal suture extends for two-thirds of the length of the crown. The ocelli are on the crown directly above the antennae and are closer to each other than are the eyes. The pronotum narrows slightly anteriorly and the scutellum is wide. The tegmen is long and narrow, has a narrow appendix and several cells are developed between the median and the first cubital vein. The hind tibia has two rows of evenly spaced similar spines, between which is a row of slightly longer spines set on enlarged bases. There is also a row of short hair-like spines.

Austronirvana flavus sp. nov. (Genotype) (Fig. 23-25)

Length, 10 mm. General coloration pale buff, eyes brown. *Tegmen* opaque, venation indistinct.

Type, ♀, from Mount Tamborine, Queensland (A. M. Lea), in the collection of the South Australian Museum.

Note—Other specimens of the species from the same locality are bright yellow with a median longitudinal orange stripe on the head and pronotum. This stripe may be bordered with white.

Note—In an earlier paper (1939) the genera *Ledrella* Ev. and *Ledraprora* Ev. were placed in a sub-family of the Ledridae, the Ledrellinae. It is now realised that this was an error, and they are herewith transferred to the family Thymbridae (Evans, 1939).

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REVISIONAL NOTES ON THE AUSTRALIAN SPECIES OF TENUIPALPUS (ACARINA, TETRANYCHIDAE)

By H. WOMERSLEY, A.L.S., F.R.E.S., South Australian Museum

Summary

In these Transactions, vol. 64, pt. 2, p. 236-242 ("Studies in Australian Acarina: Tetranychidae and Trichodenidae"), I described or recorded the following species of *Tennipalpus* Donnadieu from Australia: *phoenicis* Geijs'kes 1939, *californicus* Banks 1904 and *vitis* Worn.

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By H. Womersley, A.L.S., F.R.E.S., South Australian Museum

[Read 8 May 1941]

In these Transactions, vol. 64, pt. 2, p. 236-242 ("Studies in Australian Acarina: Tetranychidae and Trichodenidae"), I described or recorded the following species of *Tenuipalpus* Donnadieu from Australia: *phoenicis* Geijskes 1939, *californicus* Banks 1904 and *vitis* Wom.

The last two species were distinct from the first in being very much less chitinised, in lacking the distinct and well-defined propodosomal and opisthosomal dorsal plates with their marked reticulations, and in the absence of the distinct ventral plates.

Since publishing my paper I have been indebted to Mr. S. L. Allman, of the Department of Agriculture, Sydney, for the loan of certain further specimens, in which he had observed that the adult cuticle was well differentiated within that of the nymph. From these specimens it is now possible to definitely ascertain the relationship of particular nymphs to particular adults, with the following results in synonymy:

Tenuipalpus californicus Banks, 1904

J. New York Entom Soc., 1904, p. 55.

= *Tenuipalpus phoenicis* Geijskes: Meded. Landbouwhoogeschool, Wageningen, 42, (4), 1939.

= ,, ,, Womersley: Trans. Roy. Soc. S. Aust., 64, (2), 237, 1940.

= ,, *californicus* Womersley: Trans. Roy. Soc. S. Aust., 64, (2), 239, 1940.

The type of this species is therefore the form (nymphal) described by Banks and also figured by Quayle (1912).

Tenuipalpus australis Tucker, 1926

Div. Entomology, Dept. Agric., Mem. No. v., S. Africa, 1926, p. 3, pl. i, pl. iii, fig. C-J.

= *Tenuipalpus vitis* Womersley: Trans. Roy. Soc. S. Aust., 64, (2), p. 241.

Specimens collected from Virginia Creeper, Armidale, New South Wales, 22 November 1940, and sent to me by Mr. Allman, show very clearly the form described and figured by Tucker, within the nymphal cuticle of *T. vitis*. It is therefore definitely established that the form *vitis* is but the early stage of *australis*.

T. australis was described from South Africa and, as such, has not hitherto been recorded from Australia. My record of *vitis* from lemons at Perth, Western Australia, must now be referred to Tucker's species.

The most obvious difference in the adult is that in *californicus* there are only 6 clavate setae around the posterior margin of the opisthosoma, whereas there are 8 in *australis*.

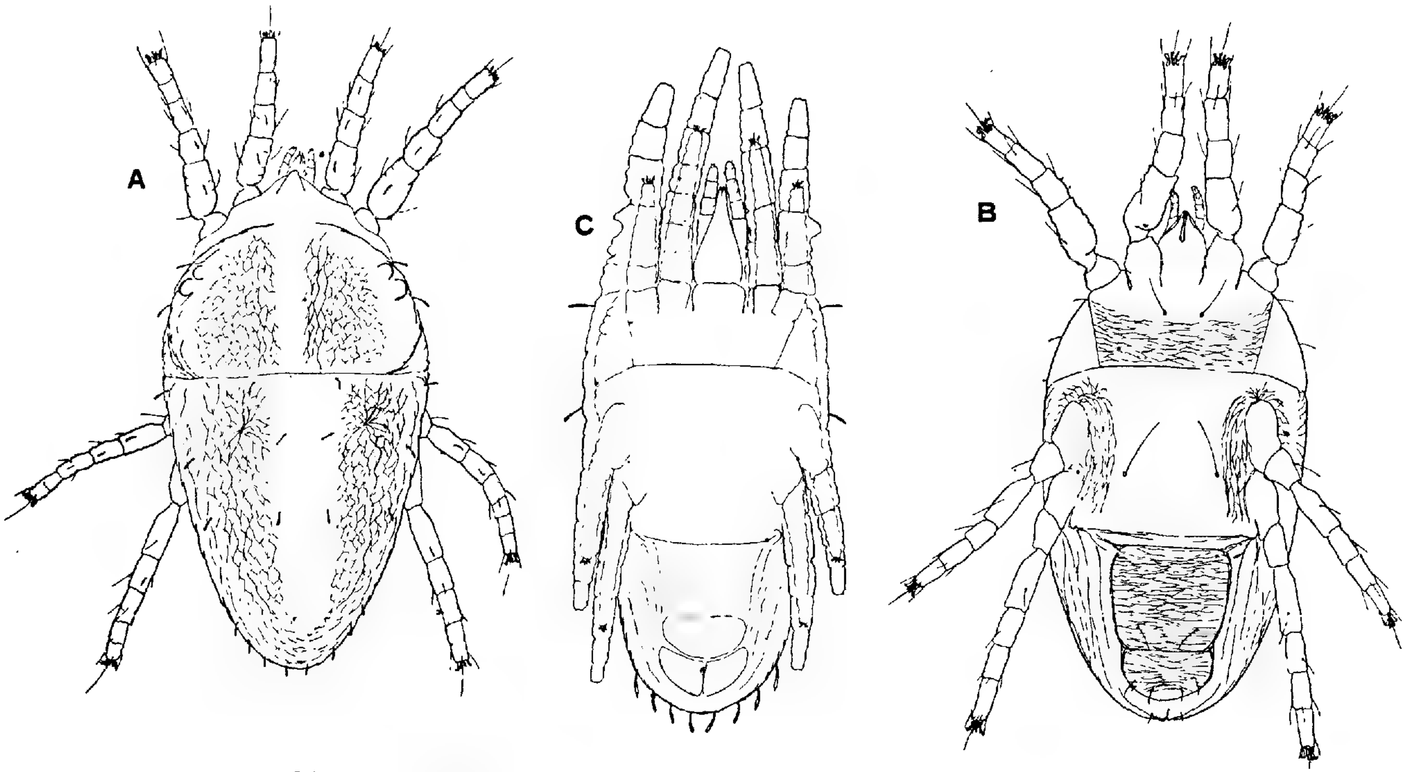


Fig. A, *Tenuipalpus australis* Tucker, dorsal view; B, ditto, ventral view;
C, *Tenuipalpus californicus* Banks showing adult instar within nymphal cuticle; ventral view.

THE PRINCIPAL SOIL AND VEGETATION RELATIONSHIPS ON YUDNAPINNA STATION, NORTH - WEST SOUTH AUSTRALIA

By R. L. CROCKER and H. R. SKEWES
(Waite Agricultural Research Institute)

Summary

Yudnapinna Station (about 50 miles north-west of Port Augusta) has been selected as the centre f or soil erosion and vegetation degeneration and regeneration studies by the Waite Agricultural Research Institute, under the Ranson Mortlock bequest. The Division of Soils of the Council for Scientific and Industrial Research was co-opted to elucidate the soil and vegetation relationships. A soil and ecological survey was made of some 25 square miles (North Lambing and South Lambing Paddocks, etc.) in which it has been considered the investigations would be centred. By means of some general traverses across the whole station a broader view of the ecology was obtained and some new types investigated.

THE PRINCIPAL SOIL AND VEGETATION RELATIONSHIPS ON YUDNAPINNA STATION, NORTH-WEST SOUTH AUSTRALIA

By R. L. Crocker and H. R. Skewes
(Waite Agricultural Research Institute)

Plates I to III

[Read 8 May, 1941]

INTRODUCTION

Yudnapinna Station (about 50 miles north-west of Port Augusta) has been selected as the centre for soil erosion and vegetation degeneration and regeneration studies, undertaken by the Waite Agricultural Research Institute, under the Ranson Mortlock bequest. The Division of Soils of the Council for Scientific and Industrial Research was co-opted to elucidate the soil and vegetation relationships. A soil and ecological survey was made of some 25 square miles (North Lambing and South Lambing Paddocks, etc.) in which it has been considered the investigations would be centred. By means of some general traverses across the whole station a broader view of the ecology was obtained and some new types investigated.

GEOLOGY AND PHYSIOGRAPHY

The general physiography is that of the last phases of a peneplain undergoing dissection. Only a few mesas and buttes give evidence of the former general level, although smaller ranges and hills are representative of successive stages of the weathering. The hills are rarely more than 300 feet above the general level,

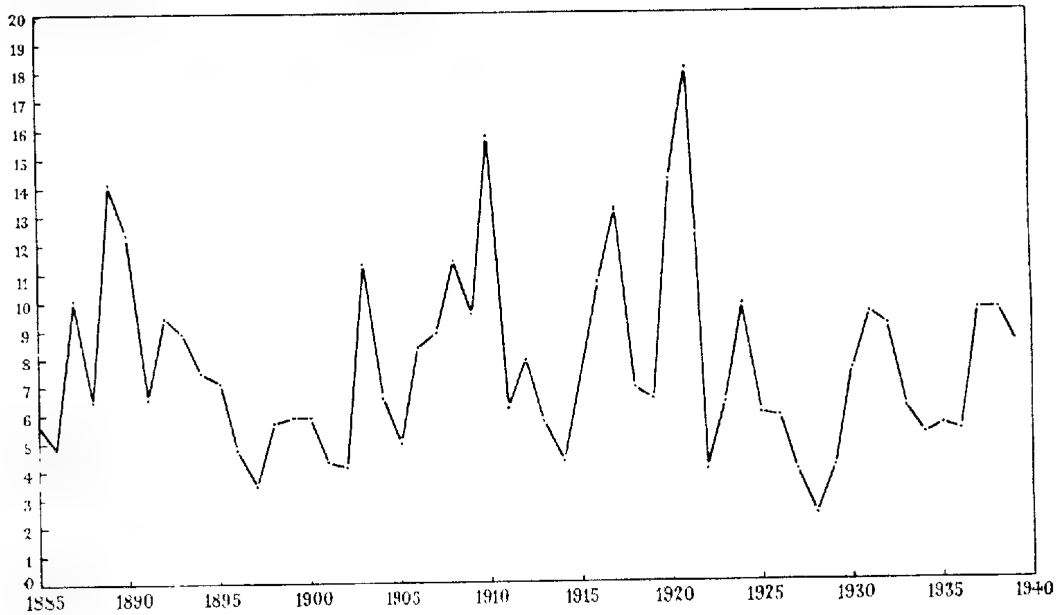


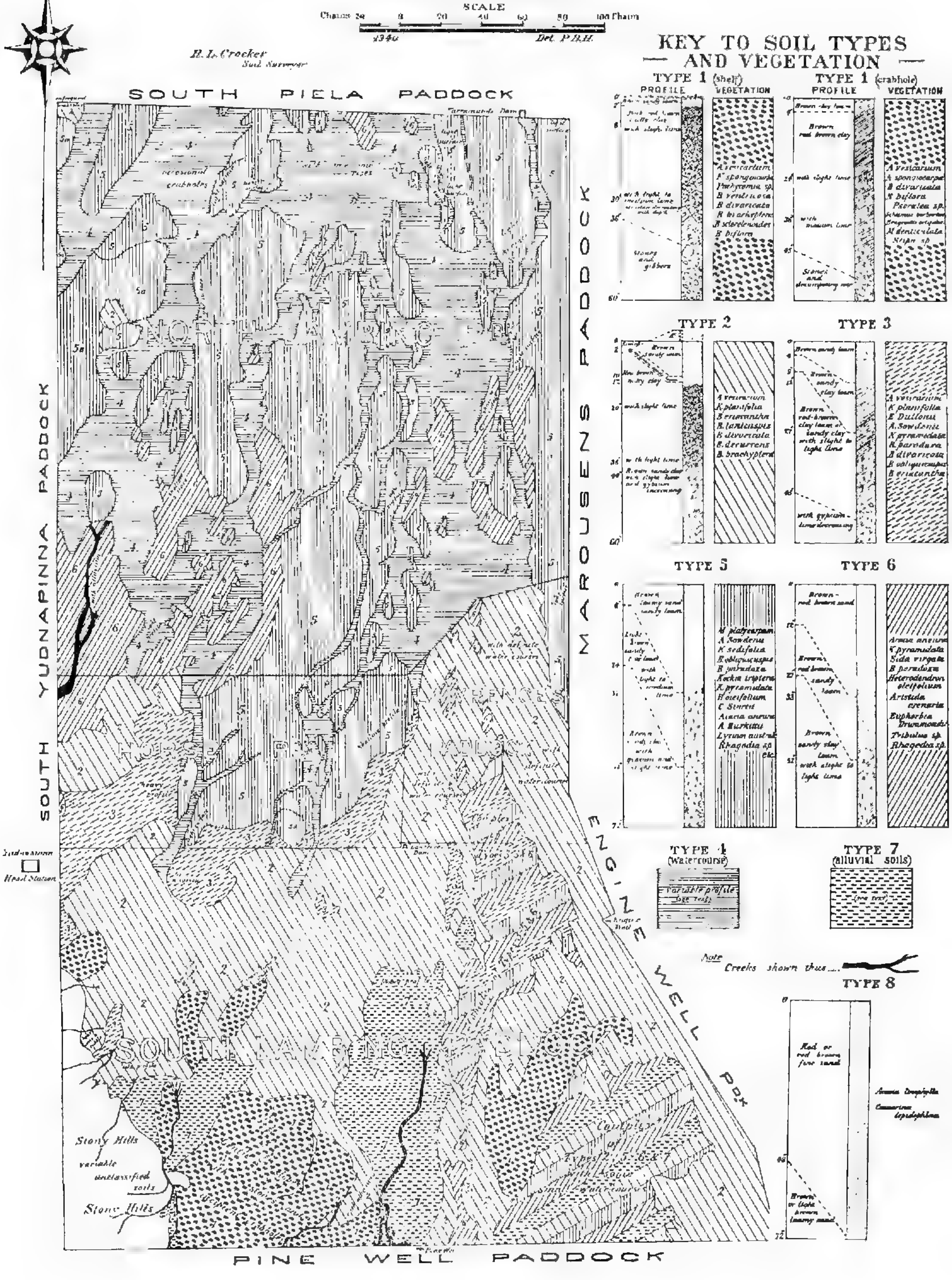
Fig. 1

and the rock strata are horizontal or slightly inclined, and for the most part sandstone, quartzose sandstone, shales and grits, of doubtful Ordovician age (Howchin (3), 1929). The tableland was one time widespread and unquestionably continuous with the Arcoona Tableland further north. Much sand has been superimposed on the area during an arid cycle in Recent (or late Pleistocene) times. In places this has been thrown up into ridges exhibiting a rough parallelism.

SOIL AND ECOLOGICAL SURVEY OF PART OF YUDNAPINNA

PASTORAL LEASE 1867

SOUTH AUSTRALIA



CLIMATIC FEATURES

The mean annual rainfall at Yudnapinna is 7·5 inches. Fig. 1 shows the annual variation for the years 1885-1939. During this time the highest rainfall recorded was 18·08 inches in 1921, and the lowest 2·36 inches in 1928. One of the most striking features is the variability of the rainfall, which is influenced by both winter low pressure systems and summer monsoonal rains. The area falls within Davidson's (2) warm temperate arid zone, with $P/E > 0{\cdot}5$ for 1-2 months of the year. Particularly in the summer months tropical downpours may be experienced. In 1938, of a total of 9·62 inches of rain, six inches fell in two days (435 points on 20 February and 165 points on 23 October). It is generally recognised that annual rainfall figures are very misleading as an index to effective rainfall. The new meteorological station placed at Yudnapinna by the Waite Institute will permit of more critical analyses of the climate in future.

THE SOILS

With the aid of aerial photographs a soil survey was made of North Lambing, South Lambing and Horse Paddocks, and Lawrence's Flat, representing a total area of about 25 square miles. Seven soil types were classified and mapped on the basis of soil profile and vegetation association. Their extent and distribution are indicated on the accompanying soil map. No attempt was made (except in the case where there were definite crabhole affinities) to differentiate the soils of stony hills—the tableland remnants.

Subsequently some three square miles included in the Yarramundi grazing experiment were also surveyed. On the more extensive reconnaissance one new type and one new phase have been added to the seven types mapped above.

The first seven types described are those differentiated in the more detailed survey of North and South Lambing Paddocks. The profile characteristics and variation of the different types are summarised in the sketch figures shown on the soil map.

Type 1—Limited to South Lambing Paddock in the detailed survey, but occurs more extensively, though sporadically, over the whole station. It is associated with the tableland remnants either on the slopes between the stony hills and the lower gently sloping plains, or on the tableland itself. It is characterised by gibber shelf and more or less gibber-free crabholes. There is no evidence of crabhole puff development. Towards the eastern side of South Lambing Paddock an area of this soil type occurs at a much lower topographical position and with a slightly modified vegetation assemblage. On some of the higher stony slopes there are practically no mature crabholes, but immature crabholes occur and affinities with this soil type are obvious.

One of the most striking features of the shelf profile is the abundance of surface gibbers and pebbles. These are iron-coated, somewhat glazed, grit and sandstone gibbers, chiefly ½ inch to 2½ inch in diameter.(1) There are occasionally isolated gibbers in the crabholes themselves, but they are usually gibber-free. Apart from the presence or absence of surface gibbers, however, there is a great difference in the structure of the clay in the two profiles, and in the distribution of lime and in relative salinity. The shelf profile shows well developed nuttiness (with some columnar tendencies) in the upper clay horizons, but there is a gradual decrease in structure with depth. In the crabhole profiles, apart from the large cracks which develop, there is no structure exhibited at all.

In the profile of Type 1 b small included ferruginous-coated pebbles and sand and coarse sand along the cleavage lines of the crabhole cracks show the maximum depth of cracking. It is approximately 33 inches. The profiles were sampled

(1) Compare shelf on Arcoona Tableland covered with large surface gibbers and plates.

about a month after a moderate fall of rain. The shelf profile was quite dry, but that of the crabhole was moist for the greater part of its depth. The better water relationships of the crabhole are further emphasised by greater leaching, resulting in low salinity and greater depth to the lime horizons relative to the shelf profiles. In both 1 a and 1 b variable amounts of gypsum are present as loose crumbs in the deep subsoil.

Type 2—Probably the most extensive occurrence of this type on Yudnapinna is in South Lambing Paddock, although it occurs elsewhere in isolated smaller areas. In South Lambing it is found over a gently sloping plain adjacent to the stony hills. Its distribution in the detailed area studied is shown on the accompanying soil map. In Lawrence's Flat and the Horse Paddock it is also important, but is here modified by watercourse conditions.

Normally there is between two and seven inches of sandy loam above the upper nutty clay horizon, but occasionally the profile is truncated and the clay much nearer the surface. With a super-imposed A_0 horizon, showing lammae of successive additions of washed soil, the depth to the clay increases.

The most constant feature of the type is the structure of the upper clay horizon—the B_1 horizon. This always shows distinct nutty tendencies—sometimes less perfectly developed, but nevertheless present. Immediately above the nutty clay, intimately associated with it, and often penetrating some short distance down vertical cracks in the clay, is a bleached grey-brown sandy loam horizon. This capping is a very constant characteristic. It varies in thickness between about $\frac{1}{4}$ inch and 2 inches, and shows on a pit face as an irregular and indefinite greyish band. In the Murrumbidgee area a grey, weakly cemented, apparently eluviated band has been described by Taylor and Hooper (8); it was sandier than the surface and usually had a lower pH. At Yudnapinna this horizon had a slightly lower pH.

Surface gibbers often occur, and very occasionally a crabhole. This and the structure of the clay represent a link with the shelf profile (Type 1 a). This soil type is associated with *Atriplex vesicarium* (saltbush) — *Kochia planifolia* (bluebush) steppe, except where modifications occur under watercourse conditions.

Type 3—In the transition zone between Type 2 and Type 5 (to be described later), soils more or less intermediate in profile occur.

Although the surface is deeper and the subsoil generally lighter with little structure, it bears a direct relationship to Type 2, in that there is often evidence of a thin bleached greyish layer immediately above the reddish-brown clay loam horizon. Surface gibbers occur occasionally, and there are frequently gibbers in the subsoil which impede the penetration of the soil auger. There is usually gypsum in the deeper subsoil. The type is of a transitional nature, and consequently somewhat variable and not important.

Type 4—Type 4 is predominantly associated with watercourses. Here the water relationships of the soils are not dependent on soil type and rainfall in the normal way. It is distinctly a wetter habitat. The small creeks from the stony hills to the south of, and in the south-west of, South Lambing, flood out over a gently sloping saltbush-bluebush plain, which itself acts as a watershed. This water is confined to more definite watercourses in the Horse Paddock and North Lambing, which is slightly higher. This means a modified soil and variation in vegetation relationships. All definite watercourses have been included in this type, and no attempt has been made at further differentiation. There is consequently a great deal of variation in soil profile. Indeed, we have variation from modified Type 2 on the one hand, where the shrub steppe gives way to more definite watercourses, to modified Type 5 on the other, where the watercourse abuts against the higher myall (*Acacia Sowdenii*) country. There is further variation introduced by the fact that some watercourses run much more frequently than others, or portion of a watercourse runs before and longer than the remainder. The soils all have one thing in common: they have all been modified by additional water and all have better water relationships than normal.

As is to be expected, the modification of Type 2, where the watercourses become more definite, is not sudden and complete, but gradual and even irregular. The red-brown clay preserves some structure, and the greyish thin band associated with it frequently persists in some degree even under watercourse conditions. On the accompanying soil map the southern boundary of North Lambing has been taken as an arbitrary boundary between Types 2 and 4. Some areas of Type 2 are included north of this, and to the south, particularly on Lawrence's Flat, there are more definite watercourses.

Type 5—This type is invariably associated with *Acacia Sowdenii* (myall)—*Myoporum platycarpum* tree steppe. It occupies a large area in North Lambing and is the most important single type over the station as a whole.

From the more extensive reconnaissance of the station as a whole it becomes desirable to regard the shallow and deeper profiles within the range of variation illustrated in the sketch figure on the map as two phases. These two phases grade into each other, but in the extremes can be correlated with variations in floristic composition of the sub-dominants. The light phase of Type 5 frequently has a more red-brown sand surface and grades into Type 6. On the accompanying soil map the lighter areas are differentiated by writing "light surface" across the map. The subsoil often seems "powdery" in the field, and it is not unusual to find a few small gibbers. These are generally coated with calcium carbonate. The amount of calcium carbonate varies considerably, but generally is less abundant in the lighter phase.

Type 5 a—On the soil map a variant of Type 5 is mapped as Type 5 a. In the field there seems little to differentiate it from the shallow phase of Type 5. It has the same powdery surface, but the sandy clay horizon is mostly shallower. It is best considered a transition type as it gives way to modified shrub steppe.

Type 6—This type was defined in North Lambing and Lawrence's Flat Paddocks, where it is associated with the low and usually narrow sandy rises adjacent to the watercourses. These rises are usually between five and ten feet above the plain or watercourse level. There is a general transition in soil type down the slope of the rise. Elsewhere on Yudnapinna the type occurs especially as low sandy elevations in the myall-sandalwood country (Type 5). Indeed, all stages in the transition between Type 6 and Type 5 (light phase) occur. These intermediate soils when mapped under Type 6 are shown by writing "shallow surface" across the soil map. They carry mulga (*Acacia aneura*). Occasionally in the lower rises the profile is heavier in the deep subsoil, or occasionally, as in the sample pit, it is underlain by large water-worn quartzite pebbles and stones. The sandy loam and sandy clay loam horizons are sometimes weakly cemented with lime.

Type 7—This type is not important. Its distribution in the area in which the detailed survey was made is limited to areas adjacent to creeks. The soils are composed principally of stratified alluvium. The surface is a sand or coarse sand, but the subsoil is sometimes as heavy as a sandy clay, usually containing water-worn and stratified stones and pebbles.

Type 8—Widely distributed over Yudnapinna, but not occurring in the area surveyed in detail, are rather jumbled sandridges, which preserve a rough sort of parallelism in any locality. Their trend is variable, but more or less east and west. They are associated with *Acacia linophylla* (mulga) and *Casuarina lepidophloia*. The soil becomes progressively shallower to the lime and the subsoil heavier, proceeding from the crest down the ridge slope. The crest is invariably sand to 72 inches. No deeper borings were made. In the occurrence near Lake MacFarlane the soils are much paler in colour and very close to the lake are light brown and light yellowish-brown. The type, however, is essentially the same.

The Stony Hills—The hills are somewhat variable, depending on the degree to which weathering has proceeded. On those hills whose flat tops still indicate the general pre-dissection level, there are usually crabholes and soils akin to Type 1 on the tableland remnant, but the soils of the slopes are variable and shallow and mixed with much screen material in the steeper places. No attempt has been made to classify these variable soils. Remnants of the old tableland, though, in every stage of disintegration, occur widely over the area.

Laboratory Examination of the Soils—Standard methods of analysis were used for the determination to be briefly described. Reaction values were determined with the glass electrode in 1: 5 soil-water suspension, previously shaken for one hour. An aliquot of this suspension was also used for the estimation of total soluble salts (conductivity methods) and chlorides (Best's (1) electrometric titration method).

Phosphoric acid was obtained from the hydrochloric acid extract. Replaceable bases were also determined by standard methods set out by Prescott and Piper (6). Caustic soda was used as a dispersing agent in the mechanical analyses which closely followed the international "A" pipette method, and the results are set out fully in the appended tables.

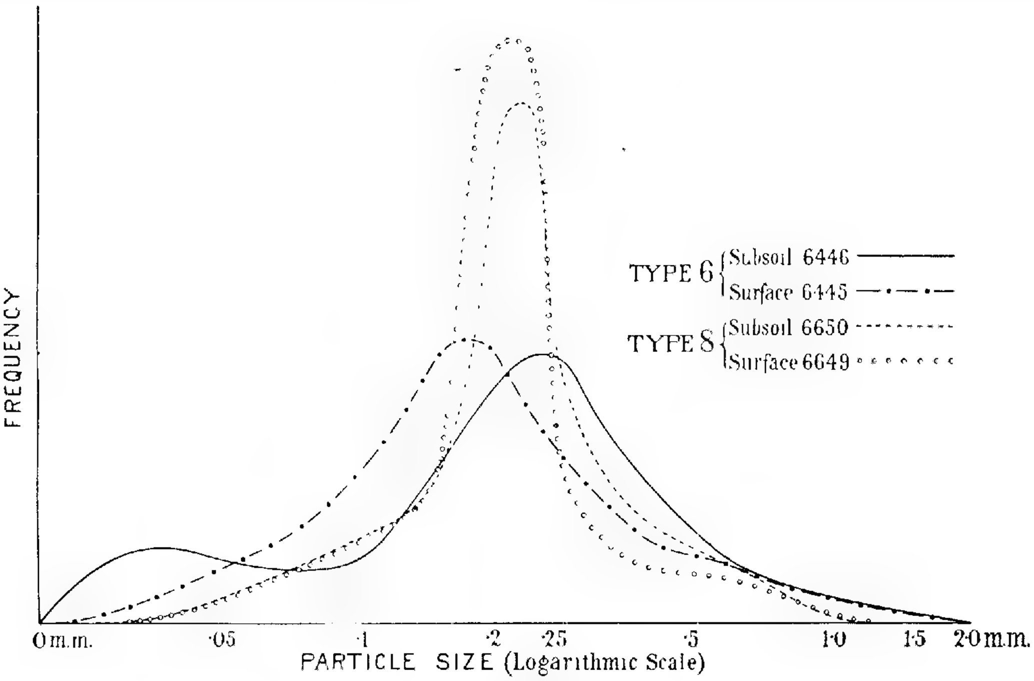


Fig. 2
Distribution Curves of Type 6 and Type 8

Mechanical Analysis—Mechanical analyses of 45 samples, representative of the major soil types, have been carried out. A noticeable feature is the predominance of coarse sand over fine sand in most of the types. In general, the relationship between field texture and mechanical composition has been satisfactory. Calcium carbonate has not been specifically determined but the "loss on acid treatment" figures are a satisfactory index, except where gypsum is present. Calcium carbonate is mostly in the form of soft lime, and rubble is relatively scarce.

Mechanical analyses were not made of the two sand types—Type 6 and Type 8. Detailed sievings, following Smith's (7) technique, were done on these, and the results expressed in a particle size distribution curve drawn from a previously constructed summation percentage particle size curve. The marked difference between the particle size distribution in the two soils is clearly shown in Fig. 2.

Soil Reaction—Soil reaction is alkaline, and in most soils markedly so, the lowest value recorded being pH 7·4 for the surface horizons of the sandridge type—Type 8.

The highest value recorded was pH 9·9 for the deep subsoil of Type 5. Most of the pH values range between pH 8·0 and pH 9·5.

Nitrogen—Total nitrogen has been determined on a number of surface and subsurface soils and is shown in Table III. The very low figures of ·020% and ·013% recorded for the mulga sandrise (Type 6) and the sandridge (Type 8) are respectively of the same order as those recorded for the parallel sandridge soils (Winkie sand) of the Murray Mallee area (4). The highest value, ·115%, was obtained with the surface horizons of the crabhole profile (Type 1b).

Phoshoric Acid—Analyses of the hydrochloric acid extracts of ten surface soils and numerous subsoil samples show that phosphates are generally low to moderate; but ·07% P_2O_5 in the surface horizons of the crabhole profile (Type 1b) is fairly high for Australian soils. They range between ·02% P_2O_5 in Type 8 to ·07% in Type 1b.

Soluble Salts—Total soluble salts and chlorides are variable but much higher on the heavier types than the lighter ones, where they are negligible. In the case of the shelf profile (Type 1a) the B_1 horizon, sampled only from 1-5 inches below the surface, contained 1·44% total soluble salts, and ·687% chlorides (as Cl). Undoubtedly this high soluble salt content, together with the great aridity of the edaphic habitat of which it is indicative, is the cause of the almost complete absence of plants on the gibber shelf. Soluble salts are also high in the subsoils of Type 1b (crabhole) and Type 2 (*A. vesicarium—K. planifolia* steppe) where, however, they have been leached to a greater depth. In most cases there is a steady increase in both total soluble salt and chloride content with depth.

Exchangeable Bases—The results of some exchangeable base analyses are set out in Table I. In general the relative proportions of the bases and their relationship to depth and texture are somewhat different from those usually found in Australian semi-arid soils. As is usual and to be expected, potassium is very low and sodium much more important, while calcium is the dominant base. The unusual thing about Type 2 (shrub steppe) is that the relative proportion of the bases remains more or less constant down the B horizon. The high proportion of sodium, combined with the fairly high clay content of the subsoils of Type 2, must considerably restrict water movement through the soil and tend to make the habitat a very arid one.

TABLE I

Exchangeable Bases in Yudnapinna Soils

Soil Type	Soil No.	Depth (inches)	pH	Total soluble salts %	Clay %	Total bases m.e./ 100 gm. soil	Percentage of total bases Ca	Mg	K	Na
2	6416	5- 7	8·8	·047	—	22·9	49	21	8	22
	6417	7-13	8·9	·172	51·3	30·0	45	20	6	29
	6418	13–19	8·9	·671	44·7	31·2	40	22	4	34
	6419	19-42	8·8	1·08	35·7	25·0	40	26	3	31
4b	6421	0- 5	8·9	·025	23·1	15·7	62	21	14	3
	6424	27-52	9·5	·051	27·8	15·6	54	28	8	10
4a	6428	4-19	8·7	·019	40·3	21·6	57	28	11	4
5a	6442	18-23	9·4	·035	18·1	9·4	62	25	5	8
	6443	23–36	9·9	·169	19·4	10·8	34	31	6	29

THE VEGETATION

The principal factors controlling the distribution of the vegetation at Yudnapinna in the regions surveyed are essentially edaphic, although abnormal water relationships are frequently a compensating factor. The floristics of a large part of the north-west—the Lake Torrens Plateau—have already been very fully dealt with by Murray (5) (1931), and the general ecology further mentioned by Wood (9) (1937). Five important associations can be recognised at Yudnapinna and are summarised in Table II.

TABLE II
Vegetation Associations

Association	Soil type	Edaphic complex	Formation
Atriplex vesicarium—Bassia spp.	1	*A. vesicarium—K. planifolia*	Shrub steppe
A. vesicarium—Kochia planifolia	2		
Acacia Sowdenii—M. platycarpum	5	*A. Sowdenii—M. platycarpum*	Tree steppe
Acacia aneura	6	*Acacia linophylla—C. lepidophloia*	Scrub
A. linophylla—C. lepidophloia	8		

(1) *Atriplex vesicarium—Bassia* spp. association.

On the gibber crabhole and shelf areas (Soil Type 1) an interrupted steppe of *Atriplex vesicarium* (bladder saltbush) principally associated with species of *Bassia* occurs (see pl. i, fig. 1). *A. vesicarium* is prominent both in and around crabholes, and is found to a much less extent on the gibber shelf. The soils of the shelf, however, in addition to being an arid habitat, have a high salinity, and vegetation is sparse or even absent. Plants occurring are *Bassia brachyptera, B. ventricosa, B. sclerolaenoides,* and sparingly *B. lanicuspis, B. divaricata* and *B. biflora.* Other plants even more sparingly present include a samphire (probably *Pachycornia tenuis*), *Kochia spongiocarpa, K. planifolia, Bassia intricata, Babbagia acroptera, Daucus glochidiatus, Frankenia* sp. and a low *Chenopodium* sp.

The crabhole habitat is a much moister one. Plants are much more abundant. After rains water frequently flows from one crabhole higher up the slope to another lower down. The most important species is *A. vesicarium,* but associated with it frequently are *Kochia spongiocarpa, K. planifolia, Bassia divaricata, B. intricata, B. uniflora* and *B. biflora.* Several grasses, including *Eragrostis setifolia, Stipa,* sp., *Panicum* sp. and *Tragus racemosus* may occur, while *Schismus barbatus* has been recorded. *Bassia brachyptera, B. ventricosa* and *Pachycornia tenuis* are occasionally found on the edge of crabholes. After rains *Atriplex spongiosum* (pop saltbush), *Convolvulus* sp. (aff. *C. erubescens*), *Psoralea* sp. and *Medicago denticulata* are usually important.

There is a modified vegetation assemblage towards the north-eastern portion of South Lambing. This area has been badly overgrazed by sheep. The principal variation is the greater relative abundance of *Kochia planifolia,* the apparent absence of *K. spongiocarpa* and the presence of *Bassia bicuspis,* which is very abundant on both the shelf and in the crabholes. *Kochia aphylla* is present occasionally in some of the crabholes. This association is widespread on the gibber shelf-crabhole areas over the whole station. It is undoubtedly allied closely to that of the Arcoona Tableland and, with modifications in composition, occurs on the Tableland remnants.

(2) *Atriplex vesicarium—Kochia planifolia* association.

On Soil Type 2 there is a shrub steppe dominated by *A. vesicarium* (bladder saltbush) and *K. planifolia* (low bluebush) (pl. i, fig. 3). The associated plants are principally chenopods of the genus *Bassia* (Bindyi)—*B. lanicuspis, B. eriacantha, B. divaricata, B. decurrens,* and *B. brachyptera* are most important, while *B. paradoxa, B. intricata, B. uniflora, B. ventricosa, B. bicuspis* and *B. biflora* are occasionally present. Grasses occur sparingly and include *Stipa* spp., *Tragus racemosus, Eragrostis* sp. and *Enneapogon nigricans.*

On overgrazed and degenerated areas Bassias (Bindyi) become even more important (particularly *B. divaricata* and *B. decurrens*). In extreme degeneration *Eragrostis Dielsii* and the annual "pop saltbush," *Atriplex spongiosum*, are practically the only plants of consequence to maintain a precarious existence, and then only after rains and where there is small drift accumulation (see pl. iii, fig. 12).

Kochia Georgei, K. aphylla, K. pyramidata and *Eremophila Duttonii* are usually prominent where water relationships are better, especially where the shrub steppe gives way to the varied association of the more definite watercourses. Although rabbit burrows are scarce in the *A. vesicarium—K. planifolia* association, where they do occur *K. pyramidata* is usually prominent on the disturbed earth (pl. i, fig. 2).

This association is not a particularly important one on Yudnapinna, and the occurrence in South Lambing is probably the most extensive. Near the eastern side of Lake MacFarlane an almost pure *A. vesicarium* steppe occurs on a lighter soil type. This association is not widespread and not fully understood, either edaphically or floristically, but *K. Georgei* occurs sparingly and the rare occurrences of a samphire suggest that soil salinity is high.

(3) *Acacia Sowdenii –Myoporum platycarpum* association.

This is the most extensive association on Yudnapinna and is associated with Soil Type 5. The association is an open one and essentially tree-shrub steppe. The dominant tree is *Acacia Sowdenii* (myall), although *M. platycarpum* ("sandalwood") is almost invariably present. It extends, with modifications, northwards to the Arcoona Tableland and south to the Gawler Ranges; south of this it is replaced by mallee. It has been mentioned earlier (p. 48) that a light and shallow phase of Soil Type 5 can be recognised. These grade into each other. In the extreme they are readily correlated with changes in floristic composition of the associated plants.

On the shallow phase of Type 5 there is a lower stratum (3 to 4 feet high) of *Kochia sedifolia* (bluebush), which gives a characteristic facies to the community (pl. i, fig. 4; pl. ii, fig. 5). The taller shrubs, *Cassia Sturtii, C. phyllodinia, H. oleifolium* and *Lycium australe*, are widespread but sparse. Other plants frequently important in the lower strata are *Kochia triptera* var. *pentaptera, K. excavata, Enchylaena tomentosa* (particularly under myall), *Chenopodium* sp., *Bassia sclerolaenoides* and *Bassia obliquicuspis*, which is very abundant. The principal grass is *Enneapogon nigricans*. Occurring sparingly are a number of other plants, including *Eremophila scoparia, Templetonia egena, Atriplex stipitatum, A. vesicarium, Kochia Georgei* and *Bassia paradoxa*. *Kochia pyramidata* (black bluebush) occurs and is common where the association has been heavily grazed. On the lighter phase of Type 5 *Kochia sedifolia* is more or less replaced (sometimes entirely) by *Atriplex vesicarium* (pl. ii, fig. 6) and to a much less extent *A. stipitatum* (mallee saltbush). The amount of free lime in the soil seems an important factor influencing the distribution of *K. sedifolia*—the lighter phase is generally less calcareous than the shallow phase but not invariably so—this tends to confuse the edaphic relationships.

Associated with the saltbushes (*Atriplex vesicarium* and *A. stipitatum*) on this light phase are a number of species which are absent or occur but rarely on the shallower phase. Generally prominent are *Templetonia egena, Acacia Burkittii* (Burkitt's wattle), *Heterodendron oleifolium, Cassia Sturtii, C. phyllodinea, Lycium australe, Kochia* sp. (aff. *K. Georgei*), *Enchylaena tomentosa, K. triptera* var. *pentaptera* and *K. pyramidata, Bassia obliquicuspis* and *B. paradoxa* are abundant, and *Stipa* sp. and *E. nigricans* are the principal grasses. Other species frequently present are *Exocarpus aphylla* (wild cherry), *Fusanus acuminatus* (wild peach), *F. persicarius, Pimelia microcephala* and *Eremophila scoparia*. *Fusanus spicatus* has now been almost entirely cut out but was once important.

On the extremely light soils bordering on Type 6, *Acacia aneura* (mulga), *Trichinium obovatum* and *Aristida arenaria* occur freely; *Kochia brevifolia* and *Hakea leucoptera* (needlebush) have been recorded. *Loranthus pendulus* is a very common parasite on myall, and *L. Preissii* on *Acacia Burkittii* and other acacias. *L. Exocarpi* occurs very rarely.

The *A. Sowdenii—M. platycarpum* association cannot be understood unless the edaphic variation and the parallel modification in floristics are kept in mind. It must be realised that there is complete variation in the type within the limits of the light and shallow phases. A modification of floristics occurs on the soil variant mapped as 5 a in the detailed survey. It is best considered a transition area. *A. Sowdenii* and *M. platycarpum* occur very sparingly; *K. sedifolia* is abundant and *K. planifolia* always associated though less important.

(4) *Acacia aneura* association (pl. ii, fig. 8).

On the low sandrises (Soil Type 6) in North Lambing and Lawrence's Flat Paddocks, *Acacia aneura* (mulga) is dominant. Elsewhere on sandrises and low sandy areas within the *A. Sowdenii—M. platycarpum* association mulga scrub occurs, but the floristics are known principally from the detailed survey of North Lambing and Lawrence's Flat paddocks. *Kochia pyramidata* (black bluebush) is prominent. Other plants commonly occurring are *Bassia paradoxa, Sida virgata, Euphorbia Drummondii* and the grass *Aristida arenaria* (mulga grass). Much less frequently *Acacia Burkittii, Heterodendron oleifolium, Rhagodia* sp. (probably *R. spinescens*), *Atriplex vesicarium, A. stipitatum, Kochia brevifolia, Templetonia egena, Bassia obliquicuspis, B. divaricata* and *Trichinium obovatum* are associated. The grasses *Stipa nitida, Enneapogon nigricans, Tragus racemosus, Trisetum pumilum* and *Paspalidium gracile* have been recorded.

Many annual and ephemeral species may be present after rains, including *Atriplex halimoides, A. angulatum, A. leptocarpum, A. limbatum, A. spongiosum, Citrullus vulgaris, Cucumis myriocarpus, Tribulus* sp. (probably *T. terrestris*), *Portulaca oleracea, Tetragonia eremea, Salsola Kali* (buckbush), *Blennodia trisecta* and the composites *Vittadinia tenuissima, Helipterum variabile, H. moschatum, H. polygalifolium,* and *Helichrysum Mellorianum*. *Emex australis, Kochia triptera* and *Kochia tomentosa* var. *appressa* occur rarely. *Casuarina lepidophloia* was recorded on one sandrise. The three mistletoes, *Loranthus Exocarpi, L. pendulus* and *L. Preissii,* all occur very sparingly on mulga.

(5) *Acacia linophylla—Casuarina lepidophloia* association (pl. iii, fig. 9 and 10).

On the sandridges (Soil Type 8) that occur in the Yarraty-Roarys Dam area, west of Lake MacFarlane (*e.g.*, Litchfield's Paddock), and elsewhere on Yudnapinna is a characteristic scrub of *Acacia linophylla* (mulga) and *Casuarina lepidophloia* (black oak). *C. lepidophloia* tends to occur on the higher ridge crests and in almost pure societies and is not as important as *A. linophylla,* which is usually 10-12 feet high and more or less spreading—it is sometimes called "umbrella mulga" locally. Associated shrubs or trees are practically limited to *Heterodendron oleifolium* (bullock bush), *Acacia aneura* (mulga) and *Lycium australe* which occur sparingly. *Myoporum* sp. (probably *M. desertorum*); *Pimelia microcephala* and *Eremophila longifolia* have been recorded. Lower down the slope of the sandridge *Acacia Burkittii, A. aneura, Fusanus acuminatus, F. persicarius,* etc., become prominent.

Other plants are principally grasses and annuals and ephemerals but are relatively scarce. The principal grasses are *Aristida arenaria, A. stipoides* and *Schismus barbatus; A. stipoides* and *A. arenaria* are sometimes locally important. The annuals and ephemerals which may be of seasonal import include *Agianthus pusillus, Calandrinia polyandra* ("parakeelya"), *Blennodia* sp., *Tetragonia eremea, Senecio Gregorii* and *Myriocephalus Stuartii.*

(6) *Other Communities.*

These five associations described are the principal ones on Yudnapinna and most variations are understandable as transitions or as modified communities on more or less intermediate soil types. For example, Soil Type 3 (see soil map) is essentially a transition type between Soil Types 5 and 2. As would be expected, the associated vegetation is more or less intermediate between the *A. Sowdenii—M. platycarpum* and the *A. vesicarium—K. planifolia* associations. The most prominent plants are *A. vesicarium* and *K. planifolia,* but other species less important and of variable frequency include *A. Sowdenii* (myall), *K. pyramidata, K. sedifolia* (where subsoil lime is abundant), *Eremophila Duttonii* and numerous Bassias, including *B. obliquicuspis, B. lanicuspis* and *B. eriacantha.*

Certain other communities should be mentioned, particularly the watercourses and the stony hills.

(a) Vegetation of the watercourses.

In the area surveyed in detail (North and South Lambing Paddocks, etc.) the watercourse soils varied (see p. 47) more or less from modified steppe soils (Type 2) to modified tree-steppe soils (Type 5). *Kochia pyramidata* (black bluebush) and *A. vesicarium* are the most frequent and consistent species.

Associated with them on the heavier soils are *Kochia Georgei, K. planifolia, K. aphylla* (cotton bush), *Sida* sp., *Sida intricata* (Paddy's lucerne), *Eremophila Duttonii, Acacia aneura, Bassia paradoxa* and *B. divaricata.* Less frequent are *Acacia Burkittii, Acacia* sp., *A. Sowdenii, Exocarpus aphylla, Pimelia microcephala, Eremophila glabra, Lycium australe, Heterodendron oleifolium, Kochia lobiflora, Bassia obliquicuspis* and *B. eriacantha.* After rains the composite *Minuria leptophylla* abounds. On the soils at the lighter end of the range with *A. vesicarium* and *K. pyramidata* are *A. aneura, A. Burkittii* (pin bush or Burkitt's wattle), *L. australe, K. planifolia, K. sedifolia, K. Georgei, Casuarina lepidophloia* (rarely), *Rhagodia* sp. (probably *R. spinescens*), *Enchylaena tomentosa, Trichinium obovatum, Atriplex stipitatum, Bassia obliquicuspis* and *B. divaricata.*

Occasional crabholes given a particular facies by the grass *Eragrostis setifolia* (never fail) occur in the watercourses. In small hollows in the *A. Sowdenii—M. platycarpum* country, where water relationships are better through inward drainage, groves of *A. aneura* (mulga) occur. Other species frequently occurring in watercourses like *Trichinium obovatum* are associated. *Lycium australe* (Australian boxthorn) is often abundant where water relationships are likewise improved.

(b) Vegetation of the stony hills.

The stony hills are remnants of the old tableland and the associated vegetation varies considerably depending on the degree to which weathering has proceeded. Where the old tableland horizon survives, or is only slightly reduced, shrub steppe, with crabholes and shelf (c.f., Type 1) usually occurs on it. The slopes, however, are usually wooded with mulga (*A. aneura*) and black oak (*C. lepidophloia*).

The hills in South Lambing Paddock, where more or less flat-topped, have definite crabhole affinities and *Kochia spongiocarpa, Atriplex vesicarium* and *Pachycornia* sp., commonly associated with crabhole and shelf, are prominent. But for the most part these hills have proceeded beyond this stage of weathering, and, as might be expected, the vegetation is variable and no doubt influenced by depth of soil and underlying rock. *Acacia aneura,* and usually where the soil is deeper *A. Sowdenii,* are fairly common. Also occurring frequently are *Acacia Burkittii, Casuarina lepidophloia, Fusanus spicatus, Dodonaea lobulata, Eremophila alternifolia, E. Latrobei, E. glabra, E. serrulata, Cassia Sturtii, Atriplex vesi-*

carium, Kochia sedifolia, K. brevifolia, K. triptera var. *pentaptera, K. triptera* var. (allied to var. *pentaptera*[2]), *Enchylaena tomentosa, Sida intricata, S. petrophila, Rhagodia Gaudichaudiana, Scaevola* sp. (probably *S. spinescens*), *Trichinium obovatum, Zygophyllum Billardieri,* and the grasses *Paspalidium gracile* and *Stipa* sp. Less frequent are *Eremophila longifolia, Portulaca oleracea, Rhagodia parabolica, Rhagodia* sp., *Tribulus* sp., *Solanum ellipticum* and several species of *Bassia.*

(c) Vegetation of the creeks and adjacent areas.

Along and in creeks like Pine Creek and the Station Creek occasional gums, *Eucalyptus intertexta,* and native pine, *Callitris glauca,* grow. *Acacia aneura, A. Burkittii* and the grass *Andropogon exaltatus* (scent grass) are common. Adjacent to the creeks on stratified alluvium (Soil Type 7) are associated *A. aneura, Dodonaea attenuata, Heterodendron oleifolium, Eremophila Duttonii, Kochia pyramidata, Atriplex vesicarium* and *Aristida arenaria.* Usually present to some extent also are *Kochia planifolia, K. tomentosa* var. *appressa, K. Georgei, Rhagodia* sp., *Eremophila glabra, Templetonia egena, Pittosporum phillyreoides, Bassia decurrens* and *B. paradoxa.*

(7) *Pyric succession.*

Much of Yudnapinna has been burnt by bushfires and some observations on succession in the *A. Sowdenii—M. platycarpum* association have been made. The fire kills most of the trees and the associated plants. Most of the species seem to regenerate readily although the time involved is doubtlessly dependant on seasonal conditions. Some of the shrubs like the Cassias (especially *C. eremophila* var. *platypoda*) are, however, relatively quick-growing compared to the young *M. platycarpum, A. Sowdenii* and *A. aneura* and may temporarily give a distinct facies to the community. This stage has been reached in the Bowen Hill area. Yudnapinna (lighter phase, Type 5), which until recently had not been stocked since the fire of 1922. Regeneration of *Atriplex vesicarium* and *Kochia sedifolia* and other bluebushes and saltbushes in the community is rather slower because, owing to the nature of the fruits, most of the seeds are probably destroyed in the fire, which assists regeneration of the Acacias, etc., by cracking the seed coat.

Further regeneration from the *Cassia eremophila* var. *platypoda* (wattle-bush) stage would no doubt be a gradual increase in the abundance of the salt-bushes and bluebushes, the Cassias will become mature scraggly shrubs and very slowly the young myalls and young Myoporums will mature until the association once more takes on its old physiognomy. Most of the mulga (*A. aneura*) will probably be destroyed by rabbits. Much observation has been made of the damage done to mulga and other young shrubs and trees through rabbits barking them. It would appear that mulga is more liable to barking than myall and probably sandalwood, too. In any case, it is very slow growing and cannot recover from this setback as readily as do most other species. Future regeneration in the Bowen Hill area will depend on the future stocking policy. There is no foundation for the statement that "where wattlebush grows nothing else will." Numerous cases can be pointed out where, beneath thick mature societies of *C. eremophila* var. *platypoda,* is good dense saltbush, bluebush, etc. The truth is that during the early stages of the pyric succession when the Cassias are lower, dense and spreading, and other species are just beginning to re-establish themselves, or as in the case of myall, much slower-growing and inconspicuous, the *C. eremophila* var. *platypoda, C. phyllodinea* and *C. Sturtii* gives the community a characteristic facies (pl. iii, fig. 11).

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(2) The genus *Kochia* is in rather a chaotic state, and present keys do not satisfactorily differentiate between what in the field are obviously different varieties or even different species.

The Relationship between Soil Type and Vegetation

The Yudnapinna area, of more than 1,200 square miles, is a complex one. The principal soil types of the area have been described and vegetation associated with them discussed. The edaphic control of the distribution of associations and formations is evident. Modified soils are associated with modifications in floristic composition. The floristics are as complete as time and the season permit them to be, and suffer mostly in the annuals and ephemerals, but these, even in watercourses, do not grow in the profusion apparent in the North-East of the State. This is probably due to lower soil fertility and initially to geology. In the north-east the rocks are principally Proterozoic and crystalline Archean of the Willyama Series. In the north-west they are the sedimentary sandstones, shales, grits, etc., of the Ordovician.

Soil Type 2 and the shelf soils of Type 1 are in this area the driest, and most saline habitats for plants. The lighter soils of Types 5, 6 and 8 represent a moister environment. The sandy surface in the lighter types acts as an absorbing medium and further restricts soil evaporation. Many plants of the myall scrub or the mulga sandrise grow on the heavier soils of the watercourses where water relationships are compensating. From a study of the species distribution of the area it is seen that *A. aneura* (mulga), *A. Burkittii* (Burkitt's wattle), *Kochia pyramidata, Templetonia egena, Lycium australe* (Australian boxthorn), *Bassia paradoxa, Trichinium obovatum,* and to a less extent *A. Sowdenii* (myall), *Heterodendron oleifolium* and others, are capable of growing on a wide range of soil types providing water relationships are suitable. They occur not only on light soils of Types 5 and 6, but on the heavier watercourses (see pl. ii, fig. 7). Thickets of mulga in lower-lying areas, which receive additional water, are common in the *A. Sowdenii —M. platycarpum* association.

Other plants like *Sida virgata,* although frequent on the sandrises, are more exacting in their edaphic environmental limits and do not occur on the heavier soils of the watercourses. *Kochia aphylla,* on the other hand, is found in the watercourses but never on the lighter soils of Type 5, 6 and 8. Some plants, like *Kochia sedifolia* and *K. excavata,* occur in soils which vary greatly in texture and profile, but which are all characterised by much lime.

DEGENERATION, EROSION AND ERODIBILITY

The area surveyed (North Lambing, South Lambing, etc.) has all been used for grazing, but over any area the rates of stocking vary considerably. Intensity of grazing is governed primarily by the disposition of the watering places, about which large numbers of sheep are concentrated, especially in the warmer summer months. Practically all serious degeneration and erosion in this area is about past and present watering centres—*e.g.,* erosion about Lawrence's Dam, Ryan's Well, Pine Well, etc., witnesses severe overgrazing in the past.

The effect of overgrazing is firstly a degeneration, and finally the disappearance of the more palatable species. In myall-sandalwood-bluebush country continuous overgrazing leads to the disappearance of *Kochia sedifolia* altogether, its place being taken (unless degeneration is far too rapid) by the valueless *K. pyramidata* (black or green bluebush). The latter species is now becoming important over large portions of the north-west and north-east. It was always present to some extent in watercourses and probably sparingly in the *A. Sowdenii —M. platycarpum* association, but it was unable to compete satisfactorily with the *K. sedifolia* here and was always subordinate. In the absence of competition resulting from overstocking and selective grazing, the species has spread considerably and is now frequently dominant. *K. pyramidata* is slowly becoming more widespread at the expense of more palatable species. If degeneration is too rapid for black bluebush to replace the *K. sedifolia* the low shrubs disappear altogether and there is a great increase in *Bassia obliquicuspis* and *B. paradoxa.* Providing the associated shrubs (*Cassia* spp., *Heterodendron*, etc.) and trees are not removed, degeneration and erosion may not progress much further than this.

In the *A. vesicarium*—*K. planifolia* steppe (Type 2) degeneration follows a somewhat different course. Overgrazing leads firstly to a disappearance of *A. vesicarium* (selective grazing) with an increase in the Bassias (especially *B. divaricata* and *B. decurrens*). Further heavy grazing gradually lowers and finally kills the *K. planifolia* with a further increase in the Bassias (Bindyis) and the appearance of the annual *Atriplex spongiosum* (pop saltbush). If this country is to be saved degeneration must not go any further. Continued heavy stocking results in partial or complete destruction of the Bindyis, mechanical disturbance of the soil surface and the gradual breaking down of the dead shrub remains. Wind erosion begins, and the surface soil, becoming unstable, is ready for potential water erosion. The wind erosion and water erosion, although working hand in hand, are, once started, almost independent of each other. From this stage onward water is the most serious eroding agent. It rapidly removes the A horizon, is somewhat retarded again by the weakly cemented grey-brown layer above the clay, but, breaking through this, has no difficulty in eroding the B horizon. Erosion of the B horizon apparently proceeds at quite a rapid rate. In places towards the north of Lawrence's Flat there is as much as 12 inches silt (A_0) accumulation, which has washed from the vicinity of Lawrence's Dam, where water erosion has proceeded well down into the B_2 horizon. This type is particularly liable to water erosion because it occurs on a gently sloping plain over which much water from the creeks off the stony hills floods out.[3]

Acknowledgments

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[3] An effort was made in the first instance to map the extent of the erosion, and to estimate it in a broad quantitative way, after the methods employed by the Soil Conservation Service in U.S.A. and set out under their printed "Procedure for making Soil Conservation Surveys." The method was found impracticable at Yudnapinna and, in the author's opinion, would be found so in most types of country. The variation in depths of horizons in any natural soil type is so great that it is impossible to estimate with any accuracy and consistency the percentage loss of A horizon, even though there are only three major divisions; less than 25%, 25-75%, and over 75%. Furthermore, assessing erosion in such detail only applies at the actual time the specific area is surveyed. By the time the survey is completed and the maps published the position might be very different. This was so to some extent at Yudnapinna following a modest rain in September, 1939.

TABLE III ANALYTICAL DA

Soil Type	1a Shelf					
Locality	South Lambing Paddock					
Soil No.	6401	6402	6403	6404	6405	6406
Depth (inches)	0–1	1–5	5–12	12–20	20–31	31–40
Coarse Sand	34·8	18·6	23·1	17·1	17·6	17·3
Fine Sand	48·4	16·5	25·4	21·8	21·0	20·3
Silt	6·7	2·6	4·0	6·1	6·0	6·2
Clay	8·6	52·8	39·3	45·8	43·1	40·9
L. on Acid Treat.	0·8	3·0	3·7	3·4	8·2	9·4
Moisture	1·0	7·6	6·3	8·3	7·9	7·9
L. on Ignition	1·7	5·4	4·7	4·7	5·6	5·6
Tot. Sol. Salts	0·143	1·44	1·32	1·74	2·34	2·26
Chlorides (Cl)	0·057	0·687	0·618	0·840	0·717	0·637
Nitrogen	0·039	0·067	0·045	—	—	—
P_2O_5	0·027	0·040	0·034	0·041	—	—
Reaction (pH)	8·02	7·7	8·4	8·4	8·2	8·2

Soil Type	Watercourse 4b				
Locality	North Lambing Paddock				
Soil No.	6421	6422	6423	6424	6425
Depth (inches)	0–5	5–12	12–27	27–52	52–59
Coarse Sand	45·6	41·6	36·5	31·2	39·4
Fine Sand	20·1	19·5	19·4	17·1	20·5
Silt	7·2	9·2	4·8	5·3	2·9
Clay	23·1	24·5	30·0	27·8	28·0
L. on Acid Treat.	1·4	3·1	5·3	16·8	7·3
Moisture	2·5	3·4	4·0	4·1	3·4
L. on Ignition	3·2	4·0	4·9	9·8	4·8
Tot. Sol. Salts	0·025	0·04	0·04	0·05	0·08
Chlorides (Cl)	—	—	—	—	0·004
Nitrogen	0·037	0·030	0·025	—	—
P_2O_5	0·037	0·033	0·032	—	—
Reaction (pH)	8·9	9·0	9·0	9·5	9·8

Soil Type	Type 5a						
Locality	North Lambing Paddock						
Soil No.	6438	6439	6440	6441	6442	6443	6444
Depth (inches)	0–2	2–7	7–11	11–18	18–23	23–36	36–60
Coarse Sand	44·4	50·7	45·1	43·1	39·7	30·3	25·8
Fine Sand	34·8	27·9	28·3	27·2	24·0	19·0	21·8
Silt	5·1	4·1	3·5	2·9	2·6	3·0	3·8
Clay	12·7	12·5	14·5	16·3	18·1	19·4	25·5
L. on Acid Treat.	1·4	3·1	7·2	8·9	14·9	26·9	22·3
Moisture	1·8	2·0	2·3	2·6	2·6	2·7	4·3
L. on Ignition	2·4	3·0	4·6	5·9	8·1	13·4	10·4
Tot. Sol. Salts	0·05	0·03	0·03	0·03	0·04	0·17	1·3
Chlorides (Cl)	—	—	—	—	—	0·036	0·156
Nitrogen	0·049	0·031	0·026	—	—	—	—
P_2O_5	0·029	0·024	0·029	0·025	—	—	—
Reaction (pH)	9·2	9·2	9·1	9·1	9·4	9·9	8·4

...n Soil Types at Yudnapinna

1b Crabhole South Lambing Paddock					Type 2 South Lambing Paddock						
6407	6408	6409	6410	6411	6413	6414	6415	6417	6418	6419	6420
0–4	4–13	13–23	23–34	34–40	0–2	2–4	4–5	7–13	13–19	19–42	42–66
16·6	21·0	25·9	18·9	12·2	54·4	52·6	55·0	23·8	22·5	25·5	31·4
23·8	21·9	22·6	20·2	17·1	27·2	31·9	27·7	13·3	14·9	15·3	16·6
7·5	4·9	4·2	4·9	5·4	5·3	6·0	7·8	4·8	5·9	6·1	4·5
42·5	42·4	39·7	42·9	36·1	10·9	8·3	8·7	51·3	44·7	35·7	33·2
2·4	3·7	3·8	7·6	18·6	0·9	0·8	0·7	2·0	5·3	11·0	11·2
6·2	6·4	5·8	7·4	8·8	1·2	1·0	1·0	7·0	7·5	7·0	5·7
6·0	4·9	4·6	5·1	7·5	2·2	1·7	1·5	5·0	6·1	7·8	7·1
0·055	0·060	0·066	1·02	1·50	0·035	0·019	0·019	0·172	0·671	1·08	1·42
—	—	0·004	0·023	0·126	—	—	—	0·066	0·302	0·486	0·483
0·115	0·044	0·032	—	—	0·048	0·022	0·017	0·044	—	—	—
0·072	0·053	0·048	—	—	0·030	0·024	0·023	0·044	0·057	—	—
8·5	8·8	9·2	8·1	8·4	8·5	8·8	8·7	8·9	8·9	8·8	8·4

Watercourse 4a North Lambing Paddock				Type 5 North Lambing Paddock					
6426	6427	6428	6430	6431	6432	6433	6434	6435	6436
0–2	2–4	4–19	36–64	0–4	4–12	12–17	17–44	44–72	72–84
54·4	50·7	31·2	33·8	53·5	46·2	42·5	37·6	41·2	26·7
19·8	18·9	15·5	17·0	26·1	28·5	27·3	22·6	25·4	22·4
6·1	7·8	4·0	3·4	4·7	3·4	3·8	3·0	2·3	4·0
15·8	20·1	40·3	31·7	13·1	13·4	17·9	17·2	18·5	31·5
1·0	0·9	1·6	11·3	1·5	6·4	8·1	19·4	11·1	9·4
1·9	2·4	5·6	4·4	1·7	2·0	2·6	2·8	2·8	6·4
2·6	2·6	4·1	7·3	2·3	4·3	5·3	9·7	6·2	3·1
0·02	0·02	0·02	0·07	0·03	0·07	0·28	0·56	0·48	1·43
—	—	—	0·004	—	0·012	0·114	0·230	0·173	0·198
0·039	0·029	0·032	—	0·026	0·028	0·021	—	—	—
0·037	0·036	0·044	—	0·027	0·027	0·026	—	—	—
8·4	8·3	8·7	9·6	9·0	9·5	9·1	8·8	8·9	7·9

Type 6 Horse Paddock				Type 8 Yarraby Paddock			Type 5 (light phase) West Strawbridge		
6445	6446	6447	6448	6649	6650	6651	6652	6653	6654
0–4	4–15	15–28	28–40	0–6	6–36	36–66	0–7	7–21	21–25
		48·9	42·9				50·6	46·0	41·2
See		29·8	24·1		See		33·2	34·9	35·0
		1·9	1·7				3·8	3·9	8·3
distribution		18·4	27·2		distribution		11·2	13·1	7·9
		0·5	2·0				0·6	0·7	5·4
curves		2·5	3·9		curves		1·3	1·9	4·5
		2·0	2·9				1·7	1·8	4·5
0·02	0·01	0·02	0·07	0·00	0·00	0·03	—	0·05	0·38
—	—	—	—	—	—	—	—	—	0·125
0·020	0·013	—	—	0·016	—	—	0·021	0·010	—
0·030	0·022	—	—	0·016	0·01	—	0·027	0·023	0·025
8·8	8·7	8·9	9·6	7·4	8·9	9·2	8·7	9·6	9·4

EXPLANATION OF PLATES I-III

Plate I

Fig. 1 *Atriplex vesicarium—Bassia* spp. association on crabhole gibber shelf (Soil Type 1). Note the almost complete absence of vegetation from the gibber shelf owing to high salinity and edaphic aridity.

Fig. 2 *K. pyramidata* (black bluebush) on disturbed earth of a rabbit warren in the crabhole shelf area (Type 1), South Lambing Paddock. *Acacia aneura* along small creek in background.

Fig. 3 *Atriplex vesicarium—Kochia planifolia* association (Soil Type 2). *Bassia lanicuspis* and *B. eriacantha* are also fairly abundant in the ground flora.

Fig. 4 *Acacia Sowdenii—Myoporum platycarpum* association (Soil Type 5). The chief undershrub is *Kochia sedifolia*, but *K. pyramidata* is also present. *Heterodendron oleifolium* (bullock bush) in left foreground. *Bassia obliquicuspis* is very prominent in the ground flora.

Plate II

Fig. 5 *Acacia Sowdenii—M. platycarpum* association. *K. sedifolia* very prominent in steppe stratum: Bookaloo Paddock.

Fig. 6 *Acacia Sowdenii—M. platycarpum* association, light phase Soil Type 5, with *Atriplex vesicarium* dominant in the shrub stratum, West Strawbridge Paddock.

Fig. 7 Mulga in watercourse, North Lambing Paddock. *Kochia pyramidata—K. aphylla* (cotton bush) are the prominent shrubs.

Fig. 8 *Acacia aneura* association on a low sandy rise (Soil Type 6); *K. pyramidata* abundant. Other plants prominent are *Sida virgata* and *Aristida arenaria.*

Plate III

Fig. 9 *Acacia linophylla—Casuarina lepidophloia* association on the crest of a sandridge, Yarraty Paddock. Soil Type 8.

Fig. 10 *Acacia linophylla* scrub. Roary's Paddock.

Fig. 11 *Cassia* society at an early stage in the pyric succession, S.E. Bowen Hill Paddock. Note the young *Myoporum platycarpum* centre right.

Fig. 12 Severe degeneration and erosion of the *Atriplex vesicarium—K. planifolia* shrub steppe, Soil Type 2, near Lawrence's Dam. *Eragrostis Dielsii* and *Salsola Kali* maintain a precarious existence on the small accumulation of sand (A_0).

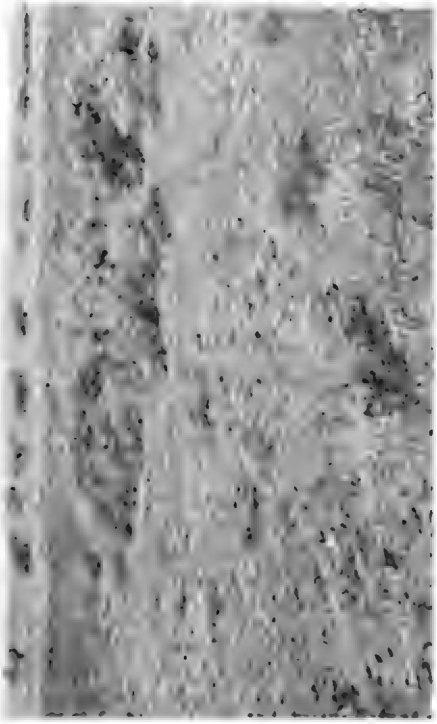

Fig. 2

Fig. 4

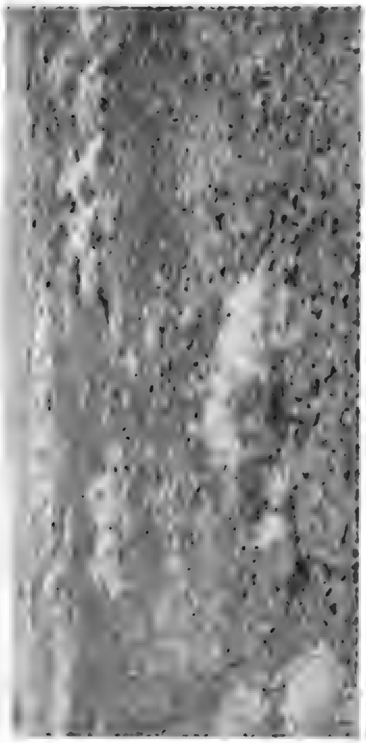

Fig. 1

Fig. 3

Fig. 6

Fig. 8

Fig. 5

Fig. 7

Fig. 10

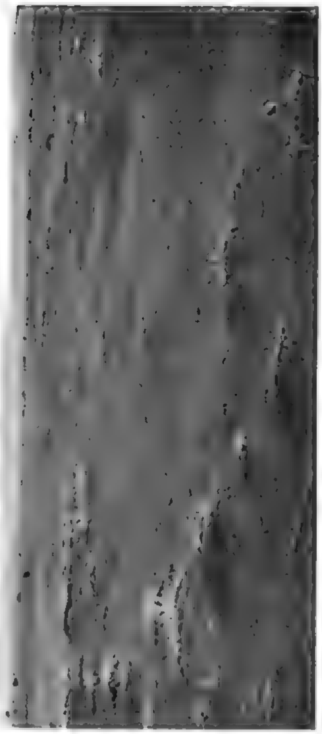

Fig. 12

Fig. 9

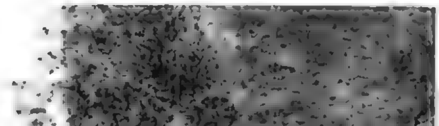

Fig. 11

NOTES ON THE SMARIDIDAE (ACARINA) OF AUSTRALIA AND NEW ZEALAND

By H. WOMERSLEY (Entomologist, South Australian Museum)
and R. V. SOUTHCOTT

Summary

In this family Vitzthum (Kukenthal's Handbuch der Zoologie, 1931, 3, (2), 148) includes only the two genera *Smaris* Latreille 1796 (= *Smaridia* Latreille 1817 = *Fessonia* von Heyden 1826 = *Phanolophus* André 1927) and *Microsmaris* Hirst 1926, both of which have been recorded from Australia. From the allied Erythraeidae he separates the family (Tierwelt Mitteleuropas, 1929, 3, (7) , 67) as follows :

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[Read 8 May 1941]

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"Mouth-parts not extrusile. Mandibles stylet-like. One or two sessile eyes. With crista metopica; two sensillary areas, on anterior and posterior ends of crista.
Erythraeidae Oudemans 1902

"Mouth-parts including palpi far extrusile. Mandibles stylet-like. One or two sessile eyes on each side. With or without crista metopica; one sensillary area on posterior end of crista or a corresponding position. *Smarididae* Kramer 1878"

It is not clear why Vitzthum placed *Microsmaris* in the Smarididae, unless it was on the absence of a crista. The mouth-parts, however, are not extrusile in this genus, and it cannot therefore be placed in this family. Probably he had not seen any specimens and was misled by the name.

In Europe there are apparently only three species recognised with certainty, placed hitherto in the genus *Smaris* Latreille 1796.

Vitzthum (*loc. cit.*, 1929) separates these species thus:

"1 Without crista metopica. Anterior end of dorsum produced in a long extended process. Two eyes on each side. *S. squamata* (Hermann 1804)

"With crista metopica. Anterior end of dorsum without extended process. 2

"2 Body hairs in form of short leaves with serrated edge. Two eyes on each side. *S. papillosa* (Hermann 1804)

"Body hairs angular, the edges with wart-like serrations. Allegedly with only 1 eye on each side. *S. ampulligera* (Berlese 1887)"

Before considering the Australian species it will be necessary to evaluate taxonomically the characters used in the above key. At first glance, in this family as well as in the Erythraeidae, the presence or absence of crista, and possibly also of a nasus, may appear to be of generic value. But are there other characters to support this?

If we look at the figures of *S. squamata* given by Berlese (A.M.S. ital. Repta., fasc. v, No. 4), and again (*ibid.*, fasc. lxxi, No. 4) we observe two distinct dorsal shields, anterior and posterior, a large ventral shield embracing the anterior two pairs of coxae, a pair of lateral ventral shields embracing coxae III and IV, as well as a large quadrangular genital shield. On the posterior margin of the anterior dorsal shield, and well behind the paired eyes, is a single pair of sensory setae. In Berlese's figures, however, of *ampulligera* (*ibid.*, fasc. xxxix, No. 10; lxxi, No. 4) and *papillosa* (*ibid.*, fasc. xvi, No. 3; lxxi, No. 4) there is no suggestion of dorsal or ventral shields and no nasus; but there is a distinct linear crista with anterior and posterior sensillary areas, and in *papillosa* an additional sensillary area in the middle. The separation of *squamata* from the other two species on the absence of a crista and the presence of a nasus is supported by the presence of dorsal and ventral shields.

In 1916 Banks (Trans. Roy. Soc. S. Aust., **40,** 225, pl. xxiii, fig. 5), described *Fessonia prominens* from ants' nests in Victoria. In 1934 (Rec. S. Aust. Mus., **5,** (2), 225) the senior author recorded the same species from various localities in other States and suggested that it was not necessarily a myrmecophilous species. Unfortunately, in that paper, the species was erroneously placed in *Calyptostoma* (Calyptostomidae), a genus and family to which it has no relation. It is re-described and refigured as *Smaris prominens* in this paper.

Although overlooked by Banks, the dorsal and ventral shields found in *squamata* are present in *prominens.* They were apparently missed as the specimens were mounted in balsam; but remounting of his co-type, in the South Australian Museum collection, in gum-chloral, renders them visible. Banks, however, does refer to several dorsal patches free of hairs, and these correspond to the smaller muscular plates described later. His figure shows only a single sensillary area with paired setae placed posterior to, but close to the eyes. It is obvious, however, that these do not correspond in position to those shown by Berlese for *squamata.* Banks also shows a distinct nasus but no crista.

Re-examination of the Australian *S. prominens* shows that there are actually two pairs of sensory setae, an anterior pair as figured by Banks, and a posterior pair (as shown by Berlese for *squamata*) on the posterior margin of the anterior shield. It appears, then, that whereas Banks overlooked the posterior pair of sensillae in *prominens,* an anterior pair, missed by Berlese, probably occurs in the European *squamata.*

Berlese (Bull. Soc. ent. Ital., 1888-90) records *Smaridia ampulligera* var. *longipes* and *S. depilata* n. sp. from South America. In the latter species he describes and figures a large diamond-shaped anterior dorsal shield and seven smaller posterior plates, one in the midline, the others more lateral; that in the midline probably corresponds to the posterior shield in *squamata,* but the others are probably muscular plates. On the anterior dorsal shield he shows two pairs of sensillae as in *prominens* and both posterior to the single eyes. The species is obviously closely related to *prominens* and *squamata.*

With regard to the eyes, Berlese (A.M.S., 1883, fasc. v, No. 4) clearly figures *S. squamata* (*Rhyncholophus squamatus*) as having only one eye on each side. In 1887 (*loc. cit.,* fasc. xxxix, No. 10) he stated that whereas previously (*loc. cit.,* 1884, fasc. xvi, No. 3) he figured *papillosa* with only one eye on each side, there was a smaller additional eye present on each side, which he had not been able to see in *squamata* and *ampulligera.* Later (*loc. cit.,* 1894, lxxi, No. 4) he describes and figures 2 + 2 eyes in *squamata.* Accordingly it appears reasonable to suppose that he missed the 2 + 2 eyes in the South American *depilata.*

It is evident, then, that *squamata, prominens* and *depilata* are closely related in the absence of a crista, the posterior position of both pairs of sensillae with regard to the eyes, and the presence of dorsal shields; but are yet generically distinct from *ampulligera* and *papillosa,* hitherto placed under *Smaris* (s.l.).

As *squamata* Hermann is the type of *Smaris* it is proposed to restrict this generic name to the above three species. Of the other two species, *papillosa* Hermann is, according to Oudemans (Krit. Overz d. Ac., III C, 954), the type of *Fessonia* von Heyden 1826. It differs from *ampulligera* in having a third and middle sensillary area to the crista and two eyes on each side.

It remains for European workers to re-investigate the presence or otherwise of the anterior pair of sensillae in *squamata* and whether *depilata* has 2 + 2 or 1 + 1 eyes.

Recently (Psyche, **45,** (2-3), 1938, 123) Jacot has rediscovered and re-described Say's American species *Trombidium sericeum,* and shown that it should be placed in *Smaris* (s.l.). It has both a linear crista and a short nasus but there is no suggestion of dorsal or ventral shields. In addition, Jacot also briefly describes but does not name a second very similar species of *Smaris* from North America. Both these species are obviously closely related to *ampulligera.*

A re-examination of the Australian *Hirstiosoma scalaris* Womersley, and of the New Zealand *H. novae-hollandiae* Womersley shows that both have extrusile mouth-parts and are closely related to *ampulligera* and to Jacot's two species. All these are generically distinct from *papillosa* (*Fessonia*) and *squamata* (*Smaris*) and accordingly require a new generic name for which *Hirstiosoma* Womersley is available, with *scalaris* Womersley as the type. In addition to the genotype it will include *H. sericea* (Say, Jacot), *H.* sp. Jacot, from North America, *H. novae-hollandiae*, New Zealand, and **H. tasmaniensis** n. sp., Tasmania.

Another genus which must be included in the Smarididae, as understood here, is *Sphaerotarsus* (genotype *S. allmani* Womersley 1936) from Australia. It is closely related to *Hirstiosoma* even in the general form of the dorsal setae, differing in having the posterior sensillary setae clavate and the ♂ hind tarsus enlarged. The genus includes *S. ripicolus* (Womersley 1934), *S. allmani* Wom. 1936, **S. leptopilus** n. sp., and **S. claviger** n. sp., all four being from Australia.

The four genera included in the family can be keyed as follows:

1 Crista absent, two sensillary areas with paired sensory setae, both placed posterior to the paired eyes. Dorsal and ventral shields present, anterior dorsal plate produced to a nasus. *Smaris* Latreille 1796,
type *S. squamata* (Hermann 1804)

Crista present, linear, with 2 or 3 sensillary areas, each with paired sensillae. Dorsal plates or shields absent. Eyes 2 + 2 or 1 + 1 about level with middle of crista. 2

2 Crista with 3 sensillary areas. Eyes 2 + 2. *Fessonia* von Heyden 1826
type *S. papillosa* (Hermann 1804)

Crista with only 2 sensillary areas, anterior and posterior. Eyes, 1 + 1. 3

3 Posterior sensillary setae tapering with ciliations minute or absent. Hind tarsi in ♂ normal. *Hirstiosoma* Womersley 1934
type *H. scalaris* Womersley 1934

Posterior sensillary setae clavate, strongly ciliated. Hind tarsi in ♂ greatly enlarged. *Sphaerotarsus* Womersley 1936
type *S. allmani* Womersley 1936

Genus Smaris Latreille

Précis car. gén. Ins., p. 180, 1796.

Smaris prominens (Banks 1916) Text fig. 1, A-T; 2, A-I; 3, A-C

Fessonia prominens Banks, Trans. Roy. Soc. S. Aust., 1916, **40**, 225.
Calyptostoma prominens Womersley, Rec. S. Aust. Mus., 1934, **5**, (2), 235

Redescription of Adult, fig. 1, A-P—Colour brown to reddish. Oval in outline with rather prominent shoulders. With distinct nasal process. Dorsum rather flat with raised marginal areas giving a sunken central portion which extends anteriorly on each side to the origin of the nasus. Length to 1·0 mm., width to 0·5 mm., greatest anterior to the middle.

Dorsally with two distinct shields; the anterior pear-shaped with the apex forming the nasus, anteriorly with two sessile eyes on each side on indistinct ocular plates, behind the eyes in the midline is a pair of sensillae, 43 μ long with their pits 49 μ apart; on the posterior margin of this shield is a second pair of sensillae, 47 μ long, with their bases 18 μ apart and the pits conjoined to form a sensillary area, the distance between anterior and posterior sensillae is 220 μ and both pairs are finely ciliated; this anterior shield extends to the middle of the body length and laterally to half-way between the midline and the lateral body margins, its length is 450 μ, width 280 μ; the posterior dorsal shield is roundish in the ♀, 180 μ long by 140 μ wide, in the ♂ it is rather straight on the anterior margin and somewhat larger than in the ♀, 250 μ by 220 μ. In both sexes between the anterior and posterior shields are two pairs of small subcuticular muscular plates which are roundish and somewhat angled medially, in the ♂ the posterior

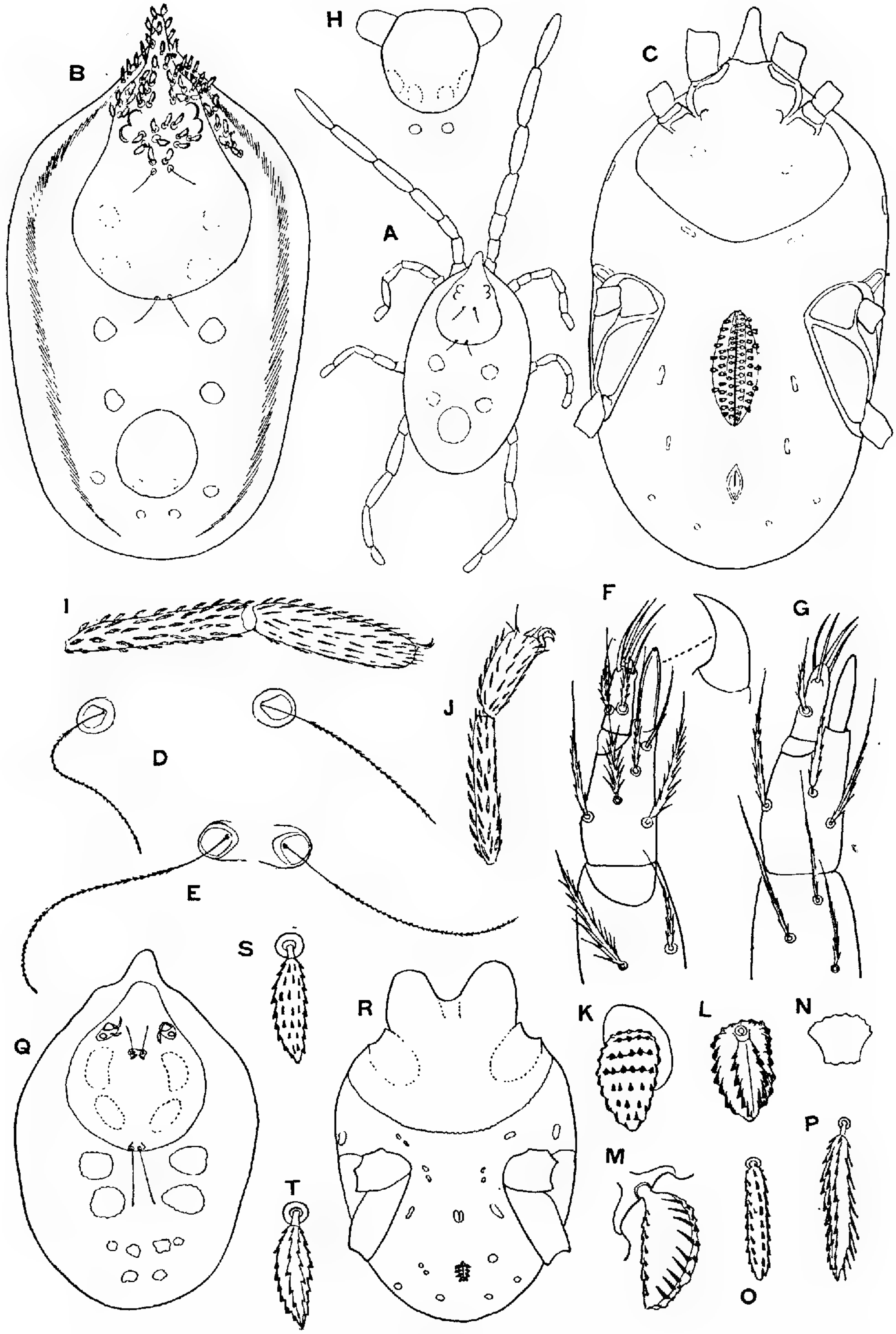

Fig. 1

Smaris prominens (Banks 1916)—A–P adult: A, entire dorsal view ♀; B, dorsum ♀; C, venter ♀; D, anterior sensillae; E, posterior sensillae; F, palp dorsal; G, palp ventral; H, post. dorsal plate ♂; I, tarsus and metatarsus I; J, tarsus and metatarsus IV; K, L, M, N, different aspects of dorsal setae (N, transverse section); O, P, leg setae; Q–T, nymph; Q, dorsum; R, venter; S, T, dorsal setae from above and below.

pair are attached to the anterior angles of the posterior shield, giving it a widened appearance anteriorly, other smaller muscular plates are as figured. Ventrally the anterior coxae are on a large somewhat triangular shield 385 μ long and 385 μ wide; the posterior coxae are on triangular lateral shields, 305 μ long by 180 μ wide; smaller muscular plates are present as figured. The genital opening is externally the same in both sexes, 280 μ long by 45 μ wide, the lips are furnished with about 18 simple spine-like setae, and outside these lips the cuticle is raised as a pair of outer ridges furnished with normal ventral setae; in neither sex are genital discs present. Legs: I 1,100 μ long, II 660 μ, III 630 μ, IV 1,020 μ (including coxae); tarsus I elongate, 190 μ by 40 μ high; metatarsus I 225 μ; all tarsi without scopulae, no difference between metatarsi and tarsi IV of ♂ and ♀. Setae: dorsal short and oval, rather flattened ventrally, broadly convex dorsally, with longitudinal rows of adnate serrations, 15-20 μ long; laterally on anterior end of dorsum are a few similar but longer ones to 45 μ; ventral setae similar to dorsal but mostly shorter 12-14 μ, some 28 μ; most leg setae similar to dorsal, 20 μ; various types of sensory setae are also present on the legs.

Mouth-parts extrusile, palpi with fine indistinctly ciliated setae dorsally, strongly ciliated ventrally, tarsus of palp shorter than the strongly curved claw and with one blunt sensory seta, three strong simple setae and four ciliated setae.

Remarks—From the figures of *squamata* given by Berlese and already referred to, our Australian species differs in the size and shape of the dorsal and ventral shields. In *squamata* the anterior shield extends much further back and is square-ended; in *prominens* it is shorter, more pear-shaped and rounded posteriorly. The posterior shield is larger and longer in *squamata*, and there is a wide quadrangular genital shield not present in *prominens*.

Description of larvae, fig. 2, A-I—Colour orange. Shape roughly ovoid, widest anterior to the middle, evenly rounded posteriorly, somewhat tapering anteriorly, length ranging from 223 μ, to 460 μ when fully gorged, width 184 μ of a specimen 254 μ long. With a single dorsal shield, as figured, with concave anterior and convex posterior margin, length 28 μ, width 45 μ, depth of anterior concavity 4 μ; with two pairs of ciliated sensillae placed as shown; anterior 27 μ posterior 44 μ; with two pairs of ordinary fairly stout ciliated setae placed at the anterior and posterior angles, anterior 45 μ long, posterior 32 μ. Eyes 2 + 2, postero-lateral to dorsal shield, anterior ocellus the larger. Dorsum with about 44 brown fairly stout blunt ciliated setae, 24-41 μ long, arranged 4.4.4.4(5). 4.4.4.8(9).4.2.

Venter: each coxa with one ciliated seta, on I 32 μ long, II 20 μ, III 26 μ, that on III blunt at tip, others pointed. Between coxae I a pair of bushy ciliated setae, 16 μ long; a pair of pointed ciliated setae, 20 μ long, between coxae III, none between coxae II, but in the usual position of such setal bases is a pair of small rings suggestive of pores rather than the bases of setae; behind coxae III are three rows of blunt ciliated setae, 20-24 μ long, arranged 4.4.3. Legs stout, I 285 μ long, II 285 μ, III 337 μ (including coxae); tarsus I 57 μ long, 30 μ high. Claws strongly pulvilliform, empodium claw-like slender and curved, much longer than the claws; tarsi I with setae as figured, metatarsus I 47 μ long.

Mouth-parts and palpi as figured; palpal claw trifurcate; femur, genu, tibia and tarsus with 1, 1, 3, 6 setae respectively.

Remarks—No larvae appear to have previously been referred to the Smarididae. Within the Erythraeidae the genus *Bochartia* Oudemans, Zool. Jahrb., Suppl. 14, pt. i, 1912, p. 126 (type *B. kuyperi* Ouds.) appears to be most closely related to the larvae of *Smaris prominens*. They agree in having a dorsal shield wider than long, furnished with two pairs of ordinary ciliated setae, and two pairs of sensillary setae, and in having 2 + 2 eyes and coxae well separated. *S. prominens* differs from all Erythraeid larvae in that the two tarsal claws are identical, strongly pulvilliform with long cilia; the palpal claw is tri- and not bifurcate as in *Bochartia*. It also differs from this genus in the scutum being crescentic or oblong rather than circular, with distinct anterior and posterior lateral angles.

Description of Pupa, fig. 3, A-C—Colour orange. Shape ovoid with a flattened ventral surface. Length 455 μ, width 295 μ; dorsal surface strongly

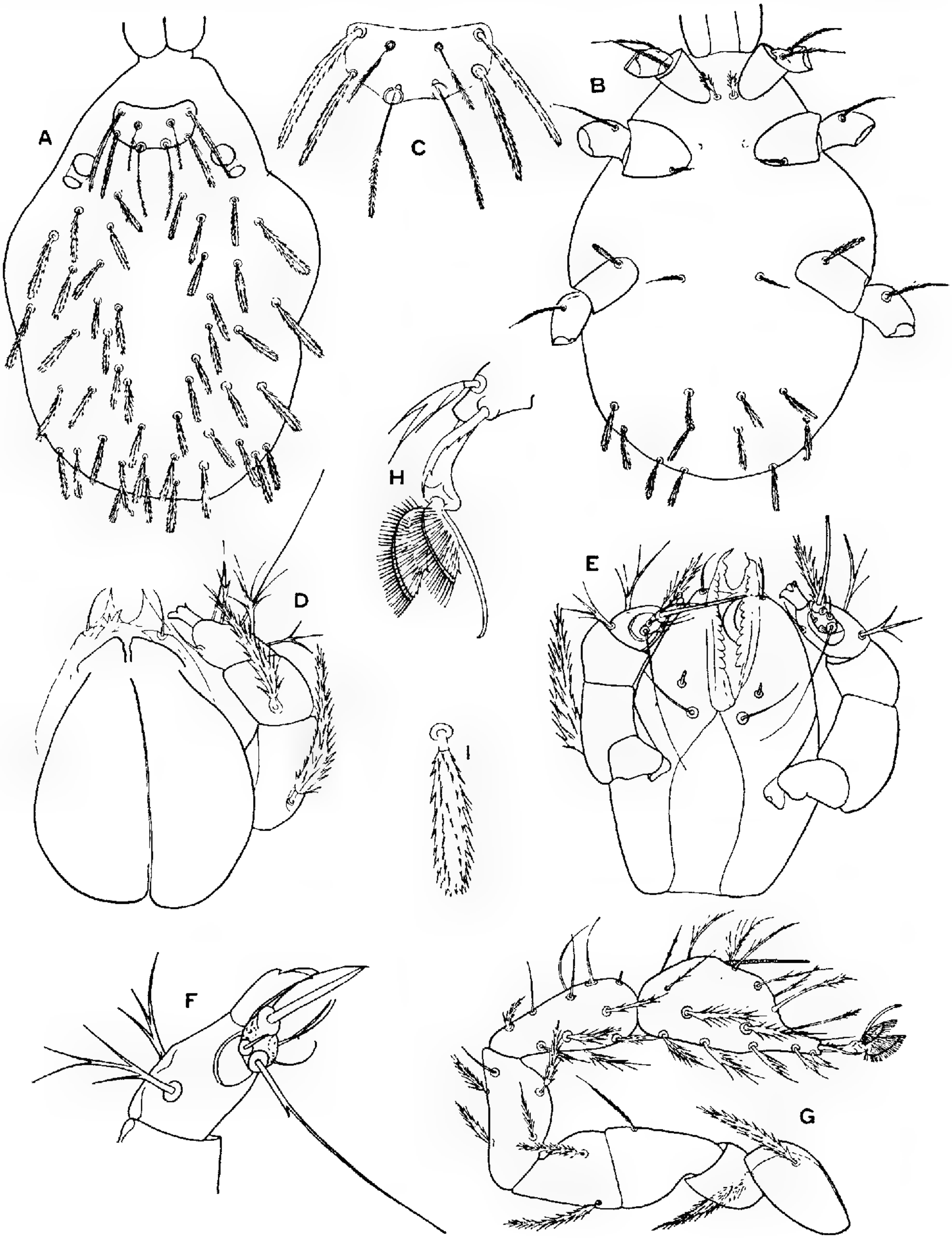

Fig. 2

Smaris prominens (Banks 1916)—Larva: A, dorsal; B, ventral; C, dorsal scutum; D, capitulum and right palp, dorsal; E, capitulum and palpi from below; F, tip of palp; G, leg I, posterior aspect; H, tip of front tarsus and claws; I, dorsal seta.

convex with the anterior end notched. Laterally the ventral surface is raised, the lateral areas merging at each end into two pairs of raised bosses in which the nymphal tarsi develop. The sunken central area is broadly convex. The dorsum entirely, and the venter peripherally, with long parallel-sided, apically-pointed setae, with serrations, setae 68-80 μ long, a few elongate-lanceolate and 34 μ long, each seta arising from a definite papilla. In well-developed pupae the nymphal parts can be seen, the eye spots being visible throughout the whole pupal stage. At first the eye spots are wide apart as in the larva, then approach gradually until the nymphal position is assumed. In ecdysis the larval skin splits transversely, one half remaining attached to each end of the pupa. The anterior half of the cast skin has the mouth-parts, legs I and II and the dorsal scutum; legs II separate to some extent from this part. The posterior half consists of the remainder, excepting perhaps the eyes, whose fate has not been ascertained.

Description of freshly emerged Nymph, fig. 1, Q-T—Colour orange. Shape oval, rather flattened dorsally with raised lateral border as in adult, length 490 μ, width 315 μ. Dorsum with only the anterior pear-shaped shield present; this

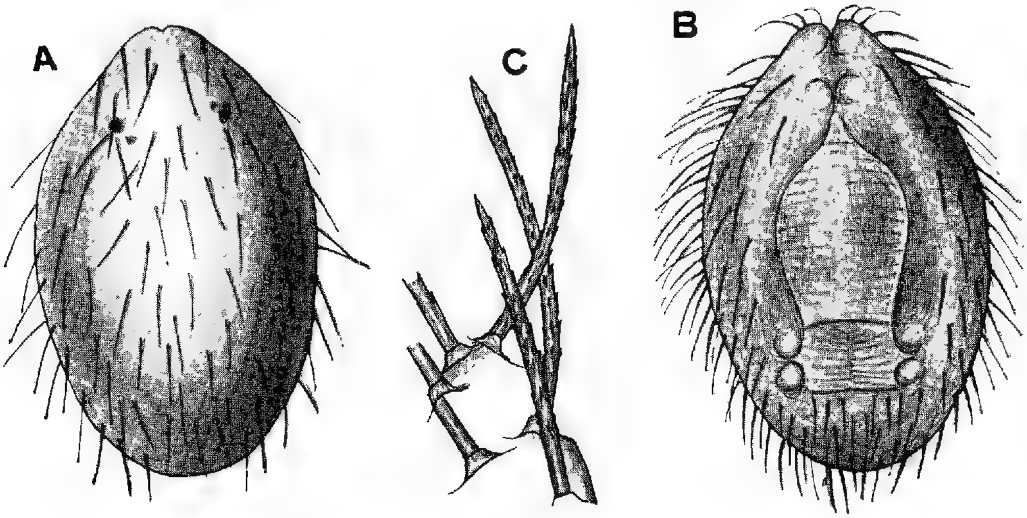

Fig. 3
Smaris prominens (Banks 1916)—Pupa: A, dorsal; B, ventral; C, setae.

carries 2 + 2 eyes and two pairs of sensillae as in the adult. The anterior sensillae are 34 μ long, their bases 39 μ apart, the posterior 57 μ and 14 μ respectively; they are all fine and shortly ciliated; as in the adult there is no crista and both pairs of sensillae are posterior to the paired eyes, the distance between the pairs of sensillae is 129 μ. With four large and a number of smaller muscular plates as in the adult.

Dorsal setae of similar form, but more elongate than in adult, 18-20 μ long, some laterally near the nasus 40 μ. Ventral setae similar to dorsal, 16-24 μ long. Coxae on ventral shields as in adult. Small ventral muscular plates as figured, devoid of cuticular striations. No genital organs present. Mouth-parts extrusile. Palpal claw stout, simple, curved.

Legs slender, I 662 μ long, II 303 μ, III 430 μ, IV 573 μ (all including coxae); tarsus I 123 μ long by 45 μ high, metatarsus I 135 μ long; normal setal clothing of legs as in adult, various sensillae also present; tarsal claws two, falciform, finely ciliated.

Localities—New South Wales: Bathurst, under logs, October 1932, one specimen (S. L. A.); Menindee, July 1928, three adults (S. H.). Victoria: Ocean Grove with *Iridomyrmex nitidus*, date ? (A. M. L.), (♀ co-type of *Fessonia prominens* Bks. in S. Aust. Museum). South Australia: Urrbrae, under bark, September 1933, one nymph (H. W.); Encounter Bay, with termites, January 1934, one adult (H. W.); Mount Barker, in moss, July 1934, one nymph (H. W.); Bordertown, December 1934, one adult (R.V. S.); Myponga, in moss, April 1935, one nymph (R. V. S.); Belair, May 1935, one adult (H. W.), January 1940, one adult (J. S. W.), May 1940, two adults (R. V. S.); Sellick's Beach, February 1937, one adult (H. M. H. and K. S.); Unley Park, August 1938, two adults and one nymph, October 1940, one nymph, all under eucalypt bark (R. V. S.); Torrens Gorge, in burnt stump of *Xanthorrhoea*, April 1939, one adult and three nymphs (R. V. S.); Glen Osmond, adults found throughout the year, 1935-40, particularly from April to June, nymphs from April to October and particularly April to May; both from soil, vegetable debris and under eucalypt bark; larvae found in similar habitat either free or attached to the introduced and cosmopolitan Psocid *Liposcelcs (Troctes) divinatorius* (Linn.), March 1935 (one specimen), April 1939 (8), May 1939 (2), April 1940 (2), (all R. V. S.).

Notes on the Biology of Smaris prominens (Bks.)

In trying to trace the life-history of this mite attempts to obtain eggs from adults in captivity have so far been unsuccessful. It has been possible, however, to rear nymphs from larvae attached to Psocids and these nymphs have been correlated with the adults on morphological grounds. The details of the four successful rearings (by the junior author) are given in the following table:

Specimen	ACA 324		ACA 326		ACA 654		ACA 661	
	Date	Period in Days	Date	Period in Days	Date	Period in Days	Date	Period in Days
Mite found	9 Apr. 39	—	7 May 39	—	21 Apr. 40	—	28 Apr. 40	—
Left host	12–15 Apr. 39	—	12 May 39	—	24 Apr. 40	—	—	—
Became dormant	12–15 Apr. 39	0	13–15 May 39	0	24 Apr. 40	0	after 29 Apr. 40	0
Skin split	18–19 Apr. 39	3–7	22 May 39	7–9	28–9 Apr. 40	4–5	before 20 May 40	0–30
Nymph emerged	12 May 39	27–30	after 5 June 39 (1)	21–24	29 May 40	35	after 19 June 40 (2)	31 51 +
Nymph still alive ..	Killed at once		—	—	16 Aug. 40	—	—	—

(1) Tube not examined until December 1939, when a dead nymph and cast larval and pupal skins were found.

(2) Pupa put into formalin; the nymph was apparently ready to emerge, showing strong development as compared with ACA 654.

The mites, together with their hosts, were kept in separate damp tubes supplied with pieces of bark or paper. When fully gorged the mites left their hosts and wandered freely about the tube for several days before becoming dormant. After several more days the skin splits transversely, revealing the pupa. Three to four weeks later the nymph emerges from a rent towards the posterior end of the pupa. After each experiment the larval skins were checked to ensure correct correlation of larva and nymph. Whether a second resting stage and nymph occurs has not been ascertained, but seems to be unlikely. One of the reared nymphs (ACA 654) lived in captivity for 80 days without any sign of further ecdysis and without any increase in body length or distance between the pairs of sensillae. Larger nymphs than the one described have been taken in the field, one from Glen Osmond, May 1937 measured 770 μ long, 460 μ wide, and 157 μ between pairs of sensillae. These dimensions, *i.e.*, body nearly as big as adult, but with distance between sensillae corresponding to proven first stage nymphs, indicate that probably there is only one nymph.

Genus Hirstiosoma Womersley

Rec. S. Aust. Mus., 1934, **5**, (2), 242. Type *H. scalaris* Wom., 1934 (*loc cit.*).

HIRSTIOSOMA SCALARIS Womersley Fig. 4, A-F; 5, A-E

Rec. S. Aust. Mus., 1934, **5**, (2), 242.

Redescription of Adult, fig. 4, A-F; 5, A-C, E—Colour red. Oval in outline with prominent shoulders and a short nasus. Length 1·0 mm., width 0·65 mm. Crista linear with two sensillary areas, anterior and posterior each with two sensillae; anterior sensillae 30 μ long, expanding slightly distally, distal half with longer outstanding ciliations, proximal half with very minute adpressed ciliations, posterior sensillae very slender and tapering, 85 μ, with adpressed minute ciliations barely visible under high magnification. Distance between anterior and posterior sensillae 300 μ. Eyes 1 + 1, level with middle of crista. Palp as figured. Dorsal setae numerous, brown but not heavily pigmented, 3-flanged, 16-24μ long. Ventral setae posteriorly similar to dorsal, anterior to genitalia oval with long strong ciliations, 14-16μ long. Legs: I 1,230 μ long, II 650 μ, III 640 μ, IV 960 μ (including coxae), tarsus I 180 μ by 45 μ high, metatarsus 240 μ, tarsus IV 81 μ by 34 μ high, metatarsus IV 228 μ long.

Description of Nymph, fig. 5, D-E—Colour red. Shape as in adult. Length 500 μ, width 295 μ. Crista and sensillary setae as in adult. Anterior sensillae 26 μ long, posterior 85 μ, distance between anterior and posterior 188 μ. Eyes 1 + 1 level with middle crista. Dorsal setae similar to adult but more elongate, 18-28μ long; ventral setae posteriorly similar to dorsal, more anteriorly elongate-oval, 14-16 μ long, with long strong ciliations. Legs not available.

Localities—South Australia: Victor Harbour, by sweeping tea-tree on banks of Hindmarsh River, one adult (type), January 1934 (H. W.); Glen Osmond, in soil at base of eucalypts, January 1938, two adults, February 1939, one adult, December 1939, one nymph, January 1940 one adult, December 1940, one adult, January 1941, one adult (R. V. S.); Rocky River, Kangaroo Island, one adult, under stone, December 1939, (R. V. S.).

Hirstiosoma tasmaniensis n. sp. Fig. 4, G-O; 5, F-J

Description of Adult, fig. 4, G-N; 5, F-H, J—Colour brownish. Oval in outline with prominent shoulders, length 1·4 mm., width 0·83 mm. Propodosoma produced into a nasus about 160 μ long. Crista linear with anterior and posterior sensillary areas each with paired sensillae, anterior sensillae strong, tapering, pointed, 50 μ long, with minute ciliations, posterior sensillae strong, long, tapering, pointed, 97 μ long, with minute ciliations, distance between anterior and posterior sensillae 323 μ. Eyes 1 + 1, level with middle of crista. Palp as figured, setae spiniform, with fine ciliations. Dorsal setae numerous, dark brown (heavily pigmented), 3-flanged, 24-31 μ long; ventral setae posteriorly similar to dorsal, anterior to genitalia oval with long strong ciliations, 14-22 μ. Legs: I 1,640 μ, II 900 μ, III 960 μ, IV 1,375 μ (including coxae); tarsus I 224 μ long by 75 μ high; metatarsus I 255 μ long; tarsus IV 97 μ long by 68 μ high, metatarsus IV 265 μ long.

Description of Nymph, fig. 4, O; 5, I—Colour brownish. Shape as in adult, length 510 μ, width 255 μ. Crista linear, as in adult, anterior sensillae fairly strong, only slightly tapering, pointed, 38μ long, with fine ciliations, posterior sensillae more slender, tapering, pointed, 87 μ long, with minute ciliations, distance between anterior and posterior sensillae 183 μ. Eyes 1 + 1, level with middle of crista. Dorsal setae similar to adult but more elongate, 22-34 μ long; ventral setae posteriorly similar to dorsal, more anteriorly a long oval with long strong ciliations, and 14-16 μ long. Legs I: 1,020 μ long, II 460 μ, III 465 μ, IV 745 μ (including coxae); tarsus I 150 μ long by 54 μ high, metatarsus I 160 μ long, tarsus IV 60 μ by 36 μ, metatarsus IV 195 μ long.

Localities—Tasmania: Mount Wellington, December 1937, one adult and one nymph; Hobart, in moss, March 1940, five adults (one the type), (J. W. E.).

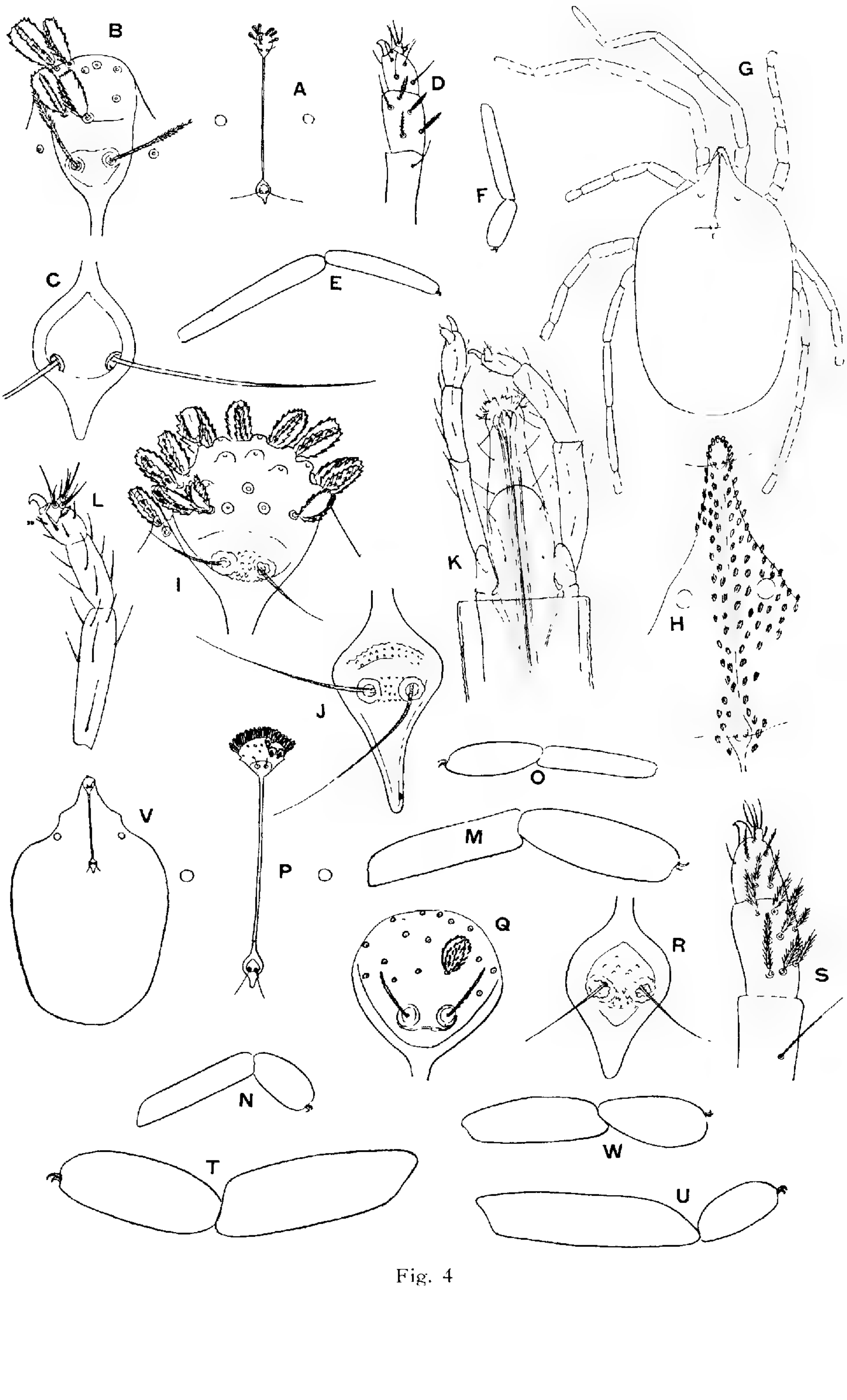

Fig. 4

HIRSTIOSOMA NOVAE-HOLLANDIAE Womersley Fig. 4, P-W; 5, H-M

J. Linn Soc., London, (Zool.), 1936, **40**, 118

Redescription of Adult, fig. 4, P-U; 5, K-M —Colour brownish. Oval in outline with prominent shoulders and a short nasus. Length 1·5 mm., width 0·95 mm. Crista linear, with anterior and posterior sensillary areas each with two sensillae; anterior sensillae fairly stout, almost parallel-sided, finely ciliated, 26 μ long; posterior sensillae 45 μ long, tapering, pointed, ciliations doubtfully visible at 3,000 diameter, distance between anterior and posterior sensillae 414 μ. Eyes 1 + 1, very slightly behind middle of crista. Palp as figured. Dorsal setae numerous, brown (heavily pigmented), 3-flanged, dorsal flange very broad and frequently with excavations, setae 24-26 μ long; ventral setae posteriorly similar to dorsal, anterior to genitalia oval with long strong ciliations, 16-20 μ long. Legs: I 1,620 μ long, II 1,030 μ, III 1,110 μ, IV 1,420 μ (including coxae); tarsus I 230 μ long by 125 μ high, metatarsus I 345 μ long; tarsus IV 115 μ long by 62 μ high, metatarsus IV 305 μ long.

Description of Nymph, fig. 4, V-W; 5, M—Colour brownish. Shape as in adult. Length 835 μ, width 525 μ. Crista linear with sensillary areas as in adult, anterior sensillae 18 μ long, fairly stout, slightly tapering and finely ciliated; posterior sensillae as in adult, 40 μ long, distance between sensillae 254 μ. Eyes 1 + 1, behind middle of crista. Dorsal setae similar to adult but more elongate and less heavily pigmented. 22-28 μ long; ventral setae posteriorly similar to dorsal, more anteriorly similar, but with strong ciliations, 16-22 μ long. Legs: I 1,125 μ long, II 640 μ, III 645 μ, IV 845 μ (including coxae); tarsus I 145 μ long by 60 μ high, metatarsus I 215 μ long; tarsus IV 73 μ long by 32 μ high, metatarsus IV 200 μ long.

Locality—New Zealand: Manurewa, Auckland, May 1934, one adult (type), (E. D. P.); August 1934, one ♂ and one nymph (E. D. P.).

GENERAL REMARKS ON THE GENUS HIRSTIOSOMA

The specific differences in this genus, although small, are important. The principal ones are the dimensions of the metatarsus and tarsus of leg I, the characters of the sensillary setae of the crista and the structure of the dorsal setae.

Previously the senior author (J. Linn. Soc., London, (Zool.), 1936, **40**, 118) used the character of the setae arising from papillae at the tip of the tarsi as being of value in separating *scalaris* and *novae-hollandiae*, those of *scalaris* having earlier (Rec. S. Aust. Mus., **5**, (2), 242, 1934) been considered as simple. Actually these setae are ciliated in all species (both adult and nymphal) of the family of which we have specimens. A key to the three species from Australia, Tasmania and New Zealand is given but their exact relationship to the other species cannot be determined from the published data.

In A.M.S. ital. Repta., xxxix, No. 10, Berlese shows the anterior sensillae of *ampulligera* as relatively short thick and apically pointed with distinct ciliations, posterior sensillae as long and slender without ciliations. In the same work, lxxi, No. 4, for the same species he shows them both as long and slender, without

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Fig. 4

Hirstiosoma—A–F, *scalaris* Wom. 1934, adult: A, crista and eyes; B, anterior sensillary area; C, post. sensillary area; D, palp; E, tarsus and metatarsus I; F, tarsus and metatarsus IV; G–O, **tasmaniensis** n. sp: G–N, adult; G, outline; H, crista and eyes; I, ant. sensillary area; J, post. sensillary area; K, mouthparts from below; L, palp; M, tarsus and metatarsus I; N, tarsus and metatarsus IV; O, tarsus and metatarsus I of nymph. P–W, *novae-hollandiae* Wom. 1936; P–U, adult; P, crista and eyes; Q, ant. sensillary area; R, post. sensillary area; S, palp from above; T, tarsus and metatarsus I; U, tarsus and metatarsus IV; V–W, nymph; V, dorsum; W, tarsus and metatarsus I. All tarsi and metatarsi are to same magnification.

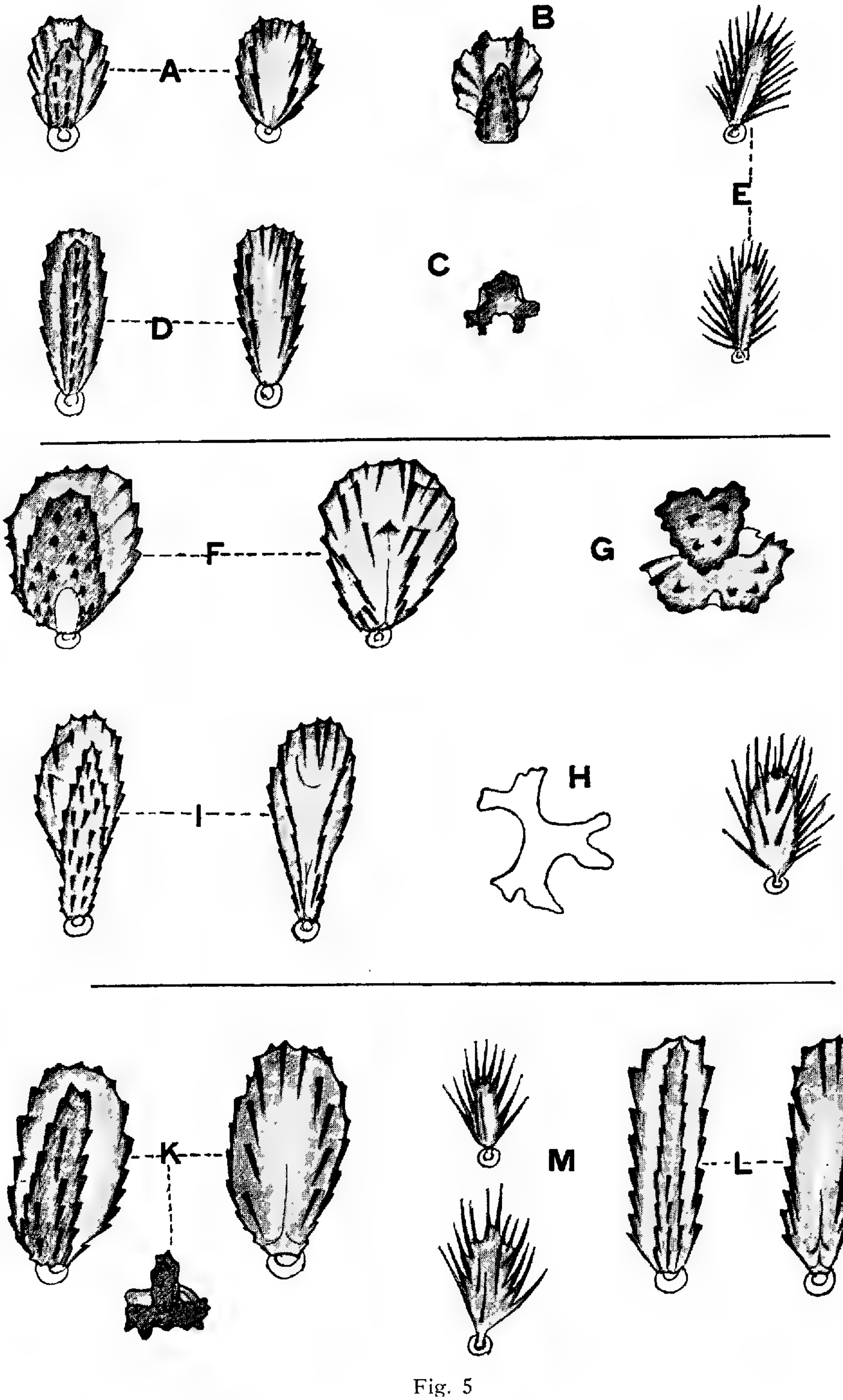

Fig. 5

ciliations. This suggests that he had more than one species. The figures of the setae given for *ampulligera* by Berlese, and for *sericea* and his second species by Jacot, do not permit of comparison with the three Australasian species.

1 Tarsus I four times as long as high. Anterior sensillae not tapering, expanding slightly distally and here with long ciliations; posterior sensillae very slender.
H. scalaris Womersley 1934

Tarsus I not more than twice as long as high. Anterior sensillae tapering. 2

2 Tarsus I one and one-half times as long as high. Posterior sensillae fairly thick, about 100 μ long. Dorsal setae widest about middle, dorsal flange of setae narrower, without basal excavations. **H. tasmaniensis** n. sp.

Tarsus I twice as long as high. Posterior sensillae slender, about 50 μ. Dorsal setae widest beyond middle; flange on dorsal surface broader, with basal excavations.
H. novae-hollandiae Womersley 1936

Genus Sphaerotarsus Womersley

J. Linn. Soc., London (Zool.), 1936, **40**, 269, 119. Type *S. allmani* Wom.

Sphaerotarsus ripicolus (Womersley, 1934) Fig. 6, A-H; 7, A-F

Sphaerotarsus ripicolus (Womersley, 1934).
Caeculisoma ripicola Womersley, 1934 (nymph), Rec. S. Aust. Mus., **5**, (2), 239.
Sphaerotarsus allmani Womersley, 1936 (part), J. Linn. Soc (*loc. cit.*).

Description of Adult, fig, 6, A-D; 7, A-D—Red. Oval, somewhat pointed anteriorly, and with prominent shoulders. Length about 1·0 mm., width about 0·6 mm. Crista linear with anterior and posterior sensillary areas each with two somewhat clavate, finely ciliate sensillae, anterior sensillae 23 μ long, posterior 40 μ; distance between centres of sensillae 264 μ. Eyes 1 + 1 behind middle of crista. Palpi very similar to nymph, but with a few more setae. Dorsal setae numerous, brown, short, ovoid (narrowing slightly distally), 3-flanged, with crossbars, and with adnate serrations, 18-24 μ long (some dorsal setae are unpigmented). Ventral setae posteriorly similar to dorsal, anterior to anus oval, with long strong ciliations, setae 17-22 μ long. Legs: I, (?) μ, II 820 μ long, III 870 μ, IV 1,170 μ (including coxae); tarsus I and metatarsus I not available, tarsus IV (♂) oval, 147 μ long by 94 μ across, metatarsus IV (♂) 230 μ long.

Redescription of Nymph, fig. 6, E-H; 7, E-F—Red. Shape as in adult. Length 0·875 mm., width 0·56 mm. Crista as in adult, anterior sensillae 22 μ long, posterior 43 μ. Distance between centres of sensillae 215 μ. Eyes as in adult. Palpi as figured. Dorsal setae shortly ovoid or elongate-ovoid, 3-flanged, with serrations, and with crossbars, 20-32 μ long; ventral setae posteriorly similar to dorsal, anterior to anus elongate-oval, with long strong ciliations, 18-20 μ long. Legs: I 805 μ long, II 555μ, III 625 μ, IV 780 μ (including coxae); tarsus I 112 μ long by 49 μ across, metatarsus I 161 μ long, tarsus IV 63 μ long by 34 μ high, metatarsus IV 170 μ long.

Localities—South Australia: Victor Harbour, by sweeping tea-tree along Hindmarsh River, January 1934, five nymphs (including type) (H. W.); Glen Osmond, November 1937, one nymph (R. V. S.). Victoria: Sandy Waterhole, Glenelg River, January 1941, one adult ♂ (H. W.).

Erratum—Rec. S. Aust. Mus., 1934, p. 239, fig. 184 and 185 should be transposed.

Fig. 5

Hirstiosoma, dorsal and ventral setae—A–E, *scalaris* Wom. 1934: A, dorsal seta of adult above and below; B, same, end view from above; C, same, transverse section; D, dorsal seta of nymph from above and below; E, ventral setae, adult above, nymph below. F–J, **tasmaniensis** n. sp.: F, dorsal seta of adult from above and below; G, same, end view; H, same, transverse section; I, dorsal seta of nymph from above and below; J, ventral seta of adult. K–M, *novae-hollandiae* Wom. 1936: K, dorsal seta of adult from above, below and end view; L, dorsal seta of nymph from above and below; M, ventral setae, adult above, nymph below. (All to same magnification.)

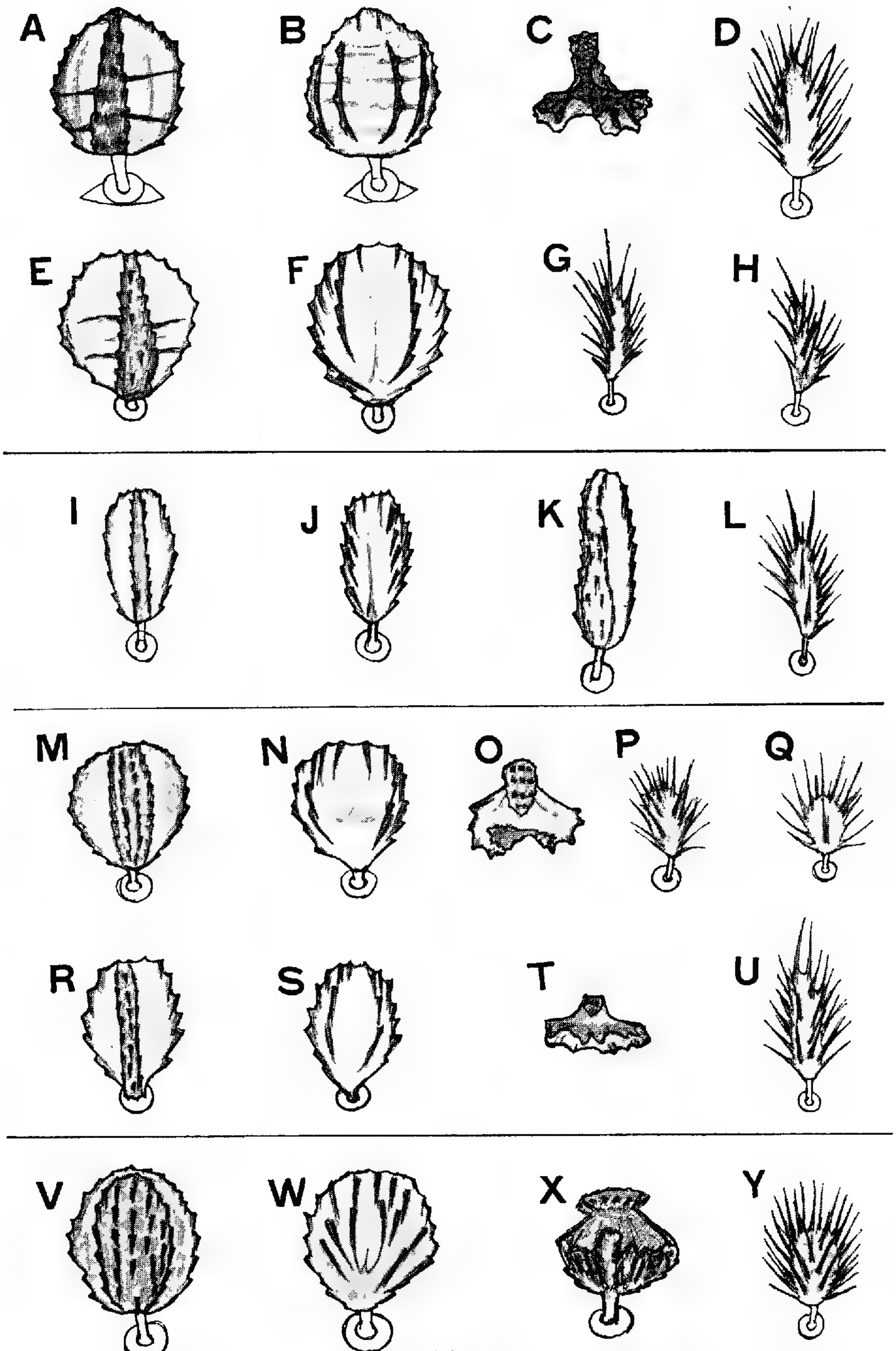

Fig. 6

Sphaerotarsus, dorsal and ventral setae—A–H, *S. ripicolus* (Wom. 1934), A–D adult: A, dorsal seta above; B same, below; C, same, end view; D, ventral seta; E–H, nymph, E, dorsal seta, above; F, same, below; G, H, ventral setae. I–L, **S. leptopilus** n. sp., nymph: I, dorsal seta, above; J, same, below; K, longer dorsal seta; L, ventral seta. M–U, *S. allmani* Wom. 1936, M–Q adult: M, dorsal seta, above; N, same, below; O, same, end view; P, Q, ventral setae; R–U, nymph; R, dorsal seta above; S, same, below; T, same, end view; U, ventral seta. V–Y, **S. claviger** n. sp., adult: V, dorsal seta, above; W, the same, below; X, same, end view (from below); Y, ventral seta. (All setae to same scale).

Sphaerotarsus leptopilus n. sp. Fig. 6, I-L; 7, G-M

Description of Nymph Colour red. Oval in outline, somewhat pointed anteriorly, and with prominent shoulders. Length 0·91 mm., width 0·67 mm. Crista linear with anterior and posterior sensillary areas, each with two clavate,

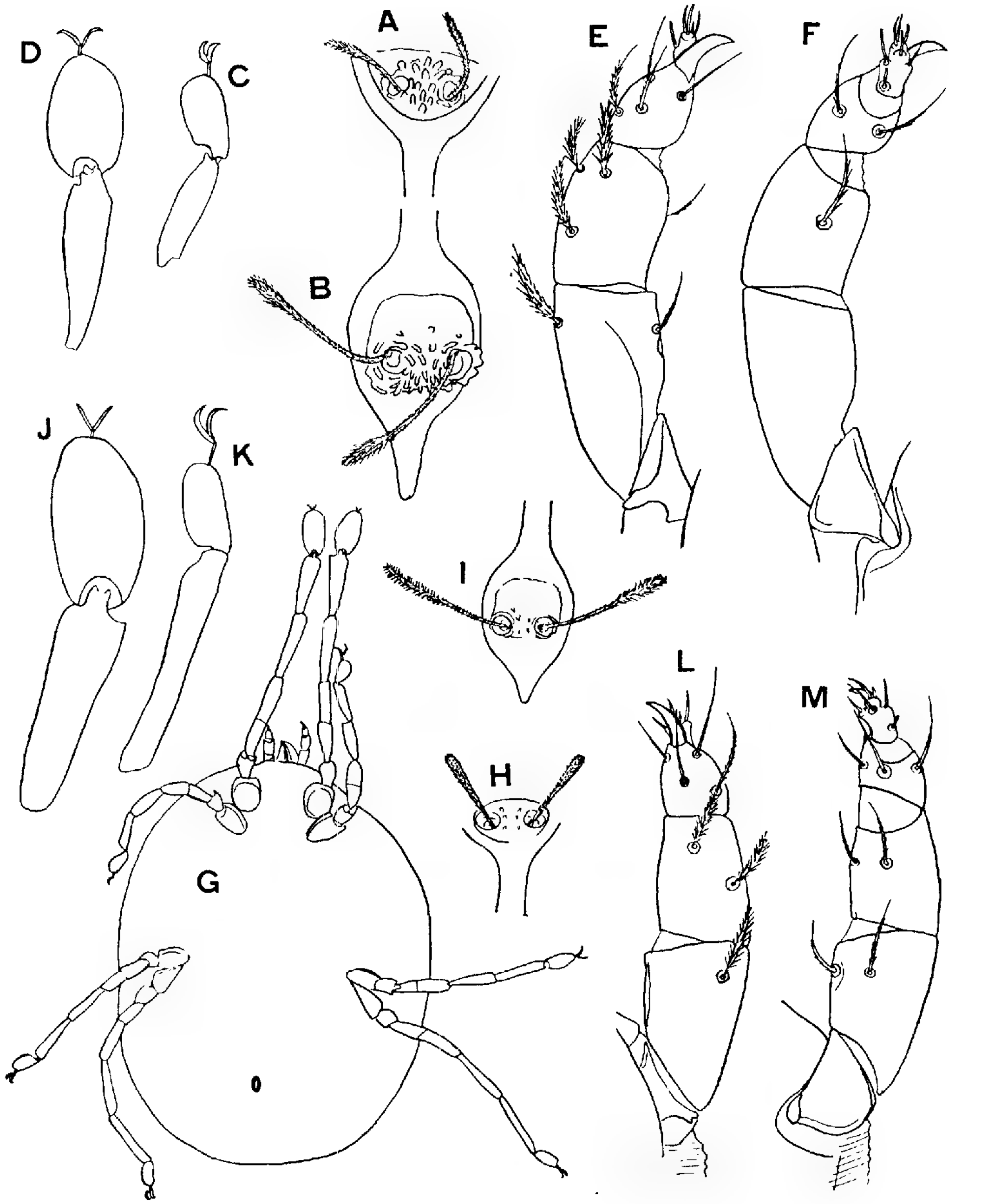

Fig. 7

Sphaerotarsus—A–F, *S. ripicolus* (Wom. 1934), A–D adult: A, anterior sensillary area; B, posterior sensillary area; C, tarsus II and metatarsus II, outline; D, tarsus IV and metatarsus IV, (♂) outline; E–F, nymph; E, palp from above; F, palp from below. G–M, **S. leptopilus** n. sp., nymph: G, outline, entire, ventral; H, anterior sensillary area; I, posterior sensillary area; J, tarsus I and metatarsus I, outline; K, tarsus IV and metatarsus IV, outline; L, palp, above; M, palp, below. (A-B; C-D; E, F, L, M; H-I; J, K, to same magnification.)

finely ciliate sensillae, anterior sensillae 22 μ long, posterior 34 μ; distance between centres of sensillae 163 μ. Eyes 1 + 1, behind middle of crista. Palpi as figured. Dorsal setae numerous, brown, elongate-ovoid, 3-flanged, with serrations, and small for genus, 14-30 μ long, the posterior setae being the longer. Dorsal setae without the crossbars present in *S. ripicolus*. Ventral setae posteriorly similar to dorsal, anterior to anus elongate (fusiform) with long strong ciliations, 14-20 μ long. Legs: I 655 μ long, II 465 μ, III 500 μ, IV 585 μ (including coxae), tarsus I 95 μ long by 52 μ across, metatarsus I 129 μ long, tarsus IV 56 μ long by 24 μ high, metatarsus IV 136 μ long.

Locality—South Australia—Victor Harbour, by sweeping tea-tree along Hindmarsh River, January 1934, one nymph (type) (H. W.).

Remarks—Closest to *S. ripicolus*, with which it was originally taken, but differs in the form of the dorsal setae, and in the dimensions of sensillae. The single nymph was among the syntypes of *S. ripicolus*.

SPHAEROTARSUS ALLMANI Womersley 1936 Fig. 6, M-U; 8, A-J

=*Sphaerotarsus allmani* Wom. 1936, J. Linn. Soc., Lon (Zool.), **40**, 269, 119.

Redescription of Adult, fig. 6, M-Q; 8, A-D—Red. Oval, somewhat pointed anteriorly, and with prominent shoulders. Length 1·1 mm., width 0·7 mm. Crista linear with anterior and posterior sensillary areas, each with two somewhat clavate finely ciliate sensillae, anterior sensillae 27 μ long, posterior 75 μ, distance between centres of sensillae 290 μ. Eyes 1 + 1, behind middle of crista. Palpi as in nymph. Dorsal setae numerous, brown, short, 3-flanged, without crossbars, with serrations, 16-20 μ long; ventral setae posteriorly similar to dorsal, anterior to anus a short oval, 16-19 μ long, with long ciliations. Legs: I 1,155 μ long, II 705 μ, III 760 μ, IV 1,050 μ (including coxae); tarsus I 154 μ long by 73 μ high, metatarsus I 205 μ long; tarsus IV (♂) nearly spherical, 148 μ long by 127 μ across, metatarsus IV 209 μ long. No genital discs.

Description of Nymph, fig. 6, R-U; 8, E-J—Red. Shape as in adult. Length 0·77 mm., width 0·5 mm. Crista as in adult, anterior sensillae 20 μ long, posterior 62 μ, distance between centres of sensillae 194 μ. Eyes as in adult. Palpi as figured. Dorsal setae similar to adult, but more elongate, 18-30 μ long, ventral setae posteriorly similar to dorsal, anterior to anus elongate-oval, with long strong ciliations, setae 15-20 μ long. Legs: I 835 μ long, II 485 μ, III 525 μ, IV 715 μ (including coxae), tarsus I 109 μ long by 41 μ across, metatarsus I 167 μ long, tarsus IV 60 μ long by 26 μ high, metatarsus IV 167 μ long.

Locality—New South Wales: Bathurst, under fallen leaves, 31 May 1934, one adult ♂ (type) and two nymphs (S. L. A.).

Sphaerotarsus claviger n. sp. Fig. 6, V-Y; 8, M-Q

Description of Adult—Colour red. Oval in outline, somewhat pointed anteriorly, and with prominent shoulders. Length 1·315 mm., width 0·755 mm. Crista linear with anterior and posterior sensillary areas, each with two clavate, finely ciliate sensillae, anterior sensillae 20 μ long, posterior 63 μ, distance between

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Fig. 8

Sphaerotarsus—A–J *allmani* Wom. 1936, A–D adult: A, anterior sensillary area, B, posterior sensillary area; C, tarsus I and metatarsus I, outline; D, tarsus IV and metatarsus IV (♂), outline; E–J, nymph; E, anterior sensillary area; F, posterior sensillary area; G, tarsus I and metatarsus I, outline; H, tarsus IV and metatarsus IV, outline; I, palp above; J, palp, below. K–Q, **claviger** n. sp., adult: K, outline, entire, dorsal; L, anterior sensillary area; M, posterior sensillary area; N, tarsus I and metatarsus I; O, tarsus IV and metatarsus IV, (♀) outline; P, palp, above; Q, palp, below. (A, B, E, F, L, M; C, D, N, O; G, H; I, J, P, Q to same magnification.)

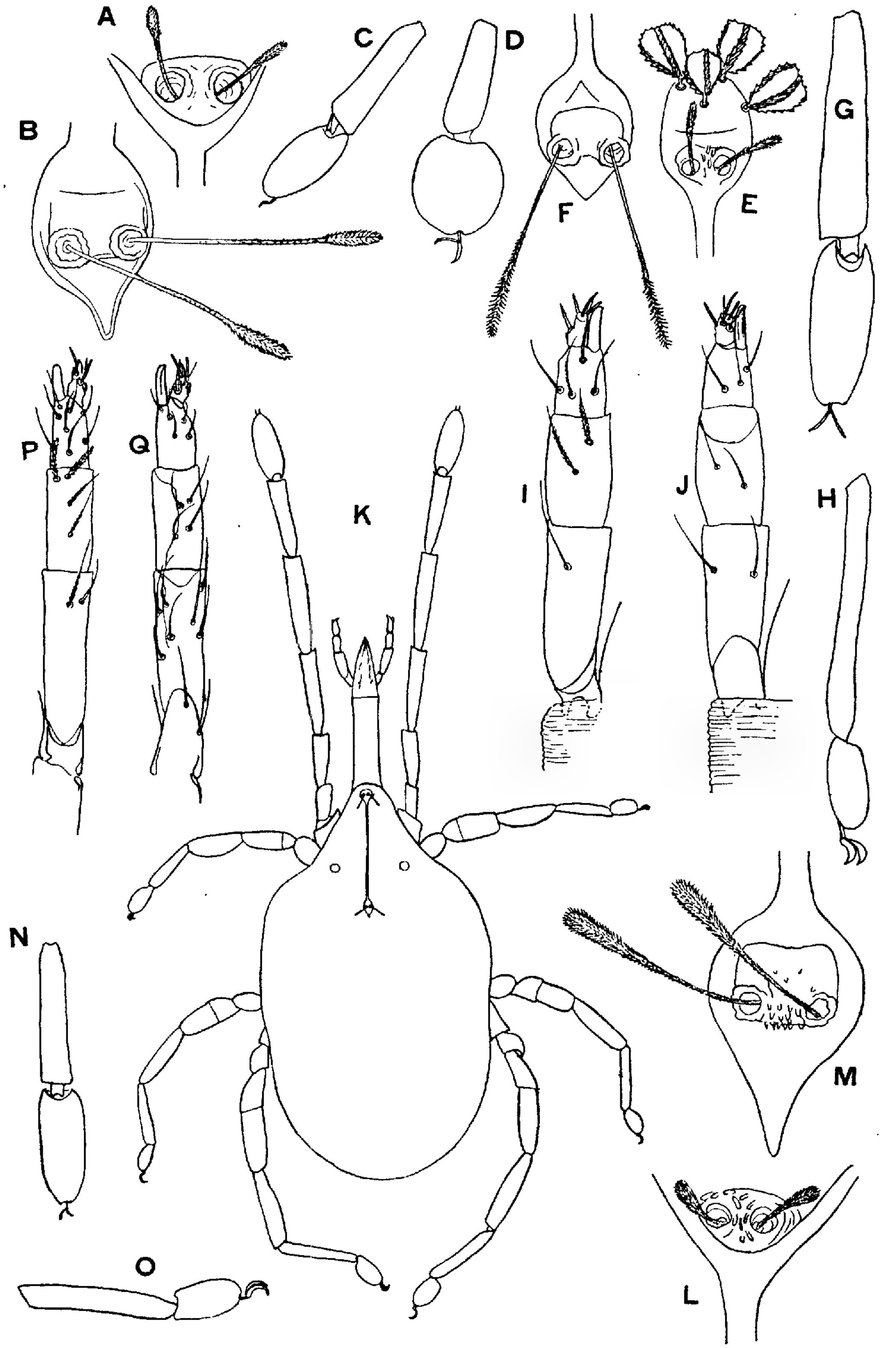

Fig. 8

centres of sensillae 352 μ. Eyes 1 + 1, behind middle of crista. Palpi as figured. Dorsal setae numerous, brown, short, 3-flanged, the dorsal flange being fairly broad, without crossbars and with serrations, setae 16-21 μ long. Ventral setae posteriorly similar to dorsal, anterior to anus oval, with long strong ciliations, setae 15-22 μ long. Legs: I 1,335 μ long, II 805 μ, III 880 μ, IV 1,205 μ (including coxae); tarsus I 178 μ long by 66 μ across, metatarsus I 242 μ long, tarsus IV (♀) 106 μ long by 49 μ high, metatarsus IV 247 μ long.

Locality—New South Wales: Bathurst, "under bark," 28 June 1932, ♂ (S.L.A.)

Remarks on the Genus Sphaerotarsus

The dorsal setae vary somewhat in form and size on different parts, especially so in the nymph. In the figures given, a typical dorsal seta, from the anterior two-thirds in each case, is shown. Those of the posterior part of the dorsum are more elongate than those more anterior.

The specific characters of most value are the structure and dimensions of the sensillae, and the character of the dorsal setae. The genus is, at present, confined to Australia.

Key to the Species of Sphaerotarsus

1 Posterior sensillary setae 1·5 x as long as anterior. Dorsal setae elongate-oval, length:breadth = 2·5:1. (Anterior sensillae 22 μ long, posterior 34 μ.) **S. leptopilus** n. sp

Posterior sensillary setae 2·0 x as long as anterior, or more. 2

2 Posterior sensillary setae 2·0 x as long as anterior. Dorsal setae broadly ovoid, narrowing slightly distally. (Anterior sensillae 22 μ, posterior 45 μ.) *S. ripicolus* (Wom. 1934)

Posterior sensillary setae about 3·0 x as long as anterior. 3

3 Dorsal flange of dorsal seta comparatively narrow, less than one-third breadth of seta, and with (generally) four longitudinal rows of serrations. On ventral surface of dorsal seta is a very broad clear central area. Posterior sensillae widest a little away from their distal end. *S. allmani* Wom. 1936

Dorsal flange of dorsal seta comparatively broad, more than one-third of breadth of seta, and with (generally) 6 longitudinal rows of serrations. The central clear area on the ventral surface of the dorsal seta is narrower. Posterior sensillae widest right at their distal end. **S. claviger** n. sp.

Summary

In this paper the family Smarididae Kramer 1878 is reviewed and the generic characters evaluated. The genera *Smaris* Latreille 1796, *Fessonia* von Heyden 1826, *Hirstiosoma* Womersley 1934, and *Sphaerotarsus* Womersley 1936 are included, but *Microsmaris* Hirst 1926 is excluded (it belonging to the Erythraeidae). The genus *Smaris* includes *S. squamata* (Hermann 1804) from Europe, *S. depilata* (Berl. 1888) from South America and *S. prominens* (Banks 1916) from Australia. *Sphaerotarsus* has four species—*S. ripicolus* (Womersley 1934), *S. allmani* Womersley 1936, **S. leptopilus** n. sp., **S. claviger** n. sp., all from Australia. *Fessonia* is at present restricted to *F. papillosa* (Hermann 1804) from Europe. *Hirstiosoma* contains *H. scalaris* Womersley 1934 and **H. tasmaniensis** n. sp. from Australia, *H. novae-hollandiae* Womersley 1936 from New Zealand; *H. ampulligera* (Berlese 1887) from Europe and (doubtfully) South America, *H. sericea* (Say 1821, Jacot 1938) and indet. sp. (Jacot 1938) from North America.

The first larval Smaridid, that of *S. prominens* (Banks), is described. It has been reared through the resting or pupal stage to the nymph which has been correlated morphologically with the adult. The nymphs of the Australasian species of *Hirstiosoma* and *Sphaerotarsus* are described and correlated (on morphology) with the adults.

GASTROPODA
FROM THE ABATTOIRS BORE, ADELAIDE, SOUTH AUSTRALIA
TOGETHER WITH
A LIST OF SOME MISCELLANEOUS FOSSILS FROM THE BORE

By N.H. LUDBROOK

Summary

The Abattoirs Bore has been an object of interest since its very rich fossiliferous material was collected in 1919 by the late Sir Joseph Verco and the late Professor Howchin. The present paper deals with the remaining groups to be considered in completing the list of species from the Bore represented in the Fate Collection. The writer is entirely dependent upon information given in conversation with Sir Joseph Verco relating to the manner of collecting and the depths from which the material was obtained. Notes by Verco, in my possession, are of conchological interest only; as the fossil species were unfamiliar to him, remarks were made on the outstanding features of shells, many of which were already described by Tate and other workers on Tertiary fossils from Victoria, Tasmania and South Australia.

GASTROPODA FROM THE ABATTOIRS BORE, ADELAIDE, SOUTH AUSTRALIA TOGETHER WITH A LIST OF SOME MISCELLANEOUS FOSSILS FROM THE BORE

By N. H. Ludbrook

[Read 8 May 1941]

Plates IV and V

INTRODUCTION

The Abattoirs Bore has been an object of interest since its very rich fossiliferous material was collected in 1919 by the late Sir Joseph Verco and the late Professor Howchin. The present paper deals with the remaining groups to be considered in completing the list of species from the Bore represented in the Tate Collection. The writer is entirely dependent upon information given in conversation with Sir Joseph Verco relating to the manner of collecting and the depths from which the material was obtained. Notes by Verco, in my possession, are of conchological interest only; as the fossil species were unfamiliar to him, remarks were made on the outstanding features of shells, many of which were already described by Tate and other workers on Tertiary fossils from Victoria, Tasmania and South Australia.

The writer has always felt that the information available to her was unsatisfactory from a stratigraphical viewpoint; Verco stated that a dray-load of fossiliferous sand, from depths of 400-500 feet, heaped beside the Bore, had been collected and the mollusca sorted out by him. A preliminary glance at the numerous species revealed that some, hitherto considered as restricted to the Barwonian in Victoria, appeared with a predominantly Pliocene assemblage. It seemed likely that the boring had penetrated more than one horizon, and an admixture of faunas resulted from an indiscriminate dumping of the material before it could be collected by someone interested primarily in stratigraphy. After listing the Pelecypoda and describing new species (34), the writer deferred work on the Gastropoda until more reliable data could be used as a basis.

Howchin and Parr (20) have since published details of the Foraminifera from the Bore, together with the driller's log, indicating that several horizons had been penetrated before the boring stopped at 820 feet. This would appear to support the writer's earlier conclusion that, as a contribution to stratigraphy, the mollusca were so confused as to be of relatively little value. More recently, through the courtesy of the South Australian Mines Department, the writer has been able to examine material from several other borings near Adelaide, all collected carefully from various depths. While none of them is as rich in the number of species as the Abattoirs, sufficient indication has been given that the Abattoirs Bore mollusca, with a few possible exceptions, represent a single stage. It is likely that they came from depths of about 360 feet to 500 feet, the "grey sand" horizon, and that the yellow underlying Miocene (20) is not represented in the mollusca. Homogeneity in the state of preservation and colour, however, is an insufficient and misleading indicator of a single stage, and in the deposits underlying the Adelaide Plains cannot be considered as such.

AGE OF THE MATERIAL

Difficulty is generally experienced in correlating Tertiary horizons in Southern Australia. Some workers have found it difficult to agree on the relative positions of numerous isolated beds, and others have, as the occasion demanded, changed their opinions as a result of increasing knowledge of the geographical and stratigraphical range of species; it is partly due to the consideration of some zoological groups to the exclusion of others, particularly with the foraminifera and mollusca. It should be possible, as Finlay and Marwick have found in New Zealand (14), to take both the macro- and micro-faunas into consideration and eliminate apparent inconsistencies.

The "grey sand" horizon under consideration here is the "Adelaidean" (Pliocene), appearing in many borings near Adelaide at somewhere near the 350-foot level. The relative position of these beds has always seemed doubtful, mainly because only the larger and more common species were identified. At first glance, a close relationship to the Kalimnan of Eastern Victoria seems obvious. The writer (21) has expressed the view that both the Kalimnan and Adelaidean stages are Lower Pliocene in age; Hall and Pritchard (16) and Chapman (1, 4) have identified the Adelaidean with the Kalimnan, though in a recent note (20) the latter has stated that its "position in the vertical scale appears to be better indicated by the comprehensive series of the foraminifera," and he agrees with Howchin that the beds are younger than Kalimnan (though not stating, as Howchin does (18, 19, 20) that they are Upper Pliocene). In an earlier paper (9) Cotton and the writer followed Howchin and referred Abattoirs Bore species of *Turritella* to the Upper Pliocene; these belong to the Adelaidean stage. Singleton classifies the Adelaidean as (?) Middle Pliocene (25).[1]

The evidence of the foraminifera cannot be overlooked, but it is doubtful whether, from early Pliocene upwards, they alone can be conclusive. Finlay and Marwick (14) have found that New Zealand Pliocene stages are indicated principally by the mollusca, and the same has been the case hitherto in Australia. With the Adelaidean stage, to the fauna of which the Abattoirs Bore makes the largest contribution, useful results are obtainable by considering the foraminifera and mollusca along parallel lines. Parr (24) has made an interesting analysis of the Kalimnan and Adelaidean foraminifera, which, from the point of view of the age of the Adelaidean, could be strengthened by comparison with the microfaunas of Pliocene localities nearer geographically to the Adelaidean.

From an analysis of the mollusca and the evidence of the foraminifera, the writer considers the Adelaidean a slightly younger stage than the Kalimnan. To adjust the Adelaidean, Werrikooian and Kalimnan to the European time-scale is not easy; if the Kalimnan is accepted as Lower Pliocene and the Werrikooian as Upper Pliocene, to place the Adelaidean without qualification in Middle Pliocene is to convey the impression that the Adelaidean provides a single link between the Kalimnan and the Werrikooian. This is far from being the case, many of the Adelaidean mollusca being restricted Kalimnan species and very few Werrikooian species are found. Since the Adelaidean beds are thicker than those of the type Kalimnan area, careful investigation of further borings may show that the Adelaidean represents a longer time range than the Kalimnan and should be classified as Lower-Middle Pliocene.

CONDITIONS OF DEPOSIT

The unusual richness, specifically and numerically, of narrow, highly fossiliferous beds of the Adelaidean stage invites comparison with thick shelly deposits on certain beaches today. Mr. B. C. Cotton states that under South Australian conditions, shells are deposited at the north-eastern part of a beach, preferably in a sheltered bay or estuary. The Abattoirs and other richly fossiliferous bores in the Adelaidean show similar conditions of deposit to those of the Outer Harbour at the present day. The maximum thickness is about 200 feet, laid down

[1] Dr. Singleton's recent publication, "The Tertiary Geology of Australia," Proc. Roy. Soc. Vict., **53**, (1), (n.s.), 1941, came to hand after the present paper had been submitted for publication.

under conditions of depression contemporaneous with early stages of the step-faulting from the Mount Lofty Ranges to St. Vincent Gulf. The gastropod genera represented indicate much warmer climatic conditions than those of the present day or of the Werrikooian, and many new species exhibit close relationships, both generically and specifically, with Recent shells of tropical Queensland to which they are possibly ancestral.

ANALYSIS OF THE GASTROPOD FAUNA

Of the 200 gastropod species, 67 occur in the Kalimnan of Victoria, either in the Gippsland Lakes area or at localities accepted as contemporaneous with the type; 16 are known previously only in the Barwonian; three are restricted to South Australian Lower Pliocene horizons; five are found elsewhere only among the "Murray Desert" (33) fossils (possibly exactly contemporaneous with the Adelaidean); 44 are peculiar to the horizon and 22 are identical with or close to Recent species not occurring in the Kalimnan; the rest are of doubtful limits (such as *Baryspira pseudaustralis* which occurs in the Barwonian, in the "Murray Desert" fossils and in the Adelaidean), or are indeterminate specifically. Of the species in common with the Kalimnan, about 22 appear to be restricted. The Adelaidean apparently has about 10% more of its gastropod species living than has the Kalimnan. This cannot be taken as a significant percentage in view of the limited geographical distribution of some of the species in question and the likelihood of many of them proving distinct as more material becomes available for comparison.

MISCELLANEOUS FAUNA

Various oddments collected with the mollusca have been listed, though the bryozoa appear to have been completely overlooked, and no information is available. Other phyla represented are consistent with species from the Kalimnan.

NOMENCLATURE

It is felt that some explanation is needed of obvious inconsistencies in the use of generic names. This list provides a working basis for comparing the fauna of the Adelaidean with those of other horizons. As far as is possible, names in present use have been employed, Cotton (8) being followed for Recent shells. Considerable difficulty arises with the fossil species. Australian workers generally have been conservative and little revision of genera has been done. To alter some generic names without investigating the group as a whole is undesirable. From a palaeontological viewpoint, the genus and subgenus method used with the Turritellidae is the most satisfactory, being intelligible to the geologist and sufficiently accurate for the specialist, and is consistent with modern trends in systematics (35).

ACKNOWLEDGMENTS

The writer wishes to express indebtedness to Mr. T. Iredale, of the Australian Museum; Mr. B. C. Cotton, of the South Australian Museum; Sir Douglas Mawson, Dr. C. T. Madigan, Miss I. Crespin, Mr. F. A. Singleton, and particularly to Miss Joyce Allan of the Australian Museum, for her excellent illustrations.

DESCRIPTION OF NEW SPECIES AND REMARKS ON NOTEWORTHY SPECIES

Holotypes of all new species are lodged in the Tate Collection, Adelaide University; the type locality of all new species is the Abattoirs Bore, Adelaide, South Australia; the geological horizon is Adelaidean, Pliocene, in each case.

Class **GASTROPODA**

Subclass **STREPTONEURA**

Ord. **ASPIDOBRANCHIA**

Subord. **ARCHAEOGASTROPODA**

Superfam. ZEUGOBRANCHIA

Fam. FISSURELLIDAE

Genus Tugali Gray 1843

Tugali infortunatum sp. nov.

(Pl. iv, fig. 1)

Shell thin, small, oblong, low. Apex small but prominent, strongly recurved, situated at about one-quarter from the posterior margin. Shell flatly convex anteriorly, slightly concave below the apex and flattening towards the posterior margin. Sculpture of about 40 primary radiating ribs with fainter secondary ribs rising irregularly between them. Numerous concentric ribs, closer and less prominent than the radials, the radials over-riding the concentrics so that there is no conspicuous granulation. Margin flattened, finely crenulate. Anterior margin sinuate, sinus produced into a faint canal within, corresponding to a thickened anterior rib on the exterior. Length, 4·2 mm.; breadth, 2·5 mm.; height, 1·0 mm.

This distinct species presents one or two unsatisfactory aspects. There are two specimens from the Bore, a larger with the margin completely broken and a smaller which is perfect but obviously immature. The younger is taken as the holotype. The only difference exhibited by the older shell is that the thickened rib from the apex to the anterior border in the juvenile extends only about half-way in the older shell, developing into three normal, radiating ribs with the regular concentrics as in the rest of the shell.

Subord. **RHIPIDOGLOSSA**

Superfam. TROCHACEA

Fam. TROCHIDAE

Genus Clanculus Montfort 1810

Clanculus quadricingulatus sp. nov.

(Pl. iv, fig. 2)

Shell solid, depressed conoidal, falsely umbilicate. Protoconch of one-and-a-half small turns, apex smooth, gradually developing four pronounced lirae; adult whorls four, sculptured with rows of granulose cinguli, four on the penultimate whorl, 13 extending from the suture to the umbilical fissure on the body whorl, the nine on the base being finer, somewhat more closely granulose and more closely situated than the four above the periphery. The granulation of the cinguli develops with the number of the whorls; part of the protoconch and the first adult whorl show smooth cinguli, the second whorl a very fine granulation which becomes increasingly coarser on the third and fourth whorls. Interstices finely axially lirate. Whorls slightly convex, suture depressed, periphery rounded. Aperture oblique, tetragonal; outer lip thick, abruptly lirate within; columella oblique, edge reflexed with one median tubercle and a prominent bifid tooth at the lower edge; umbilical depression relatively deep and narrow, strongly dentate. Height, 6·2 mm.; diameter, 6·9 mm.

A larger specimen, differing slightly from the type, but apparently conspecific with it, shows 10 cinguli on the base and four on the whorl, with an additional very fine spiral lira developed by intercalation.

Clanculus eucarinatus sp. nov.

(Pl. iv, fig. 3)

Shell solid, depressed conoidal, falsely umbilicate. Protoconch small, of one-and-a-half flattened turns, smooth at the origin, gradually developing four spiral lirae which become granulose cinguli on the adult whorls. Adult whorls four, very slightly convex, bearing four cinguli, three of approximately equal size, the fourth immediately above the suture being more strongly developed and producing a distinct carination in the body whorl. Suture deeply canaliculate. Cinguli granulose, interstices axially lirate, three lirae corresponding generally to two granules on the cinguli. Periphery roundly carinate, base convex, with nine fine granulose cinguli with axially lirate interstices. Aperture oblique, tetragonal; outer lip thick, with two rows of denticles, the outer corresponding to the cinguli, the inner about six in number; columella oblique, reflexed, with a bifid tooth at the lower edge; umbilical cavity deep, narrow, dentate. Height, 5·2 mm.; diameter, 5·6 mm.

Genus Phasianotrochus Fischer 1885

Phasianotrochus laxegemmatus sp. nov.

(Pl. iv, fig. 4)

Shell small, acutely conical, falsely perforate. Protoconch of one-and-a-half convex turns; adult whorls five, flat, sculptured with a strong peripheral cord above the suture bearing numerous fine lirae and prominent, fairly widely-spaced tubercles, which are more prominent on the early whorls. Above the cord five equal spiral lirae, broader than interstices, crossed by numerous crowded axial lirae. Suture linear. Base convex with about 11 spiral lirae of unequal size faintly crossed by numerous radial striae. Periphery angulate. Aperture roundly quadrate, somewhat angularly produced in the outer lip, columella arcuate. Height, 4·6 mm.; diameter, 4·1 mm.

Phasianotrochus subsimplex sp. nov.

(Pl. iv, fig. 10)

Shell small, thin, conical, whorls evenly sloping, suture linear, impressed. Protoconch flattened, of two-and-a-half smooth, rounded turns, adult whorls five, sculptured with numerous, crowded, microscopic and sometimes obscure spiral striae, crossed by microscopic oblique axial growth striae. Periphery sharply angulate; base very slightly convex, with about 12 spiral striae, stronger than those on the whorl, and faint but definite oblique axials. Aperture quadrate, slightly produced and angled at the periphery. Columella somewhat curved, with a small tooth at the base. Height, 4·8 mm.; diameter, 3·7 mm.

Genus Calthalotia Iredale 1929

Calthalotia nitidissima sp. nov.

(Pl. iv, fig. 11)

Shell small, thin but solid, imperforate, almost perfectly conical with a slight impression above the suture on the evenly-sloping whorls. Protoconch small, of one-and-a-half turns, adult whorls five, with strong spiral ribs of approximately equal size, increasing from three in the first to seven in the body whorl; interspaces crossed by oblique axial lirae growing more numerous towards the last whorl. In the earlier whorls, an oblique cancellation between and granulation on the ribs is produced; on the last whorl the cancellation gives way to a strong and even granulation, the axials showing relatively fainter on the interspaces. Base convex, with nine narrow, slightly granulose spirals and numerous axials of growth. Aperture trapezate, produced in the outer lip, roundly angled at the periphery, channelled within, following the exterior spiral ribs. Columella slightly curved, with a slight callus. Height, 6 mm.; diameter, 5 mm.

Calthalotia fictilis sp. nov.

(Pl. iv, fig. 14)

Shell small, fairly thin, conical, falsely perforate. Protoconch of one-and-a-half small, smooth turns; adult whorls four, evenly sloping, sculptured with fine, subequal spiral lirae, eight on the body whorl, reticulated by numerous fine, oblique axial lirae of about half the strength of the spirals. Base convex, with eight smooth spirals crossed by minute accremental striae, progressively weakening from the periphery to the umbilical fissure. Periphery angulate, aperture roundly quadrate, outer lip slightly effuse, columella arcuate, expanded at the umbilical fissure. Height, 4·0 mm.; diameter, 3·5 mm.

Observations—This species is slightly variable, particularly in the degree of prominence of the spirals above the suture. The two above the suture in some specimens are more prominent than the rest and produce a slight carination. The number of spirals varies with the size of the specimen. The holotype is, unfortunately, a young shell, larger specimens being broken at the tips. The diameter of a large example is 7·1 mm.

Genus Laetifautor Iredale 1929

Laetifautor obliquicancellatus sp. nov.

(Pl. iv, fig. 7)

Shell fairly small, conical, imperforate. Protoconch and earliest whorls missing, four remaining on the holotype. Aperture approximately one-quarter height of shell. Whorls flat, sloping towards the angular periphery. Sculpture varies on individuals, but consists in the holotype of five strong spiral lirae, increasing to seven on the body-whorl, two being less conspicuous than the others. These are crossed obliquely by equal-sized, strong, sharp axial ridges, producing a rhombic cancellation with deep interstitial pits; points of intersection developed into rounded granules. Base flat, with 10 basal spirals crossed by close, valid radial lirae producing granules nearly twice as frequent as those on the whorls. Columella slightly curved, with tooth at the base. Aperture subquadrate, broken. Height (estimated), 8 mm.; diameter, 6 mm.

Observations—Fragments of larger specimens reveal the regularity of the primary spiral lirae, though the secondary lirae may vary in number.

Laetifautor spinicarinatus sp. nov.

(Pl. iv, fig. 8)

Shell moderately small, fairly thin, broadly conical, imperforate. Protoconch (slightly damaged) of one-and-a-half turns; adult whorls four, slightly concave, anteriorly carinate. Sculpture of three strong spiral lirae on the posterior half of the whorl, two keels on the anterior half, each surmounted by two or three crowded lirae, those on the keel nearer the suture being of equal, those on the further of unequal strength; lirae of both anterior and posterior areas crossed by strong, sharp, oblique axial lirae producing a rhombic sculpture with deep, clearly defined interstitial pits; intersections with spinulose granules. Base flat, with eight strong spirals, faintly crossed and granulated by numerous radial lirae. Aperture rectangular on inner lip, acute-angled on outer lip which is produced into two ridges corresponding to the keels on the periphery. Columella almost straight, with tooth at base. Height, 5·5 mm.; diameter, 4·8 mm.

L. similaris Reeve, is very close to this fossil species.

LAETIFAUTOR sp.

This is a species closely related to *L. spinicarinatus*, but there is no specimen sufficiently complete for an accurate diagnosis to be made. The one shell that is almost complete shows sculptural features approximating very closely to the former from which it differs in that the anterior ribs on each whorl are less strongly developed and can scarcely be described as keels. They are, however, surmounted by lirae in the same manner, and it is probable that the species is merely an aberrant form of *spinicarinatus*.

Laetifautor crebrinodulosus sp. nov.

(Pl. iv, fig. 9)

Shell conical, fairly small, stout, imperforate. Protoconch very small, of one-and-a-half turns, faintly axially lirate; adult whorls six, slightly convex, sculptured with strong spirals, increasing by intercalation from three primary on the first whorl to four primary and three secondary on the body whorl. Spirals narrower than interspaces, crossed by evenly-spaced oblique axials, about 20 on the penultimate whorl, producing granules at the intersections and deep interstitial pits between. Base slightly convex, with seven spirals, equal in width to interspaces, crossed by numerous fine radials producing a faint granulation. Aperture subquadrate, columella oblique, outer lip produced, roughly crenulate within. Height, 7·9 mm.; diameter, 6 mm.

Observations—This species has features in common with *Calliostoma spinulosa*, Tate, *Calliostoma balcombensis* Chapple, and *Thalotia exigua* T. Woods, but is distinct from each.

Laetifautor bicarinatus sp. nov.

(Pl. iv, fig. 13)

Shell rather small, fairly stout, conical, higher than broad, falsely perforate. Protoconch very small, of one-and-a-half turns; adult whorls six, slightly convex in the early whorls, sculptured above the suture with a strong peripheral cord supporting in the body and penultimate whorls four beaded lirae, fewer in number in the early whorls; above this a narrow beaded cord and then four small, strong, beaded, equal lirae. In the early whorls oblique axial lirae are strongly marked, with beads at the junction of axials and spirals and deep interstitial pits between. These become obsolete in the penultimate and body whorls, the effect being that of simple granulation of the spirals. Base flat, with eight spiral lirae of approximately equal size with the interspaces. Aperture (broken) somewhat oblique, subquadrate, about one-quarter height of shell, columella straight. Height, 6·5 mm.; diameter, 4·8 mm.

These specimens are all small. The species is extremely close to *L. spinicarinatus* and is possibly conspecific with it. In general the sculpture of *bicarinatus* is more even, particularly on the keel, and there is a less rugged appearance about the shell generally. The keels are more strongly developed than in *spinicarinatus*.

LAETIFAUTOR sp. 2

Fragments of a large *Laetifautor*, the sculpture of which consists of a broad peripheral carina supporting several beaded threads; a narrower rib above this also surmounted by beaded lirae, and several small beaded lirae of varying size on the posterior portion of the whorl. Base flat, with about 16 spirals crossed and beaded by fine radials of growth.

LAETIFAUTOR sp. 3

Fragments of a large *Laetifautor* similar to the previous species, but differing in the unbeaded nature of the spirals on the whorls and in the smaller number of the basal spirals.

Genus Astele Swainson 1855

Astele fanaticum sp. nov.

(Pl. iv, fig. 6)

Shell depressed-conical, perforate; whorls somewhat concave, sloping. Protoconch small, slightly broken in the holotype, of two depressed rounded turns; adult whorls three, flattened beneath the suture in an almost horizontal narrow plane, then steeply sloping for the rest of the whorl. Periphery carinate. Sculpture of fine approximately equidistant spiral threads, four on the infra-sutural plane, nine on the sloping section of the whorl, 14 on the base of the body whorl. Interstices broader than lirae, crossed by crowded, very fine axial threads following the lines of growth. Base convex. Umbilicus deep. Aperture subovate; outer lip thin, angulate, following the peripheral carina. Height, 6·1 mm.; diameter, 7·0 mm.

Genus Pulchrastele Iredale 1929

Pulchrastele planiconicum sp. nov.

(Pl. iv, fig. 12)

Shell moderately small, conical, higher than broad, narrowly perforate, whorls evenly sloping, flattened. Protoconch small but prominent, of two turns; adult whorls six, sculptured above the suture with a strong peripheral cord which supports beaded lirae increasing in number to five on the body whorl; above the cord prominent lirae increasing by intercalation from three on the early whorls to five on the body whorl. Spirals crossed by numerous strong axial lirae producing a cancellation in the early whorls with granules on the spirals; the axials become relatively more frequent and less prominent in the last whorls and the cancellation develops into a mere granulation. Base flat, with 11 primary spiral lirae and one or two faint secondary lirae on the interspaces, somewhat granulose near the umbilicus, faintly crossed by numerous radial striae. Aperture broken, quadrate, produced in the outer lip and angled at the peripheral cord; outer lip thin; inner lip straight with a slight denticle at the base. Height, 8 mm.; diameter, 5·5 mm.

Pulchrastele tuberculatum sp. nov.

(Pl. iv, fig. 15)

Shell small, broadly conical, narrowly umbilicate, stout, whorls evenly sloping. Protoconch slightly broken, very small, flattened, of one-and-a-half turns; adult whorls five, sculptured with a thick cord supporting four small tuberculate lirae at the sharply-angled periphery; above the cord three narrow spirals with small prominent tubercles on each whorl, about half as wide as the interspaces; number of tubercles on the periphery increases on each whorl, there being about 40 on the periphery of the body-whorl in the holotype. Aperture relatively small, rhombic, produced and sharply angled in the outer lip; inner lip damaged but showing a callus reflected towards the umbilicus. Base flat, with eight strong spirals, narrower than interspaces; umbilical spirals tuberculate. Height, 4·8 mm.; diameter, 4·5 mm.

Genus Ethminolia Iredale 1924

Ethminolia perglobosa sp. nov.

(Pl. iv, fig. 5)

Shell solid, obtuse, globose conic, perforate. Protoconch somewhat flattened, turbinate, of three very small turns; adult whorls three, convex, sculptured with numerous fine spiral striae, crossed irregularly and frequently by faint, oblique striae of growth. Periphery rounded, base convex, sculptured with spiral striae as whorls, striae broadening somewhat and deepening near the umbilicus. Aperture subcircular, outer lip moderately thick, obscurely crenulate within;

inner lip arcuate, with faint suggestion of tooth at base. Height, 4·6 mm.; diameter, 5·8 mm.

Observations—The sculpture of this species varies somewhat, some specimens presenting finer spiral striae than others. *Ethminolia probabilis* Iredale is the closest Recent species.

Fam. TUBIOLIDAE

Genus PARTUBIOLA Iredale 1936

Partubiola depressispira sp. nov.

(Pl. iv, fig. 16)

Shell very small, subdiscoidal, depressed, broadly umbilicate, tricarinate. Protoconch very small, slightly elevated, helicoid; adult whorls three, at first more or less rounded; body whorl with three regularly disposed carinae with flattened areas between; that between the suture and the carina below it decidedly sunken. Spiral sculpture of fine, more-or-less regular lirae, about six between each two keels; axial sculpture of indistinct growth lines on the spire faintly reticulating the spirals; axials much more prominent on the base, strongly reticulating the spirals in the umbilical area. Base flattened near the keel, convex towards the umbilicus. Umbilicus broad, showing all the whorls. Aperture wide, roundly quadrate, peristome not continuous; outer lip attached to whorl above at median carina, overhanging aperture above, excavate below. Height, 1·5 mm.; diameter, 3·5 mm.

Partubiola varilirata sp. nov.

(Pl. iv, fig. 17)

Shell very small, subdiscoidal, depressed, broadly umbilicate. Protoconch very small, of about two helicoid turns, elevated; adult whorls three, with one carina at the posterior one-third of the whorl. Area between suture and carina flat, depressed, sculptured about eight very fine spiral lirae; below the carina whorls convex, spiral lirae stronger and more widely separated. On the body-whorl about 12 subequal, strong lirae extend from the carina to the umbilicus, where they disappear; umbilical area with very faint spirals. Axials faint or absent in the region of strong spirals, finely reticulating the fine spirals below the suture and in the umbilicus. Umbilicus broad, showing all the whorls; aperture rounded, peristome not entire; outer lip overhanging above and excavate below. Height, 1·3 mm.; diameter, 3·5 mm.

Observations—This species is very like *P. blancha* Iredale, from which it differs in sculpture and size.

Fam. STOMATELLIDAE

Genus HERPETOPOMA Pilsbry 1889

Herpetopoma pliocenica sp. nov.

(Pl. iv, fig. 18)

Euchelus baccatus Chapman 1914 non Menke sp.; Chapman, Proc. Roy. Soc. Vict., **26**, (2). (n.s.), 316.

Shell small, globose-conical, thin, perforate. Protoconch very small, of one-and-a-half flatly convex, axially lirate turns; adult whorls 4, convex, body whorl globose. Aperture about three-quarters as high as spire, suture deep, impressed. Sculpture of equidistant, granulose, spiral ribs, three on the post-embryonic whorl, increasing by intercalation to nine on the penultimate whorl; 13 on the body whorl extending evenly from the suture to the umbilicus. Interspaces wider than ribs, adorned with fine, regular, axial threads which are more distinct in the earlier whorls. Granules on the ribs correspond to threads on the interspaces. Periphery rounded. Aperture circular, entire; outer lip thin, crenate within; inner lip reflexed; columella rounded, smooth. Umbilicus narrow, deep. Height, 9 mm.; diameter, 7 mm.

Observations This species is very like, and is probably ancestral to *H. baccata* (Menke); the sculpture of *H. pliocenica* is finer and the axial threads sharper and more clearly defined on most specimens. *H. pliocenica* is a smaller shell, less than half the size of the Recent *baccata*. A difference between the Pliocene species and the Recent was recognised by Chapman who states, "The Mallee example appears at first sight to have a neater and more concise ornament than fresh shells of the living species."

Fam. LIOTIIDAE

Genus DOLICROSSEA Iredale 1924

DOLICROSSEA LABIATA (Tenison Woods 1876)

Five small examples of this species occur; it is represented in the Barwonian as *D. sublabiata* (Tate). The Adelaidean specimens approximate more closely to the Recent *labiata* than to *sublabiata* and are smaller than either.

Superfam. NERITACEA

Fam. PHENACOLEPADIDAE

Genus PHENACOLEPAS Pilsbry 1891

Phenacolepas tela sp. nov.

(Pl. iv, fig. 19)

Shell moderately small, thin, oval, fairly low; apex prominent, slightly recurved, situated one-eighth distance from posterior border. Sculpture absent near apex, elsewhere of 80-90 radial ribs, with about 11 raised, sharp, concentric ridges, between which are very fine, crowded, inconspicuous, concentric lirae. Ridges crowded posterior to the apex, widely spaced anteriorly. Margin of shell raised slightly in the central portion, smooth; interior of shell smooth with faint irregular grooves corresponding to growth lines and radial ribs. Length, 7·5 mm.; breadth, 5·2 mm.; height, 2·5 mm.

Ord. **PECTINIBRANCHIA**

Subord. **TAENIOGLOSSA**

Section PLATYPODA

Superfam, RISSOACEA

Fam. RISSOIDAE

Genus **Kaurnella** nov.

Shell small, stout, imperforate, subglobose-conical. Apex paucispiral, smooth, small. Spire short, body whorl large; suture linear, whorls spirally lirate; aperture subcircular, entire. Genotype *Kaurnella denotata* sp. nov.

Kaurnella denotata sp. nov.

(Pl. v, fig. 1)

Shell small, fairly stout, subglobose-conical, imperforate. Spire small, body whorl large and globose. Protoconch of one-and-a-half very small, flatly convex, smooth, shining turns; adult whorls four, rapidly increasing, inflated; suture linear, deep. Whorls sculptured with numerous fine, spiral lirae, two of which are more prominent than the rest, crossed by inconspicuous, fine, oblique axial striae. Each whorl absolutely semi-ribbed, seven on the last whorl, producing a more-or-less obscure tuberculation on the prominent lirae. Base convex, lirate. Aperture subcircular; outer lip thickened; columella very slightly concave. Height, 3·1 mm.; diameter, 2·2 mm.

Superfam. CERITHIACEA

Fam. STRUTHIOLARIIDAE

Genus TYLOSPIRA Harris 1897

TYLOSPIRA CORONATA MARWICKI (Finlay 1931)

Pelicaria coronata Tate: Tate 1890, Trans. Roy. Soc. S. Aust., **13**, (2), 176; *marwicki* Finlay 1931, Trans. N.Z. Inst., **62**, (1), 17; *howchini* Cotton 1934, S.A. Nat., **16**, (1), 7; Howchin 1936, Trans. Roy. Soc. S. Aust., **60**, 19; *coronata* Tate subsp. *howchini* Cotton, Howchin 1935, Trans. Roy. Soc. S. Aust., **59**, 85, 90.

Tylospira coronata Tate: Dennant and Kitson, 1903, Rec. Geol. Surv. Vict., **1**, (2), 144.

Confusion appears to have arisen over the identification of this common and restricted Kalimnan species, probably on account of the few specimens examined by various authors. In the opinion of the writer the Adelaidean examples are merely geographical variants of *Tylospira coronata* as it occurs in Victoria. Examination of a large series of these shells—and they are extremely abundant—shows that the species is considerably variable between localities, those from the Adelaidean departing furthest from the type. The Adelaidean specimens, in general, show a weaker tendency to sulcation at the suture, but this, together with the height of the spire, is very variable in individuals from the same locality. Tate himself identified Adelaidean specimens with *coronata*. However, the writer acknowledges that differences occur, principally in the degree of sulcation and shape of the whorls, sufficiently general to permit the classification of the Adelaidean examples as a subspecies.

Finlay's name (no figure) has priority over Cotton's; the latter was evidently unfamiliar with the species and figured an extremely eroded shell. *Tylospira* is the correct genus.

Fam. CERITHIIDAE

Genus CLYPEOMORUS Jousseaume 1888

Clypeomorus bivaricatus sp. nov.

(Pl. iv, fig. 20)

Shell moderately small, turreted, spire elongate. Protoconch of one-and-a-half small, inconspicuous turns, sharp at the origin; adult whorls nine, angulate at the posterior third, almost vertical in the anterior two-thirds; angulation more pronounced in the early whorls; body whorl more or less rounded, convex. Suture linear, impressed. Sculpture of curved axial costae, about 15 on the penultimate whorl, tuberculate at the angle, crossed by about six strong spiral lirae in the anterior two-thirds, and four much weaker, more closely-set lirae above the shoulder; the number of lirae increases slowly by intercalation from two on the earliest whorls. Two varices on each whorl, fairly prominent, one at the aperture. Sculpture finer on the base, about six fine spiral lirae extending from the columella. Aperture ovate, with a short, recurved anterior canal; outer lip thin, columella concave, inner lip with a thin callus. Height, 11 mm.; diameter, 3·1 mm.

Observations—The sculpture of this species is variable, its characteristics in general being that of tuberculate axial costae crossed by spiral lirae of unequal strength; angulation of the whorls is always present, at least in the early whorls.

Clypeomorus multiliratus sp. nov.

(Pl. iv, fig. 22)

Shell moderately small, turreted, spire elongate. Protoconch of three relatively large, convex whorls; adult whorls seven, convex, sculptured with prominent curved axial costae, increasing from seven in the first adult whorl to 11 in the body whorl. Spiral sculpture of numerous fine lirae, wider than interspaces; about 15 on the penultimate whorl. Three varices of each whorl, only slightly more prominent than the costae. Sculpture on the base comparatively weak, about seven widely-spaced, faint spiral lirae being developed on an otherwise smooth surface. Aperture subovate, outer lip thin, broken in the holotype; canal short, slightly recurved; columella smooth, curved. Height, 9·7 mm.; diameter, 3·6 mm.

Genus **Adelacerithium** nov.

Shell small, elongate-turreted, spirally and axially ribbed. Apex prominent, paucispiral. Suture impressed, whorls flat. Columella with a strong twist or fold; aperture somewhat pyriform; outer lip not expanded, thin. Genus recalling *Ataxocerithium* but lacking pagodoid formation and possessing vertagoid columellar plait. Genotype *Adelacerithium merultum* sp. nov.

Adelacerithium merultum sp. nov.

(Pl. iv, fig. 23)

Shell fairly small, elongate-turreted. Tip of protoconch broken, one smooth convex whorl remaining; adult whorls 14, flattened; suture deep, impressed. Sculpture of fine, prominent, axial costae crossed by approximately equidistant spiral lirae, with a slight granulation at the intersections; about 24 axial costae on the penultimate whorl, with five spirals; the number of costae increases rapidly at about the seventh adult whorl; earlier whorls show a much coarser cancellation than the subsequent. Aperture broken in the holotype, subpyriform; columella short, with a strong plait; canal short, recurved. Height, 9·5 mm.; diameter, 2·2 mm.

Genus Obtortio Hedley 1899

Obtortio liratus sp. nov.

(Pl. iv, fig. 24)

Shell small, thin, elongate-turreted. Protoconch of one-and-a-half small, smooth turns; adult whorls seven, angulate at the posterior third, sculptured with fine, prominent, spiral lirae below the angle, absent or inconspicuous above; spirals crossed by about 14 curved, axial costae, more prominent in the early whorls and weakening considerably in the body whorl. Whorls varicate. Base spirally lirate, not so strongly as whorls. Aperture subovate, with a very short anterior canal. Height, 5·2 mm.; diameter, 1·7 mm.

Observations—The axial costae vary in intensity and in the degree of curvature or angulation. The angulation is modified in the holotype, but may be pronounced and the costae be somewhat tuberculate at the shoulder.

Genus Cerithiopsis Forbes and Hanley 1849

Cerithiopsis perelongatus sp. nov.

(Pl. iv, fig. 25)

Shell small, very elongate-turreted, whorls flattened. Protoconch of three carinate, smooth, tapering whorls; tip heterostrophic. Adult whorls eight, sculptured with three spiral costae of about equal size with the interspaces, crossed by about 16 axial costae, less conspicuous than the spirals and producing a flattened gemmulation on the spirals. Suture linear; base smooth. Aperture with outer lip broken, columella curved, with a short curved anterior canal. Height, 6·1 mm.; diameter, 1·1 mm.

Paratype—One specimen consists of the last whorls of a much larger shell, the height of which is estimated at 12 mm., the diameter 2·5 mm. The sculpture is consistent with that of the holotype.

Genus TEREBRALIA Swainson 1840

Terebralia fallax sp. nov.

(Pl. iv, fig. 21)

Shell elongate-turreted, of moderate size. Protoconch missing in the holotype; adult whorls 13, the first six convex and cancellate, the posterior half of the whorl more finely cancellate than the anterior; plications develop at about the sixth whorl and become increasingly prominent throughout the rest of the shell. Seven plications to each whorl narrow, curved, crossed by spiral sculpture; spiral sculpture commences in the post-embryonic whorls as fine, thread-like ribs, more prominent in the centre of the whorl and coarser in the anterior half; the ribs become wider and more nearly equal in size in the succeeding whorls; in the early whorls ribs are more or less rounded, in the latter whorls they are flattened and rectangular in section, interspaces correspondingly channelled with vertical sides; narrower than ribs. Each rib in the last whorl supports a fine median striation. Axial sculpture equal to the spiral in the post-embryonic whorls, obsolete in the last whorls. Base spirally lirate. Aperture and body whorl broken, columella concave; a short, slightly recurved anterior canal. Height, 31 mm.; diameter, 11·5 mm.

Paratype—A portion of a small shell has the protoconch intact, of two small globose turns, smooth and shining; succeeding whorls are convex and cancellate as in the holotype.

Observations—The sculpture and shape of this species are very like some forms of *Pyrazus ebeninus,* the common Sydney whelk, but the resemblance is superficial only. The species is not uncommon in the Bore, but no perfect specimen is available; the holotype is the most complete, fragments of two others are larger, about half the size of *Pyrazus ebeninus.*

Genus MANULONA nov.

Shell small, elongate-turreted; protoconch straight, paucispiral, smooth; suture linear; whorls flat, spirally sculptured; sculpture tuberculate; aperture sub-ovate; canal short, almost straight or only slightly reflexed; columella slightly arcuate. Genotype *Manulona arrugosa* sp. nov.

Manulona arrugosa sp. nov.

(Pl. iv, fig. 26)

Shell small, slender, turreted; whorls flat to concave. Apex straight, of two smooth whorls; adult whorls 10, prominently sculptured with a supra-sutural thread above which is a prominent band with about 12 elevated tubercles; above the band, three flattened, beaded lirae, the beads being about twice as numerous as, and very much smaller than the tubercles; interspaces very narrow. Suture linear, irregular. Base striate, aperture sub-ovate, broken in the holotype, with a faint anterior canal. Height, 8·7 mm.; diameter, 2·2 mm.

Manulona lirasuturalis sp. nov.

(Pl. iv, fig. 27)

Shell small, slender, turreted, whorls slightly carinate. Protoconch of two smooth, convex whorls; adult whorls 11. Whorls more or less smooth, faintly axially and spirally striate, with a row of about nine tubercles above the suture giving a carinate appearance to the whorls; below the suture an inconspicuous row of fine, numerous beads. Suture linear, with a single, fine lira imbricating above; the lira shows conspicuously on the periphery of the body whorl. Base spirally striate. Aperture broken in the holotype, columella curved. Height, 9·1 mm.; diameter, 2·2 mm.

Observations—This species is very similar to *M. arrugosa*, from which it differs in its sculpture. The aperture of specimens otherwise less complete than the holotype is shown as subquadrate, with a short anterior canal.

Fam. TRIPHORIIDAE

Genus TRIPHORA (s.l.) Blainville 1828

TRIPHORA (s.l.) spp

The only species of *Triphora* recorded from the Kalimnan is *T. wilkinsoni*, but it seems more than likely that several genera and species may be represented. Adelaidean examples, of which there are two species, do not seem to answer to the description of *wilkinsoni* T. Woods (Proc. Linn. Soc. N.S.W., 1878, 3, 233), although they belong to the same species as some from the Kalimnan. It is desirable to investigate further material, including authentic examples from the Barwonian, before identifying the present specimens in more than a broad sense.

Fam. DIALIDAE

Genus **Mereldia** nov.

Shell small, solid, subulate; apex paucispiral, smooth, dome-shaped; whorls numerous, flattened, striate; aperture relatively small, ovate; columella almost straight, short, smooth. Genus allied to *Diala*, differing in size, apex, and striation of whorls. Genotype *Mereldia incommoda* sp. nov.

Mereldia incommoda sp. nov.

(Pl. v, fig. 3)

Shell small, solid, subulate, whorls with straight sides. Protoconch of two flattened, dome-shaped, smooth, convex whorls; adult whorls nine, flattened, gradually tapering posteriorly; suture linear, impressed. Whorls shining but sculptured with numerous fine spiral striae. Aperture small, ovate; outer lip thin, simple; columella short, straight, smooth. Height, 10 mm.; diameter, 3·6 mm.

Superfam. AGLOSSA

Fam. PYRAMIDELLIDAE

Genus SYRNOLA A. Adams, 1860

Syrnola acrisecta sp. nov.

(Pl. v, fig. 2)

Shell very small, moderately tapering, thin, shining. Protoconch prominent, of two smooth, heterostrophic turns; adult whorls six, moderately rapidly increasing, flattened. Suture canaliculate, impressed. Sides of body whorl almost vertical, base convex, an obscure angulation at the periphery. Aperture elongate-pyriform, columellar fold near the origin, inner lip effuse, slightly expanded below. Height, 3·3 mm.; diameter, 1·1 mm.

Observations—This small species bears strong resemblances to *S. infrasulcata* and *S. jonesiana*; it is somewhat broader than either and is more deeply impressed at the suture.

Genus TURBONILLA Risso 1826

Turbonilla vixcostata sp. nov.

(Pl. v, fig. 6)

Shell elongate-turreted, solid, fairly thin. Protoconch of two prominent somewhat globose heterostrophic turns; adult whorls nine, slightly convex, slowly increasing; suture impressed and well defined. Axial costae about 14, from suture to suture in the early whorls but becoming less conspicuous to the sixth whorl, from which they are obsolete for the rest of the shell; in the last three whorls costae give way to faint axial striae of growth; whorls also very obscurely striated spirally. Aperture subquadrate, elongate; columella almost straight, slightly plicate; outer lip thin. Height, 9·8 mm.; diameter, 2·2 mm.

(?) TURBONILLA sp.

Six specimens of a *Turbonilla*-like shell, all with the early whorls missing. There is no axial ribbing shown on any of the shells, though the most complete shows a suggestion of costae in its first whorl. The species is very like, though not identical with, *T. vixcostata;* however, there is absence of ribbing, the shell is thicker and in the anterior quarter of each whorl there is a suggestion of angulation with a sudden oblique descent to the suture.

Turbonilla subfusca sp. nov.

(Pl. v, fig. 7)

Shell very small, elongate-turreted, thin. Protoconch of two small heterostrophic turns, smooth and prominent; adult whorls seven, slightly convex, the first two of which are not or only obscurely costate. The costae rise towards the end of the second post-embryonic whorl and are almost fully developed in the third; in later whorls the costae are prominent, extending from suture to suture; about 16 costae on the penultimate whorl, slightly oblique and of approximately equal size with the interspaces. Suture impressed, deep. Aperture subquadrate; outer lip parallel to columella, with a downward turn at its junction with the previous whorl; aperture rounded anteriorly. Base without costae. Height, 5·1 mm.; diameter, 1·0 mm.

Observations—*T. subfusca* is somewhat like *T. radicans* Chapman and Crespin, but is a more fragile shell, with more numerous ribs. Its nearest resemblance is to the Recent *T. fusca* Adams, from which it differs in the sculpture of the early whorls, in the shape of the aperture and in possessing flatter whorls.

Fam. EULIMIDAE

Genus EULIMA Risso 1826

Eulima longiconica sp. nov.

(Pl. v, fig. 4)

Shell small, shining, smooth, narrowly conical, very slightly curved. Protoconch of one inconspicuous flattened turn followed by eight adult whorls, nearly straight, slowly increasing. Suture linear, slightly impressed. Aperture ovate, outer lip entire; columella nearly straight, with a slight callus. Height, 5 mm.; diameter, 2 mm.

Observations—The nearest living species to this shell is *E. roegerae* Cotton and Godfrey.

Eulima minuticonica sp. nov.

(Pl. v, fig. 5)

Shell minute, smooth, shining, subulate. Protoconch of two conspicuous, smooth, convex turns; adult whorls 7, straightly sloping; suture linear; body whorl with an obscure angulation. Aperture pyriform; columella slightly concave, reflexed. Height, 3·1 mm.; diameter, 1·0 mm.

Observations—Practically identical in shape with *E. longiconica,* distinguished by smaller size and number and shape of embryonic whorls.

Superfam. CHEILEACEA

Fam. CHEILEIDAE

Genus CHEILEA Modeer 1793

Cheilea adelaidensis sp. nov.

(Pl. v, fig. 8, 9)

Shell considerably broken, size and adult shape indeterminate, elevated; apex anterior, smooth and sharply curved in two turbinate whorls. Shell fairly smooth in the neighbourhood of the apex, central portion of the shell forming a cap with steep sides, rest of the shell apparently more or less flattened and irregular in shape. Sculpture of numerous, very fine, waving, radial lirae slightly wider than interspaces, broken by irregular, concentric lines of growth and crossed irregularly by diagonal radial grooves; sculpture extends from edge of smooth portion surrounding apex to the adult area outside the cap. Internal appendage fairly strong, broken in the holotype. Dimensions (of cap only)—height, 4 mm.; diameter, 6 mm.

Paratype—The internal appendage of the paratype is semi-circular in basal outline, convex in front, fairly wide and showing irregular growth lines.

Observations—Although neither of the two specimens is complete, it is desirable to describe this apparently rare and interesting shell. It differs markedly from either of the two Recent South Australian species, and like *C. occidua* Cotton forming a distinct cap in the early part of the shell, although the sculpture in no way resembles that of *occidua*.

Superfam. CYPRAEACEA

Fam. TRIVIIDAE

Genus ELLATRIVIA Iredale 1931

Ellatrivia wirrata sp. nov.

(Pl. v, fig. 16)

Shell small, thin, globular, narrowed anteriorly, spire conspicuous and globular. Surface of shell sculptured with fairly even, fine, sharp prominent ribs, most extending over the dorsal surface without interruption by medial line, others meeting at an angle in the medial dorsal region. About 35 ribs approach the outer lip over the dorsal surface, approximately 20 of which continue over the thickened, inflected outer lip and denticulate it within; about the same number denticulate the inner lip, extending across the columellar groove. Aperture arcuate, narrow, slightly widened anteriorly. Length, 9 mm.; breadth, 7 mm.; height, 6 mm.

Observations—*Ellatrivia merces* Iredale, the genotype, is very close to *E. wirrata* which is more globular, has a more prominent spire, and closer and finer ribs.

Superfam. DOLIACEA

Fam. CYMATIIDAE

Genus CYMATIELLA Iredale 1924

Cymatiella adelaidensis sp. nov.

(Pl. v, fig. 10)

Shell of moderate size, strong, elongate-fusiform, spire one-and-a-half times height of canal and aperture. Protoconch of three smooth, globose whorls, the first very small, the rest rapidly increasing; adult whorls six, with a strong varix every three-quarters of a volution. Sculpture of prominent, narrow, elevated axial costae, the number varying from four to five on different whorls, between each varix; between the costae numerous irregular striae of growth; axial sculpture crossed by small, narrow, spiral ribs, wider than interspaces, irregular and unequal in size; faint nodulation where the spirals cross the axials. Aperture subovate, with a fairly short, sharply recurved anterior canal; outer lip strongly variced, with elongate denticles more or less in pairs within; inner lip smooth, reflected over columella, faintly nodulose below; columella arcuate. Height, 15 mm.; diameter, 8 mm.

Observations.—Two Pliocene species come close to *C. adelaidensis*, the Upper Aldingan *C. sexcostata* (Tate), which differs in the number of intervariceal costae and in the spiral sculpture, and *Personella clarkei* Chapman and Crespin, which has less prominent axial costae and is not so slender as the Adelaidean species.

Subord. **STENOGLOSSA**

Section RACHIGLOSSA

Superfam. MURICACEA

Fam. MURICIDAE

Genus Murex Linné 1758

Murex peramangus sp. nov.

(Pl. v, fig. 24)

Shell of moderate size, triangularly ovate, imperforate, somewhat squat; spire half length of aperture and canal; body whorl large, with seven varices. Varices stout, prominent, squamose; sculpture of fairly fine, spiral lirae of unequal size, narrower than interspaces, crossed by frequent, finely-waving, axial lirae and foliaceous growth lamellae. Varices foliaceous below; umbilical depression conspicuous. Aperture ovate, outer lip variced; inner lip thickened, reflected over columella; columella arcuate; canal tubular, almost closed, recurved. Height, 33 mm.; diameter, 25 mm.

Observations.—This species appears to be considerably variable in the strength of the spiral lirae and in the height of the spire, and to grade into *M. biconicus* Tate, which is a more elongated shell with a distinct sculpture. A graduated series from the 7-variced, squat *M. peramangus* to the elongate, 6-variced *M. biconicus* occurs in the Bore, but it is possible to separate the two species fairly easily. *M. biconicus* is a common species in the Adelaidean, though it is apparently rare elsewhere; so far as the writer is aware, the "Murray Desert" (type locality) is the only other locality at which it occurs.

Genus **Widningia** nov.

Shell moderate, elongate-fusiform, spire shorter than aperture; apex small, paucispiral; whorls convex, axially lamellose-costate, spirally lirate; sculpture squamose, resembling *Bedeva*. Aperture ovate, canal long, obliquely curved, columella without plait, otherwise shell resembles *Peristernia*. Unlike *Nodopelagia*. Genotype *Widningia crassiplicata* sp. nov.

Widningia crassiplicata sp. nov.

(Pl. v, fig. 25)

Shell of moderate size, fusiform, elongate, spire shorter than aperture and canal. Protoconch eroded, one small tooth turn remaining; adult whorls six, rapidly increasing, body whorl large. Six plicate axial costae on the body whorl, increasing gradually in number posteriorly; whorls completely and evenly sculptured with numerous spiral lirae which are more prominent on the anterior half of the whorl; these are crossed by crowded, squamose, waving, fine lamellae, the waves of which are regularly directed backwards over the lirae and forwards in the interspaces; lamellae slightly more prominent over the costae and becoming foliaceous, as do the plicate costae, towards the base. Shape of the whorls somewhat angulate from the prominence of the costae. Aperture elongate-ovate with a large canal; margin of aperture broken in the holotype; inner lip reflected over columella. Height, 40 mm.; diameter, 17 mm; length of aperture, 12 mm.; length of canal, 11 mm.

Paratype—A specimen, more eroded than the holotype, with the aperture and canal complete. Outer lip with two rows of small, elongate, numerous denticles; canal recurved, half closed. Umbilical fissure wide in this specimen.

Superfam. BUCCINACEA

Fam. PYRENIDAE

Genus **Ademitrella** nov.

Shell small, elongate-fusiform, spire comparatively short, aperture long; protoconch smooth, subconical tip small, pointed, eccentric; whorls smooth, suture linear; columella smooth, outer lip of aperture thickened, subvaricose, smooth within. Genotype *Ademitrella insolentior* sp. nov.

Ademitrella insolentior sp. nov.

(Pl. v, fig. 11)

Shell small, spindle-shaped, with a comparatively short spire. Protoconch sharp, sub-conical, of one-and-a-half smooth turns, the apex eccentric; adult whorls three-and-a-half, smooth, flattened or slightly convex; body whorl large, compressed at the base. Whorls smooth except for faint, axial growth striae and about eight spiral striae on the base. Suture distinct, linear, ascending near the aperture. Aperture elongate, outer lip thickened, subvaricose, slightly excavate above, inflected below, smooth within; columella excavate a little above the middle, slightly twisted below and turned to the left. Height, 6·2 mm.; diameter, 2·1 mm.

Genus Zemitrella Finlay 1926

Zemitrella muscula sp. nov.

(Pl. v, fig. 12)

Shell very small, bluntly fusiform, spire approximately equal to aperture. Protoconch of one blunt, flattened, smooth, convex turn; adult whorls four, flattened; body whorl moderately convex, tapering anteriorly. Suture canaliculate; whorls smooth except for indistinct axial growth lines and about 10 incised spiral striae at the base. Aperture elongate, fairly narrow; outer lip somewhat notched above and inflected below, conspicuously and finely dentate within; columella slightly excavate above, almost straight and turned to the left below. Height, 4·2 mm.; diameter, 2 mm.

Superfam. VOLUTACEA

Fam. MITRIDAE

Genus Austromitra Finlay 1926

Austromitra angusticostata sp. nov.

(Pl. v, fig. 13)

Shell small, rather thin, turreted. Protoconch of one-and-a-half small globose, smooth turns; adult whorls five, convex, sculptured with strong, arcuate, axial ribs, narrower than interspaces, 11 on the penultimate whorl; interspaces very finely axially striate. Suture deep, impressed. Aperture elongate, narrowing anteriorly; outer lip broken but apparently smooth within; columella with four sharp, fairly stout plications; base strongly spirally lirate, six lirae on the holotype. Height, 8 mm.; diameter, 3 mm.

Observations—This species comes very close to *A. schomburgki* (Angas), but differs in having its axial ribs decidedly curved, and in the number of columellar plications. It is slightly more slender than *A. schomburgki*. In similar respects it is distinct from *A. scalariformis* (T. Woods).

Fam. TUDICLIDAE

Genus Tudicla Bolten 1798

Tudicla sinotecta sp. nov.

(Pl. v, fig. 14)

Shell of moderate size, thin; spire conical, very short; body whorl large and elongate-conical. Protoconch very conspicuous of two prominent, convex turns, completely flattened at the top; adult whorls three, very rapidly increasing; whorls with slightly concave sides; body whorl concave posteriorly, rising at the periphery to a sharp angulation, slowly descending anteriorly. About 12 sharp angular ridges on the periphery becoming obsolete towards the edges of the whorl. These ridges are shown on the suture as even deep undulations imbricating the suture which is prominent and waving. Elsewhere sculpture of uneven, spiral ribs and threads crossed by irregular growth striae. Aperture elongate-ovate with a long canal; outer lip thin, broken; inner lip thickened; columella with a single twist, fold not prominent. Height, 23·5 mm.; diameter, 15 mm. Height of aperture and canal, 20 mm.

Fam. MARGINELLIDAE

Genus Marginella Lamarck 1801

Marginella moana sp. nov.

(Pl. v, fig. 15)

Shell small, solid, pyriform, spire immersed, apical portion depressed. Body whorl completely enveloping the rest of the shell. Aperture long, narrow, curved, with margins parallel; aperture raised above the apex of the shell and curving somewhat towards the origin. Outer lip thickened, faintly and finely denticulate within; columella with four plaits, the anterior shorter than the rest and bordering the canal; canal narrow, curving inwards. Height of whorl, 4·1 mm.; height of aperture, 4·3 mm.; diameter, 3·1 mm.

Observations—This pear-shaped species comes closest to *M. globiformis* Chapman and Crespin, also occurring in the Abattoirs Bore.

Marginella sp.

Shell small, stout, elongate-ovate, spire bluntly rounded, body whorl large, somewhat cylindrical. Protoconch roundly depressed, of one convex turn; adult whorls three, each almost covering the preceding whorl. Aperture nearly twice height of spire, elongate, narrow posteriorly and broadening anteriorly; outer lip constricted in the middle, with a row of fine denticles along almost the whole length; columella with four parallel plaits, one bordering the broad anterior canal.

The single specimens from the present bore being somewhat freakish, complete description of this species is deferred.

Superfam. TOXOGLOSSA

Fam. TURRIDAE

Genus Bathytoma Harris and Burrows 1891

Bathytoma adelaidensis sp. nov.

(Pl. v, fig. 17)

Shell of moderate size, broadly fusiform, solid, turreted. Protoconch of two fairly large, flatly globose, smooth whorls; adult whorls six, sculptured with two strong spiral cords close together on the shoulder; above the cords fine spiral ribs crossed by numerous, obliquely curved axial threads; below the cords one or two fine spiral ribs increasing in number on each whorl. On the body whorl, strongly costate from shoulder to base, about 10 prominent ribs approximately equal to the interspaces which bear from one to four fine spiral lirae. Spirals crossed by numerous fine growth lines showing a conspicuous sinus. Whorls carinate at the shoulder, concave above and below; suture linear. Aperture oblique, elongate-pyriform, fairly narrow; outer lip slightly broken, with a sinus at the shoulder, canal short and slightly flexuous; columella somewhat oblique and concave; inner lip thin, smooth, reflected over columella. Height, 20 mm.; diameter, 8·5 mm.

Observations—Three specimens occur, apparently of the same species, with a narrower spire angle, the relative dimensions being 21 x 8 mm. The spiral sculpture is less prominent but otherwise resembles that of *B. adelaidensis* which is variable.

Genus INQUISITOR Hedley 1918

Inquisitor detritus sp. nov.

(Pl. v, fig. 18)

Shell small, narrowly fusiform. Protoconch of two somewhat flattened, convex, smooth turns; adult whorls six, slightly angled just above the middle of each whorl; suture impressed. Axial sculpture of about 11 prominent narrow costae to each whorl, extending from just above the angulation to the suture below, most prominent at the angle; spiral sculpture of one prominent rib immediately below the suture, followed by numerous, very fine, inconspicuous, crowded lirae to the angle, then by about five strong striae, crossing the axial ribs and the interspaces; on the body whorl the striae continue from the periphery to the base, about 16 in number. Aperture oblique, elongate, fairly narrow; outer lip broken in the holotype but obviously carrying a prominent sinus above the periphery; columella straight above, turned to the left below; inner lip smooth; canal almost straight, obliquely turned to the left. Height, 12 mm.; diameter, 3·8 mm.

Observations—This fossil species fairly closely resembles the Recent *I. flindersianus* Hedley, a larger shell lacking the rib beneath the suture. It appears to be not uncommon in the Kalimnan, part, though not all, of the examples identified with the New Zealand *I. wanganuiensis* (Hutton), belonging to this species. Adelaidean specimens are certainly not *wanganuiensis*.

Genus AUSTRODRILLIA Hedley 1918

Austrodrillia trucidata sp. nov.

(Pl. v, fig. 20)

Shell small, turreted, spire elongate. Protoconch smooth, of two flatly globose turns; adult whorls seven, gradually increasing, angulate at the middle. Sculpture of oblique axial costae, 12 on the penultimate whorl, sharp and prominent on the angle of the whorl and extending nearly to the suture below, absent above the angle, the post-angular area being more or less sharply excavate; numerous fine axial threads of growth; spiral sculpture absent except for about eight fine lines at the base. Aperture elongate-pyriform, about two-thirds height of spire, with a deep narrow sinus near the junction with the penultimate whorl; outer lip broken but fairly thick; columella straight above, slightly turned at the canal; inner lip callused over the columella and thickened into a tooth-like prominence near the sinus. Height, 15 mm.; diameter, 5 mm.; height of aperture and canal, 6 mm.

Austrodrillia decemcostata sp. nov.

(Pl. v, fig. 19)

Shell small, elongate-fusiform, moderately thick. Protoconch of one-and-a-half globose, smooth turns; adult whorls five, angulate at the middle in the early whorls, less so in the later. Sculpture of 10 axial costae on each whorl, more prominent in the middle but extending to the suture in each direction; whorls otherwise smooth except for very faint axial growth striae and six short spiral lirae adjacent to the canal in the body whorl. Suture impressed. Aperture oblique, fairly open; outer lip with a prominent sinus above and inflected below; columella almost vertical; anterior canal short, with a broad notch; inner lip smooth and slightly callused; callus near the sinus developed into a slight tubercle. Height, 7·2 mm.; diameter, 2·2 mm.; height of aperture, 2·2 mm.

Observations—A small species, very like *A. trucidata;* size distinct and costae extend from suture to suture, instead of being cut off above as in the former species.

Genus **Mappingia** nov.

Shell very small, elongate-subfusiform, near *Guraleus* in general appearance; apex multi-spiral; whorls convex, axially costate, spirally lirate; aperture pyriform, columella smooth; outer lip with a very shallow sinus, somewhat thickened and conspicuously dentate within. Genotype *Mappingia acutispira* sp. nov.

Mappingia acutispira sp. nov.

(Pl. v, fig. 21)

Shell very small, subfusiform, spire elongate. Protoconch of three elevated, convex, smooth turns; adult whorls four, convex, constricted at the suture which is irregular and impressed. Sculpture strong, of prominent, oblique slightly curved, plicate axial ribs, eight on the penultimate whorl, extending from suture to suture on the spire whorls and on the body whorl weakening from the periphery to the base where they disappear; axial sculpture crossed by fine, spiral lirae extending over the whole of the whorl including the base of the body whorl. Aperture narrow, elongate-pyriform; outer lip with a faint sinus at the suture; lip inflected below and conspicuously dentate within—about 10 small denticles altogether; columella almost vertical above, turned to the left and retroflect below; canal fairly long, narrow, deep, and slightly recurved; inner lip smooth. Height, 5·5 mm.; diameter, 2 mm.

Genus Etrema Hedley 1918

Etrema peramoena sp. nov.

(Pl. v, fig. 23)

Shell very small, fusiform, with sharply carinate whorls. Protoconch of two large, erect, globose, smooth turns; adult whorls three, carinate at the middle. Above the carina sculpture of about six very fine spiral lirae crossed by curved, oblique axials, very fine but widely separated; spirals about three times as close as axials; on and below the carina sculpture of two fine spiral costae crossed by oblique axials producing a cancellation with sharp nodules at the intersections. Body whorl about equal to the spire, with coarse sculpture of the anterior half of each whorl continued to the base, the spirals becoming more numerous and crowded on the canal area, the axials growing fainter and disappearing. Aperture elongate-pyriform with a deep subquadrate sinus above the carina; outer lip slightly expanded below the carina, smooth within except for roughening by the spiral ribs; columella straight above, turned to the left below; canal very slightly curved. Height, 4·1 mm. diameter, 2·1 mm.

Genus Guraleus Hedley 1918

Guraleus subnitidus sp. nov.

(Pl. v, fig. 22)

Shell very small, fusiform, spire gradate. Protoconch elevated, of three smooth, convex, flattened turns, the first very small; adult whorls four, roundly angulate just above the middle, deeply constricted at the suture; suture irregular, impressed. Axial sculpture of strong costae—10 on the penultimate whorl—strongest and most prominent at the angle; below the angle slightly oblique, in the narrow area above curved in the manner of the apertural sinus; costae weakening towards the sutures, fading out towards the base of the body whorl; spiral sculpture of numerous fine lirae (less strongly developed in the holotype than in most specimens, which vary considerably in the number and prominence of the spiral lirae); lirae stronger on the base in the holotype, about 12 in number. Aperture fairly narrow, sides subparallel, with a bluntly-rounded sinus below the suture, constricted below to a short, open, slightly recurved canal; outer lip with sinus above, inflected below; columella slightly oblique, straight. Height, 4·8 mm.; diameter, 1·8 mm.

List of Species

Gastropoda

**Haliotis naevosoides* McCoy 1876; *Tugali cicatricosa* Adams 1851, *infortunata*, sp. nov.; *Emarginula candida* Adams 1851, †*delicatissima* Chap. & Gab. 1923, **dennanti* Chap. and Gab. 1923; **Sophismalepas nigrita* (Sow. 1834); *Clanculus quadricingulatus*, *eucarinatus*, *Phasianotrochus laxegemmatus*, *subsimplex*, *Calthalotia nitidissima*, *fictilis*, *Lactifautor obliquicancellatus*, *spinicarinatus*, *crebrinodulosus*, **bicarinatus* spp. nov.; *Lactifautor* spp. indet.; *Astele fanaticum*, **Pulchrastele planiconicum*, *tuberculatum*, *Ethminolia perglobosa* spp. nov.; **Solariella strigata* (T. Woods 1878); **Teinostoma depressula* Chap. & Gab. 1914; *Partubiola depressispira*, *varilirata*, **Herpetopoma pliocenica* spp. nov.; *Gena* sp.; **Liotella capitata* Hedley 1907; *Liotella* sp.; **Liotina lamellosa* (T. Woods 1876); **Dolicrossea labiata* (T. Woods 1876), cf. *Turbo* sp. (operculum), cf. *Astraea* sp.; **Astraea* (*Bellastraea*) *aster* (T. Woods 1878); **Phasianella dennanti* Cresp. 1925; *Phasianella* sp. (opercula); *Phenacolepas tela* sp. nov.; **Cocculina praecompressa* Chap. & Gab. 1923;

Kaurnella denotata sp. nov.; *Haurakia* cf. *novarensis* (Frauend. 1867); *cf. *demessa* Tate & May 1900; *Merelina* cf. *suprasculpta* May 1915; **Epigrus chrysalidus* (Chap. and Gab. 1914), **cylindraceus* (T. Woods 1878); **Estea* cf. *bicolor* (Petterd 1884); *Rissoina elegantula* Angas 1880, *nivea* Adams 1851; **Turritella* (*Gazameda*) *acricula adelaidensis* C. & W. 1935; *subacricula* C. & W. 1935, * (*Maoricolpus*) *murrayana subrudis* C. & W. 1935, sp. aff. *platyspira* T. Woods 1878, (*Ctenocolpus*) *trilix* C. & W. 1935; **Tylospira coronata marwicki* (Finlay 1931); *Siliquaria australis* Q. & G. 1934; **Neodiastoma provisi* (Tate 1893); **Zeacumantus diemenensis* (Q. & G. 1835); *Clypeomorus bivaricatus*, *multiliratus* spp. nov.; *Cacozeliana* cf. *granaria* (Kiener 1842); †*Ataxocerithium concatenatum* Tate 1893, cf. *Ataxocerithium* sp.; *Adelacerithium merultum* sp. nov.; cf. *Hypotrochus penetricinctus* C. 1932, cf. *Hypotrochus monachus* (Crosse and Fischer 1864), cf. *Hypotrochus* sp. indet.; *Obtortio liratus* sp. nov.; *Semivertagus capillatus* Tate 1893; *Terebralia fallax* sp. nov., *adelaidensis* How. & C. 1936, cf. *Cerithiopsis* sp.;

†*Trichotropis accrescens* Tate 1890; *Cerithiopsis perelongatus* sp. nov.; **Cerithiella trigemmata* Chap. & Cresp. 1928; *Manulona arrugosa*, *lirasuturalis* spp. nov.; *Seila* (*Notoseila*) *crocea* Angas 1871; †*Triphora* spp.; *Mereldia incommoda* sp. nov.; **Architectonica wannonensis* (T. Woods 1878); *Epitonium* cf. *interstriatum* (Tate 1890); **Eglisia triplicata* (Tate 1890), sp. indet.; **Odostomia* cf. *deplexa* Tate & May 1900; *Syrnola bifasciata* T. Woods 1875, **tasmanica* T. Woods 1876, **tincta* Angas 1871, *infrasulcata* Tate 1898, *acrisecta* sp. nov., *Syrnola* sp.; **Turbonilla radicans* Chap. & Cresp. 1928, *subfusca* sp. nov., **liraecostata* T. Woods 1877, cf. *mariae* T. Woods 1876, *cf. *radicans* Chap. & Cresp. 1928, *vixcostata* sp. nov., (?) *Turbonilla* sp.; **Eulima longiconica*, *minuticonica* spp. nov., sp.; **Niso psila* T. Woods 1879; *Sabia conica* (Schum. 1817); †*Capulus circinatus* Tate 1893; †*Crepidula hainsworthi* Johnston 1885, **dubitabilis* Tate 1893, **unguiformis* Lamk. 1822; **Sigapatella crassa* (Tate 1893); *Cheilea pliocenica* sp. nov.; **Polinices balteatellus* (Tate 1893), **substolidus* (Tate 1893), **subvarians* (Tate 1893), ** (?) *huttoni* von Ihering 1907; **Sigaretotrema subinfundibula* (Tate 1893); **Natica hamiltonensis* Tate 1893, "*Natica*" sp. opercula, cf. *Ampullina* sp.; *Cypraea* sp. indet.; **Nototrivia* sp.; *Ellatrivia wirrata* sp. nov.; †*Proterato australis* (Tate 1890); **Hypocassis textilis* (Tate 1882); ***Semicassis transenna* Tate 1889, ***radiata* Tate 1889; (?) *Cymatium* sp.

***Austrotriton armatus* (Tate 1887), †*woodsi* (Tate 1879); *Cymatiella adelaidensis* sp. nov.; *Colubraria* sp.; *Widningia crassiplicata*, *Murex peramangus* spp. nov., ***Murex biconicus* Tate 1887, spp. indet.; †*Typhis laciniatus* Tate 1887, cf. *Fusinus* sp. indet.; †*Fusinus dictyotis* (Tate 1887); *Zemitrella menkeana* (Reeve 1858), *lincolnensis* (Reeve 1859), *cf. *tayloriana* (Reeve 1859), *muscula* sp. nov.; *Aidemitrella insolentior* sp. nov.; cf. *Zafra* sp.; *Cominella* sp. indet.; **Nassarius tatei* (T. Woods 1878); **Olivella nymphalis* (Tate 1889); ***Baryspira pseudaustralis* (Tate 1889), **tatei* (Marwk. 1924); *Austromitra schomburgki* (Angas 1878), *angusticostata* sp. nov., *scalariformis* (T. Woods 1876), sp.; *Mitra rhodia* (?) Reeve 1845, *glabra* Swain. 1821, *fodinalis* Tate 1899; †*Austroharpa sulcosa* (Tate 1889); *Tudicla sinotecta* sp. nov.; ***Aulica tabulata* (Tate 1889); ***Voluta uncifera* Tate 1889. **ellipsoidea* Tate 1889; †*Fulgoraria ancilloides* (Tate 1889); **Oamaruia tatei* (Cossm. 1889); *Cancellaria* spp. indet.; †*Marginella kitsoni* Chap. 1922; **wentworthi* T. Woods 1877, **globiformis* Chap. & Cresp. 1928, **muscarioides* Tate 1878, *tasmanica* T. Woods 1876, **kalimnae* Chap. & Cresp. 1933, sp. nov., *moana* sp. nov., spp. indet.; (?) *Asthenotoma subtilinea* Hedley 1918; **Filodrillia dilectoides* Chap. & Gab. 1916, cf. *Filodrillia* sp.; *Bathytoma* sp.; *adelaidensis* sp. nov.; **Inquisitor detritus*; **Austro-*

* Species (not necessarily subspecies) occurring in Kalimnan or Lower Pliocene.

† Species previously recorded only from Barwonian.

** Species occurring among "Murray Desert" fossils.

drillia decemcostata, **trucidata*; *Mappingia acutispira*; *Etrema peramoena* spp. nov.; †*Etrema praespurca* Chap. & Cresp. 1928; **Guraleus* cf. *tasmanicus* (T. Woods 1876), **subnitidus* sp. nov., sp.; **Conus hamiltonensis* Tate 1890; ***Terebra subspectabilis* Tate 1889, ***angulosa* Tate 1889, †*additoides* T. Woods 1877, sp.; †*Acteon scrobiculatus* T. Woods 1877, cf. *Acteon* sp.; **Semiacteon microplocus* Cossn. 1897; **Retusa longispira* (Cossn. 1897), **apiculata* Tate 1879; **Volvulella rostrata* (A. Adams 1850); **Cylichnella cuneopsis* (Cossn. 1897), *cf. *angustata* (Tate & Cossn. 1897); **Scaphander tatei* Cossn. 1897; **Roxania bullaeformis* Cossn. 1897.

SCAPHOPODA

Dentalium (Paradentalium) howchini Cott. & Ludb. 1938, * *(Fissidentalium) bifrons* Tate 1887; †*Cadulus mucronatus* Tate 1887, **acuminatus* Tate 1887.

VERMES

**Ditrupa cornea wormbetiensis* McCoy 1874.

ECHINODERMATA

* (?) *Goniocidaris mortensi* Chap. & Cud. 1934.

ARTHROPODA

**Balanus (Chirona) zelandicus* Withers 1924, **amphitrite acutus* Withers 1924.

PISCES

**Odontaspis contortidens* Ag. 1843; *Lamna* sp.; **Carcharias (Prionodon) aculeatus* (Davis 1888); **Myliobatis moorabbinensis* Chap. & Prit. 1907.

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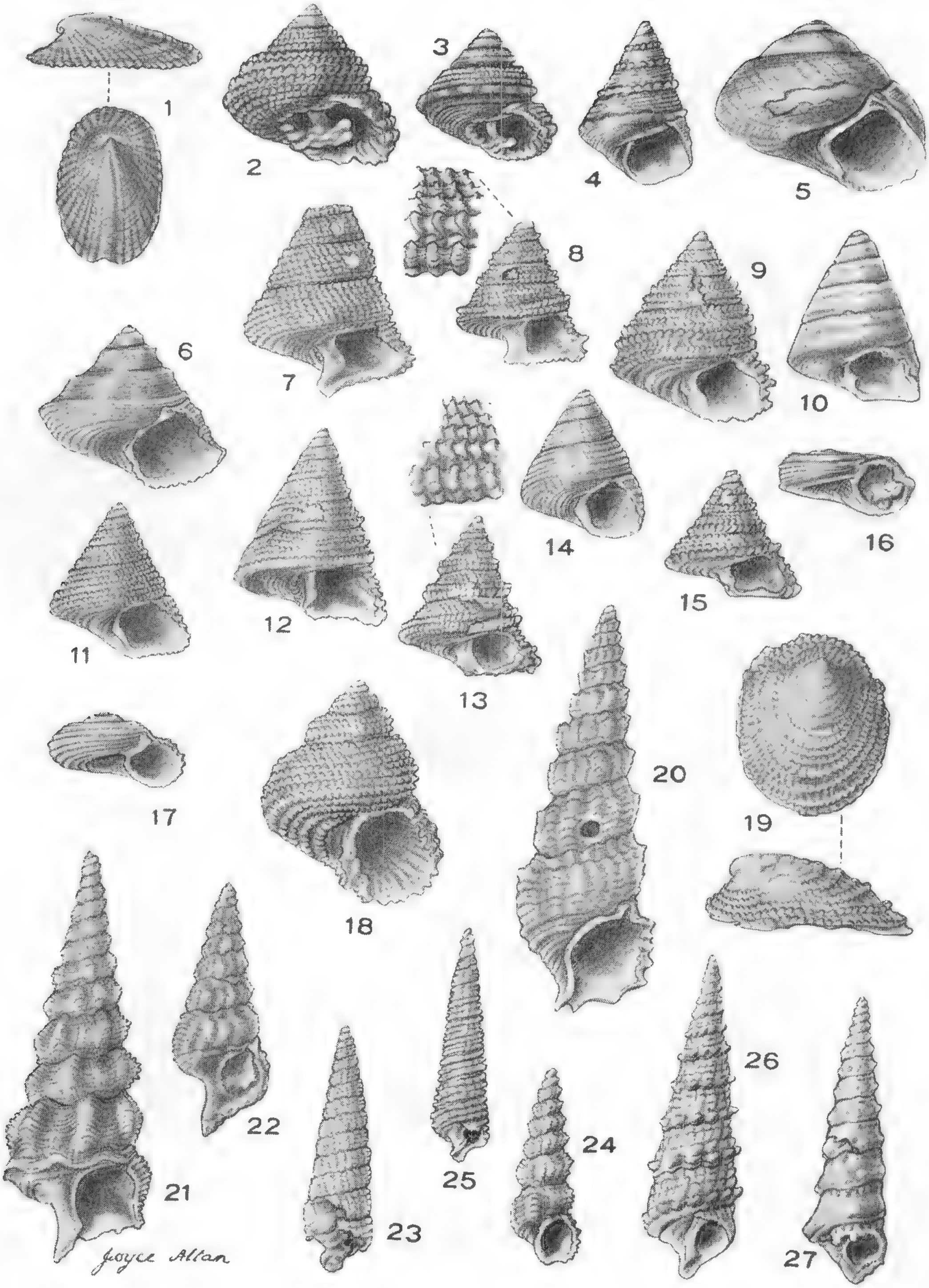
EXPLANATION OF PLATES IV AND V

Plate IV

1 *Tugali infortunatum* sp. nov. Holotype, side and dorsal view, X 5
2 *Clanculus quadricingulatus* sp. nov. Holotype, X 3½
3 *Clanculus eucarinatus* sp. nov. Holotype X 3½
4 *Phasianotrochus laxegematus* sp. nov. Holotype X 5
5 *Ethminolia perglobosa* sp. nov. Holotype X 5
6 *Astele fanaticum* sp. nov. Holotype X 3½
7 *Laetifautor obliquicancellatus* sp. nov. Holotype X 3½
8 *Laetifautor spinicarinatus* sp. nov. Holotype X 3½
9 *Laetifautor crebrinodulosus* sp. nov. Holotype X 3½
10 *Phasianotrochus subsimplex* sp. nov. Holotype X 5
11 *Calthalotia nitidissima* sp. nov. Holotype X 3½
12 *Pulchrastele planiconicum* sp. nov. Holotype X 3½
13 *Laetifautor bicarinatus* sp. nov. Holotype X 3½
14 *Calthalotia fictilis* sp. nov. Holotype X 5
15 *Pulchrastele tuberculatum* sp. nov. Holotype X 4
16 *Partubiola depressispira* sp. nov. Holotype X 5
17 *Partubiola varilirata* sp. nov. Holotype X 5
18 *Herpetopoma pliocenica* sp. nov. Holotype X 3½
19 *Phenacolepas tela* sp. nov. Holotype, side and dorsal view, X3½
20 *Clypeomorus bivaricatus* sp. nov. Holotype X 5
21 *Terebralia fallax* sp. nov. Holotype X 2
22 *Clypeomorus multiliratus* sp. nov. Holotype X 3½
23 *Adelacerithium merultum* sp. nov. Holotype X 3½
24 *Obtortio liratus* sp. nov. Holotype X 5
25 *Cerithiopsis perelongatus* sp. nov. Holotype X 5
26 *Manulona arrugosa* sp. nov. Holotype X 5
27 *Manulona linasuturalis* sp. nov. Holotype X 4

Plate V

1 *Kaurnella denotata* sp. nov. Holotype X 6
2 *Syrnola acrisecta* sp. nov. Holotype X 6
3 *Mereldia incommoda* sp. nov. Holotype X 4
4 *Eulima longiconica* sp. nov. Holotype X 4
5 *Eulima minuticonica* sp. nov. Holotype X 5½
6 *Turbonilla vixcostata* sp. nov. Holotype X 4
7 *Turbonilla subfusca* sp. nov. Holotype X 4
8 *Cheilea adelaidensis* sp. nov. Holotype, exterior view, X 4
9 *Cheilea adelaidensis* sp. nov. Paratype, interior view, 4
10 *Cymatiella adelaidensis* sp. nov. Holotype X 2½
11 *Ademitrella insolentior* sp. nov. Holotype X 4
12 *Zemitrella muscula* sp. nov. Holotype X 6
13 *Austromitra angusticostata* sp. nov. Holotype X 4
14 *Tudicla sinotecta* sp. nov. Holotype X 2
15 *Marginella moana* sp. nov. Holotype X4
16 *Ellatrivia wirrata* sp. nov. Holotype X 3
17 *Bathytoma adelaidensis* sp. nov. Holotype X 2
18 *Inquisitor detritus* sp. nov. Holotype X 2½
19 *Austrodrillia decemcostata* sp. nov. Holotype X 3½
20 *Austrodrillia trucidata* sp. nov. Holotype X 2½
21 *Mappingia acutispira* sp. nov. Holotype X 7
22 *Guraleus subnitidus* sp. nov. Holotype X 6
23 *Etrema peramoena* sp. nov. Holotype X 6
24 *Murex peramangus* sp. nov. Holotype c. nat. size
25 *Widningia crassiplicata* sp. nov. Holotype c. nat. size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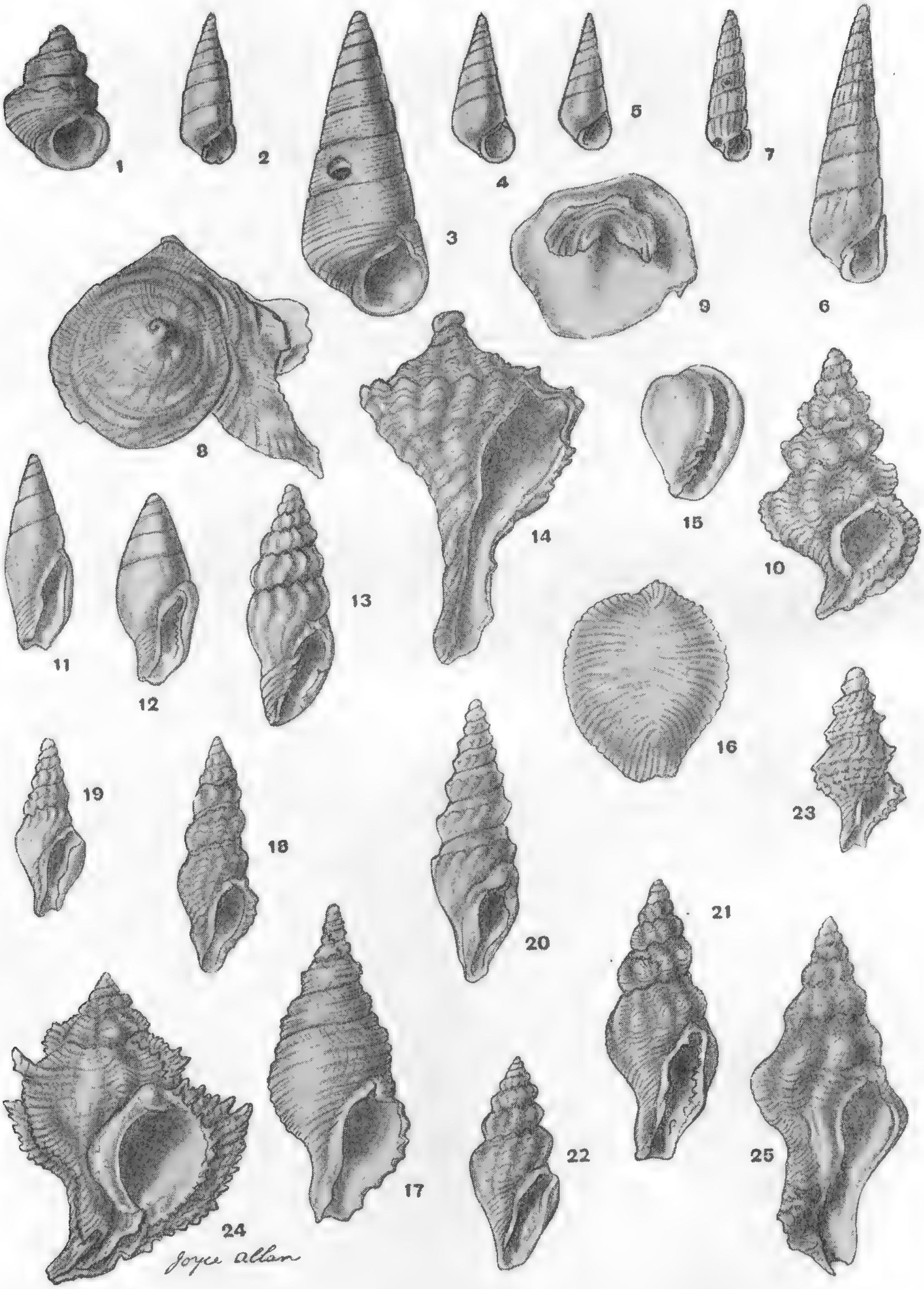
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Joyce Allan

NOTES ON THE GEOLOGY AND PHYSIOGRAPHY OF SOUTH-EAST SOUTH AUSTRALIA WITH REFERENCE TO LATE CLIMATIC HISTORY

By R. L. CROCKER

Summary

The chief physiographic feature of the South-East generally is the unique arrangement of sand dune ranges parallel to the existing coastline. These ranges are frequently indurated. They are rarely more than 100 feet above the general level and between them are series of flats or plains. The ranges are generally recognized (11, 2, 5) as representing old coastal dunes, or dune remnants, connected with successive stages in the retreat of the sea in late Pleistocene or Recent geological times. These superimposed ranges have impeded the natural drainage to the sea and have preserved a topography of extreme immaturity.

NOTES ON THE GEOLOGY AND PHYSIOGRAPHY OF SOUTH-EAST SOUTH AUSTRALIA WITH REFERENCE TO LATE CLIMATIC HISTORY

By R. L. Crocker

[Read 8 May, 1941]

The chief physiographic feature of the South-East generally is the unique arrangement of sand dune ranges parallel to the existing coastline. These ranges are frequently indurated. They are rarely more than 100 feet above the general level and between them are series of flats or plains. The ranges are generally recognised (11, 2, 5) as representing old coastal dunes, or dune remnants, connected with successive stages in the retreat of the sea in late Pleistocene or Recent geological times. These superimposed ranges have impeded the natural drainage to the sea and have preserved a topography of extreme immaturity.

Fenner (2) considers that the Naracoorte Range represents an old fault scarp and not a sand dune ridge. According to Howchin (5): "In the Mosquito Creek near Struan there is . . . . a beach at the foot of the limestone ridge. This old beach is now 200 feet above present sea level, and about 50 miles from the coast." The Naracoorte Range may represent a fault line, but, if so, there are sand dunes and indurated dunes superimposed upon it. The important thing is that the country to the east of this range is much higher. Its physiography is now modified but it was the old land surface prior to the positive earth movements, of late Pleistocene and Recent times, which resulted in the retreat of the sea (4). The major physiographic features of the Lower South-East are illustrated in fig. 1. The figures represent heights above sea level (normal spring tides) at some selected centres. Proceeding across sand range and inter-range flat, from the coast to the most inward range, the Naracoorte Range, it is possible to retrace the successive steps in the recession of the sea. The plains are underlain by flat-bedded Miocene marine limestones, but at least in part these are overlain by more recent calcareous material and recent deposits of sand and clay. This is especially so in the flat heath areas so characteristic of the Hundred of Coles and northwards.

The sand dune ranges reach their maximum development in the Mount Burr Range, but the geological features are here further complicated by the existence of numerous small and isolated basaltic, ash and tuff hills. Mount Lyon, Mount Burr, Mount Edward, Mount Watch, Mount Lookout, Mount Muir, Mount Muirhead, Mount Grahame, the Bluff, Mount MacIntyre, etc., all have volcanic affinities, and are capped with either basalt, or tuff and ash. This volcanic capping is frequently of very limited extent and in some cases is limited to a few square chains—at Mount Lookout it is much less. These are generally considered to be the same as, and probably contemporaneous with, volcanic activity in the Mount Gambier district, which Fenner (1) considers very recent or "prehistoric." From new evidence, both of a geological and pedological nature, it seems certain that the western volcanic activity of the Mount Burr Range preceded that of Mount Gambier and Mount Schank. But before detailing this evidence it will be necessary to deal more fully with the dune range remnants.

The Dune Range Remnants—The old dunes have been preserved in two forms—firstly, as consolidated dunes, and secondly as unconsolidated siliceous sands. The Woakwine Range is a "consolidated dune" range almost entirely free from siliceous sands, and the ranges extending easterly to the Naracoorte Range include both siliceous and consolidated dunes.

It is a well-known fact that the present-day dunes of our southern coast are of a predominantly calcareous nature, although quartz sand frequently forms a considerable part. At Robe (Thomas, 8) quartz sand forms some 25% of most of the aeolian sand soils. These calcareous dunes are well known in South Australia because of "coastiness" in sheep associated with them in the South-East and on Kangaroo Island.

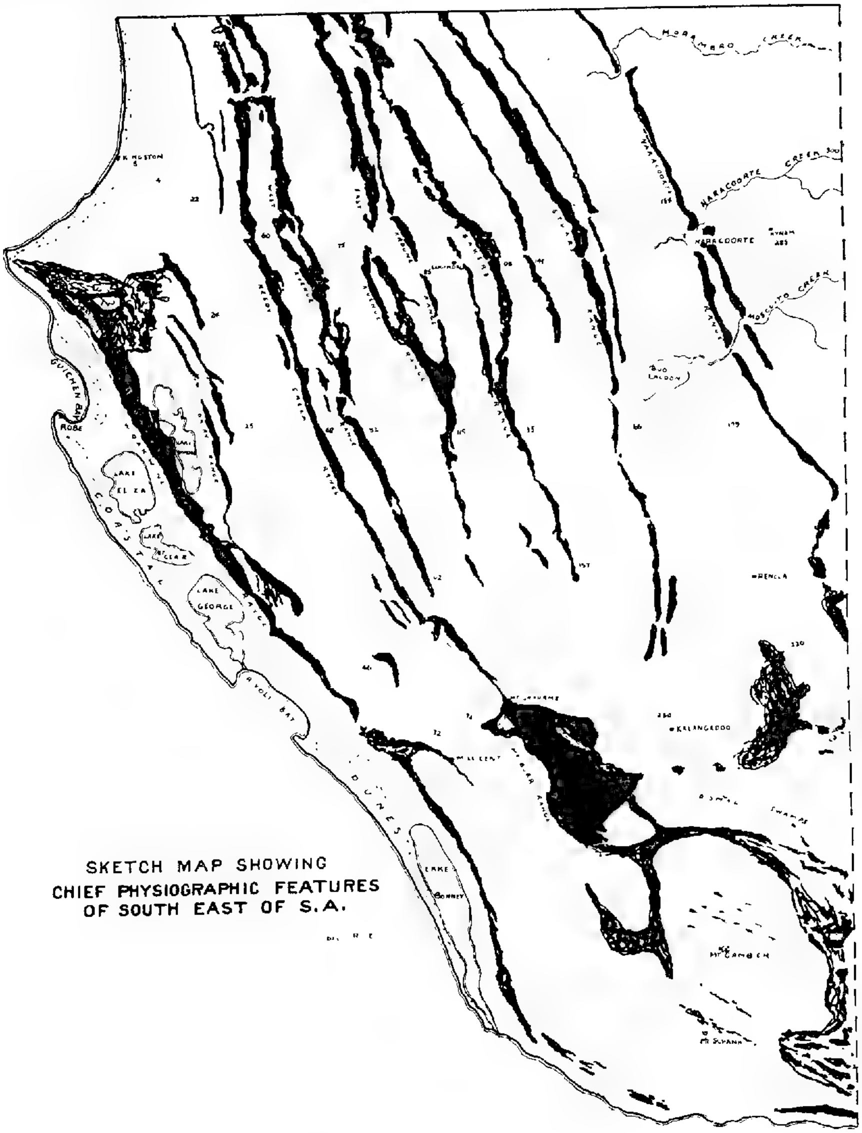

Fig. 1

The problem of why the sands of the dune ranges are so siliceous, and how other dunes have become indurated, has always been a puzzling one. It is unreasonable to suggest that the beach ridges during the Pleistocene elevations were not calcareous, as today, and a simple explanation is now offered on pedological evidence. It is supposed that leaching of former calcareous dunes led to a complete removal of the calcium carbonate and other more soluble salts from the upper horizons, leaving them predominantly siliceous. Leaching, however, was not complete, and the calcium carbonate was deposited in definite horizons lower down. Pedologists have established conditions of moderate to low rainfall (semi-aridity) for development of lime pans in soils, and it is necessary to presuppose these conditions. This period of lime pan formation was probably concerned with the onset of a period of great aridity that was to follow it. This arid period must have developed very rapidly in its final stages and have been very severe, for vegetation was not able to exploit the new environment and maintain soil stability. This loss of stability resulted in a general aeolian re-sorting of the upper leached layers with a consequent exposure of the zone of lime accumulation—the old B (illuvial) horizon of the soil. The re-sorted upper horizons today form the siliceous sands of the South-East, and the old zone of calcium carbonate deposition is preserved in the consolidated dunes.

In the Woakwine Range (see fig. 1), where the consolidated dunes are most exposed and where practically all the siliceous sands have been removed, the sandy limestone varies in thickness between one foot and several feet and is underlain by a highly calcareous sand with abundant fine shell fragments. This material is practically identical with that in the present-day coastal dunes. Similar calcareous sand can be seen underlying the limestone mantle in the consolidated dunes further inland, e.g., there is a good exposure in a road cutting in West Avenue Range, near Bull Island. No doubt the method of "consolidation" has been similar.

Evidence for a particularly arid period in late Pleistocene or Recent times can be found in other parts of the State. On south Kangaroo Island unconsolidated calcareous coastal dunes, in composition very like those of the South-East (Thomas, 8), overlie an old consolidated dune formation (fig. 2). The upper leached horizons have been completely removed during this arid cycle and are represented today in the grey and light grey sands which occur (particularly in valleys and on slopes) in the lateritic areas, and the grey-white siliceous sands in the region of Mount Stockdale and Mount Taylor. The more or less parallel sandrises of the Murray Mallee, with their east-west trend and the sandridges of the north-west of South Australia, must also have been built up during a late period of great desiccation and wind erosion on a grand scale. Whitehouse (10) considers that there has been an arid period in the late Pleistocene in Queensland and that since then rainfall increased, although it may possibly be declining now. He suggests that the large dune ridge formations of the Simpson Desert were built up during this aridity. Hills (4) believes that the rainfall decreased after the Pleistocene in Victoria, but that during Recent times there have been relatively wetter and drier periods. That the climate in South Australia has become wetter since the arid period is demonstrated by the fact that the then unstable siliceous sands of the South-East are now fixed by vegetation—indeed, are supporting a dry sclerophyll forest. The sandrises of the Mallee, too, are stabilised by whipstick mallee and porcupine grass, and in the North-West the ridges are largely fixed by *Acacia linophylla* (mulga) and *Casuarina lepidophloia* (black oak).

Hills (3) considers that the Pleistocene period exhibits in Victoria a succession of dune-building periods with intervening periods of sand stability, and suggests that the period of dune building may be correlated with ice-cap formation (after Sayles). Considering the present-day dunes along our southern coast, and particularly the large area occupied by them on south Kangaroo Island, it does not seem necessary to postulate conditions very different from today to explain the building up of coastal dunes.

It has been recognised (Hills) that, could the age of the consolidated dunes be determined, a period of great stratigraphical significance in deciding the age of many of the Cainozoic volcanic rocks of Southern Australia would be fixed. It seems evident that pedologists, physiographers and geologists must take increasing cognisance of late geological climatic changes. Our sandridge deserts, for example, are almost certainly connected with the last great arid cycle rather than with the present-day climate. This probably explains the very imperfect correlation obtained by Prescott (6) in attempting to relate them to the present climate by means of precipitation/saturation deficit-ratio zones.

While not yet prepared to place the last arid period as late Pleistocene or Recent, it is suggested that the South-East of South Australia may prove a critical area for its study. If one accepts Tindale's (9) correlation of coastal terraces in U.S.A. and the South-East the Woakwine Range would be very late Pleistocene, and the arid period Recent. Without fixing this horizon definitely, use can already be made of it in establishing some of the stratigraphical sequence in this region.

Volcanic Activity in South-East South Australia—Owing to the limited extent and greater complexity of the volcanic rocks of the Mount Burr Range area they have been little studied geologically, but the evidence for their being older than the Mount Gambier and Mount Schank activity can be detailed briefly.

Firstly, in the Mount Burr region the yellow and grey siliceous sands are superimposed upon the general volcanic framework, which means that volcanic activity must have been of the pre-arid period. At Mount Gambier, on the other hand, gently undulating siliceous sandrises have a capping of volcanic ash varying in thickness up to approximately one-and-a-half feet and weathering to a rich volcanic

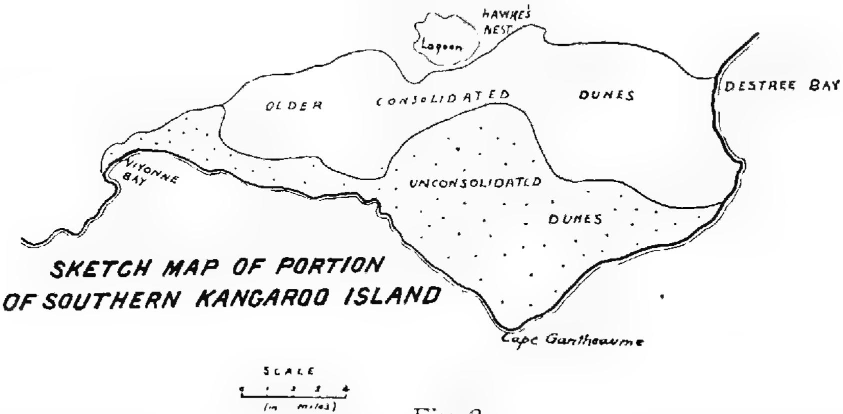

Fig. 2

loam. The Mount Gambier activity, therefore, has been of the post-arid period. Secondly, Howchin (5) draws attention to a raised sea beach on the sides of Mount Grahame which, he says, "shows that the sea must have encroached upon the locality, and again receded since the volcanoes were in eruption." Other strong evidence, too, (a) water-worn basaltic grit and pebbles in a bore put down near the Mount Burr Forest Homestead (and noted by the author), and (b) the occurrence of a shell bed (very like that on Mount Grahame) above volcanic tuff, in a deep observation pit of the Forest Research Station, suggests inundation. There is no evidence (1) of a similar inundation in the Mount Gambier district. It may be, of course, that the raised beach at Mount Grahame does not mean an incursion of the sea, but rather that this region was an island during the Pleistocene retreat. This fact is rather supported in that on the slope of Mount Grahame, and to Mount Muirhead and beyond, there are frequent outcrops of consolidated dune limestone at two separate horizons, and suggestive of successive stages in the retreat of the sea. Thirdly, the volcanic soils of the Mount Burr region are more acid in reaction, indicative of longer leaching, and range as low as pH 5·2 in samples collected by Stephens.[1] In the Mount Gambier region, according to Prescott and Piper (7), the reaction range is from pH 6·4 to pH 8·2.

[1] Stephens, C. G., private communication.

The volcanic activity of the Mount Burr region is, therefore, older than that at Mount Gambier, which seems to have been placed accurately by Fenner as "prehistoric." It is now also possible to limit within some degree the period of the retreat of the sea. For example, prior to the arid period, the coastline of the South-East must have been very similar in outline to the coast today, as consolidated dunes occur in the succession of all the ranges from the Naracoorte Range to the Woakwine Range. If this arid period can be chronologically fixed a very great step forward in interpretation of late climatic history, and its effect on present land form and pedogenics, will be made.

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WORORA KINSHIP GESTURES

By J. B. LOVE

Summary

The Worora recognise sixteen degrees of kinship, for which there are sixteen terms, as listed below. These sixteen degrees are included in ten gestures. There are also separate words for the relationship of elder and younger brother and sister, but the elder or younger relationship does not alter the status of the individual with regard to other members of the tribe, and there is no separate gesture to denote elder or younger. In general the terms for brother and sister in any degree are the same, with the masculine and feminine form of the noun in each case. The exceptions to this rule are: (1) mother and mother's brother; (2) wife and wife's brother; also wife's-father, wife's-brother's-son, and all the male line of the wife's horde; (3) father and father's sister. In this last instance, however, it is to be noted that, though father's-sister is in adult speech a different term from father (being the same as man's daughter), in baby talk the father and father's-sister are denoted by the masculine and feminine forms of the same term. *viz.,* [djidai] and [djidjinjaj. Not counting the separate terms for elder and younger brother and sister, nor masculine and feminine forms as separate terms. the sixteen kinship terms of the Worora are as follows

WORORA KINSHIP GESTURES

By J. R. B. Love

[Read 12 June 1941]

Plate VI

The Worora recognise sixteen degrees of kinship, for which there are sixteen terms, as listed below. These sixteen degrees are included in ten gestures. There are also separate words for the relationship of elder and younger brother and sister, but the elder or younger relationship does not alter the status of the individual with regard to other members of the tribe, and there is no separate gesture to denote elder or younger. In general the terms for brother and sister in any degree are the same, with the masculine and feminine form of the noun in each case. The exceptions to this rule are: (1) mother and mother's brother; (2) wife and wife's brother; also wife's-father, wife's-brother's-son, and all the male line of the wife's horde; (3) father and father's sister. In this last instance, however, it is to be noted that, though father's-sister is in adult speech a different term from father (being the same as man's daughter), in baby talk the father and father's-sister are denoted by the masculine and feminine forms of the same term, *viz.*, [djidai] and [djidjinja]. Not counting the separate terms for elder and younger brother and sister, nor masculine and feminine forms as separate terms, the sixteen kinship terms of the Worora are as follows:

1 Father, for which the Worora word is [irai]. In reciprocal speech the father and son will address one another as [irai], but in speaking of one another the son will speak of his father as [irai], while the father will speak of his son as [kaŋo:lu] (or some other grammatical form of that word, which is not a noun, but a verb, meaning I-beget-him).

2 Man's-son, [iŋko:lu], which means Whom-he-begets.

3 Man's-daughter, [pamaranja]. Father's sister is also denoted by this term [pamaranja].

4 Mother [karanja].

5 Woman's-son and woman's-daughter, [ibai] and [ibanja].

6 Mother's-brother, [kakai]. Man's-sister's-child, [ibai] and [ibanja].

7 Brother and sister, [ŋawaia] and [ŋawanja]. Elder-brother is [abia], elder-sister is [abi:nja], younger-brother is [iwomalė], younger-sister is [njimbomalinja].

8 Mother's mother, [kadjanja]. Mother's-mother's-brother is [kadjaia].

9 Woman's-daughter's-son and woman's-daughter's-daughter, [buda] and [budinja].

10 Husband, [kulai]. Husband's-sister is [kulanja].

11 Wife, [maŋganja].

12 Wife's-brother, also wife's-father, and all males in wife's line, [waia].

13 Wife's-mother, *i.e.*, man's mother-in-law, [kurumanja]. Man's mother-in-law's-brother is [kurum].

14 Woman's-daughter's-husband, *i.e.*, woman's son-in-law, [wolbaia]. Woman's daughter's-husband's-sister is [wolbanja].

15 Husband's-mother, *i.e.*, woman's-mother-in-law, [ŋalindjanja]. Husband's-mother's-brother is [ŋalindjaia]. Woman's-son's-wife, *i.e.*, woman's daughter-in-law is the same term as husband's mother, *viz.*, [ŋalindjanja]; also woman's-son's-wife's-brother is [ŋalindjaia].

16 Mother's-father, [tjamaia]. Mother's-father's-sister is [tjamanja]; but man's-daughter's-child is called by the same term as the daughter uses, *viz.*, [ibai] or [ibanja], the same term that is used by the mother's brother.


1
2
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3a
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Father's-father is classed with elder-brother, and son's-son is classed with younger-brother. Husband's brother is classed with husband, and wife's-sister is classed with wife. Father and son address each other reciprocally as ["irai"]; hence son's-wife is classed with mother, *viz.*, ["karanja".] A man addresses his daughter's husband by the term the daughter uses, *viz.*, ["kulai,"] husband.

The masculine terminations of the kinship terms may be heard as [-ai] or [-aia]. Wife's-brother (etc.) is always heard as [waia], avoiding the monosyllable [wai], which is another word; the longer words more usually are heard as ending in [-ai.]

Most gestures are used repicrocally to denote either party to degree of kinship.

Terms 1, 2 and 3, the father-child relationship, is shown by bending up the arm and touching the shoulder with the hand. See fig. 1.

Term 4, the mother-child relationship; mother holding her breast. (Fig. 2.)

Term 5, the child-mother relationship, is shown by placing one hand below the thigh near the buttock. The son, or daughter, also uses this same gesture to denote mother's-brother. See fig. 3. An alternative is for the son or daughter to place the clasped hands behind the neck. See fig. 3a.

Term 6, the man's-sister's-child relationship, is denoted by the mother's brother pointing to his belly. (Not figured.)

Term 7, the brother-brother, brother-sister, and sister-sister relationship, is denoted by placing a hand on the lower leg, either shin or calf. See fig. 4.

Terms 8 and 9, the mother's-mother and daughter's-child relationship, is denoted by touching one knee. See fig. 5.

Terms 10 and 11, the husband-and-wife relationship, is denoted by touching one hip. See fig. 6. Term 12, wife's-brother or father, is included in this gesture.

Terms 13 and 14, the mother-in-law and son-in-law relationship, is denoted by placing one hand on the shoulder-blade. See fig. 7.

Term 15, the mother-in-law and daughter-in-law relationship, is shown by touching the spine about the region of the kidneys. See fig. 8. N.B.—In this figure the mother-in-law's brother, [ŋalindjaia], is making the gesture.

Term 16, mother's-father, is shown by placing the hand below the thigh, near the knee. See fig. 9. An alternative is to touch the spine high up, either by reaching the hand over the shoulder, or by reaching up the back.

The sixteen kinship terms, with their ten gestures, may be summarised as follows: Father : son : daughter, three terms, one gesture; mother : child : mother's-brother, three terms, three gestures; brother : brother : sister, one term, one gesture; maternal-grandmother : grandchild, two terms, one gesture; husband : wife : wife's-brother, three terms, one gesture; mother-in-law : daughter-in-law, one term, one gesture; mother-in-law : son-in-law, two terms, one gesture; mother's-father, one term, one gesture.

In daily use the gestures accompany the spoken word for the degree of kinship. In introducing a stranger, the one making the introduction will name the relationship that exists between himself or herself and the stranger, and at the same time, make the gesture for that relationship. So, also, in answering a question as to the relationship that exists between a person interrogated, the one answering will name the relationship and, at the same time, make the gesture.

In reply to a question as to why the gestures are used, or what purpose they serve, one man said, "For use at a distance." This would seem quite a reasonable answer, as the gesture can be conveyed at a distance, when speech might not be convenient. The majority of men questioned simply said, ["juŋ"]. ["juŋ"] is the way things have always been from time immemorial. Men have conceived the spirits of their children in a dream ["juŋ"]; the Worora people used these signs.

In addition, a very full set of gestures denotes the animals, and would seem to serve the purpose of communicating at a distance. Several of the kinship gestures are very obvious in their meaning. Others seem to have been deliberately devised to complete the set to include the whole kinship system.

ASCAROID NEMATODES FROM AUSTRALIAN BIRDS

By T. HARVEY JOHNSTON and PATRICIA M. MAWSON, University, Adelaide

Summary

Much of the material referred to in this paper was collected by the late Dr. T. L. Bancroft at Eidsvold, Burnett River, Queensland; his daughter, Dr. M. J. Mackerras, from the same locality, and from the Thompson River at Longreach, Western Queensland; Professor J. B. Cleland from some localities in New South Wales, South Australia and Western Australia; J. T. Gray, Orroroo, South Australia; and the late Dr. W. D. Walker at Morgan, Murray River, South Australia. Some of Krefft's original material was forwarded by the Director of the Australian Museum. Sydney for our examination. The rest was obtained by the senior author from localities in Queensland, New South Wales, and South Australia, the material from Tailem Bend having been found in birds collected for us by Messrs. G. and F. Jaensch and L. Ellis. To all who have assisted us we tender our thanks. The study of the material was made possible by the Commonwealth Research Grant to the University of Adelaide.

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By T. Harvey Johnston and Patricia M. Mawson, University, Adelaide

[Read 12 June 1941]

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Most of the species described below belong to *Contracaecum*. It is regretted that, in the past, many authors omitted to indicate the ratios of lengths of parts of the alimentary canal and of the spicules to the total body length. In the older and even in some of the recent descriptions a wide range of body length but only one length of spicule is given, so that the actual ratio which appears to us to be of systematic value is not available for comparison. In describing the new species, we have stressed what have appeared to us to be the main distinguishing specific characters—the shape and relative lengths of lips and interlabia, width of the head relative to the body, the ratios of the oesophagus and of the diverticula of the alimentary canal to the body length, the ratio of the spicules to the body length, the position of the vulva, and the arrangement of the male caudal papillae. The two last-mentioned features are similar in several different species, so that they alone are insufficient for diagnostic purposes.

Types of the new species have been deposited in the South Australian Museum.

List of Parasites arranged under their Hosts

Phalacrocorax carbo Linn. (var. novae-hollandiae). *Contracaecum spiculigerum* Rud. (Lower Hawkesbury R., N.S.W.; Tailem Bend, S. Aust.). *C. sinulabiatum* n. sp. (Eidsvold, Qld.).

Phalacrocorax fuscescens Vieill. *C. spiculigerum* Rud. (Kangaroo Island).

Phalacrocorax varius Gmelin. *Contracaecum spiculigerum* Rud. (Perth, W.A.).

Phalacrocorax melanoleucus Vieill. *Contracaecum spiculigerum* Rud. (Hawkesbury R., N.S.W.; Thompson R., Qld.; Adelaide, Orroroo, and Encounter Bay, S. Aust.). *C. sinulabiatum* n. sp. (Tailem Bend, S. Aust.).

Phalacrocorax sulcirostris Brandt. *Contracaecum spiculigerum* Rud. (Thompson R. and Burnett R., Qld.; Adelaide).

Plotus novae-hollandiae Gould. *Contracaecum sinulabiatum* n. sp. (Burnett R. and Thompson R., Qld.). *C. tricuspe* (Ged.) (Australian Museum; Burnett R., Qld.).

Pelecanus conspicillatus Temm. *Contracaecum bancrofti* n. sp. (Burnett R. and Thompson R., Qld.; Sydney Zoological Gardens, from N.S.W.; Morgan, S. Aust.). *C. clelandi* n. sp (Perth). *Contracaecum* sp., larvae and immature worms (Perth; Tailem Bend, S. Aust.).

Notophoyx pacifica Lath. *Porrocaecum reticulatum* Linst. (Thompson R. and Eidsvold, Qld.). *Contracaecum spiculigerum* Rud. and *Contracaecum* sp. (Thompson R., Qld.).

NOTOPHOYX NOVAE-HOLLANDIAE Lath. *Contracaecum spiculigerum* Rud. (N.S.W.). *Contracaecum* sp., fragments and larvae (Tailem Bend, S. Aust.).
NYCTICORAX CALEDONICUS Gmelin. *Contracaecum spiculigerum* Rud. (Tailem Bend, S. Aust.).
BOTAURUS POECILOPTILUS Wagl. *Contracaecum spiculigerum* Rud. (Orroroo S. Aust.).
XENORHYNCHUS ASIATICUS Lath. *Contracaecum* sp. larvae (Zoological Gardens, Adelaide, from Murray R., S. Aust.).
EGRETTA ALBA Less. *Porrocaecum reticulatum* (Linst.) (Thompson R., Qld.). *Contracaecum* sp., larvae (Tailem Bend, S. Aust.).
CHENONETTA JUBATA Lath. *Heterakis chenonettae* Johnst. (Sydney Zoological Gardens, from N.S.W.).
ANAS BOSCHAS Linn. (DOMESTICA Briss.). *Contracaecum microcephalum* (Rud.) and *Heterakis isolonche* Linst. (Lord Howe Island).
ANAS SUPERCILIOSA Gmelin. *Contracaecum microcephalum* Rud. (N.S.W.).
EUDYPTULA MINOR Forst. *Contracaecum* sp., larva (Brighton, S. Aust.).
ANOUS STOLIDUS Linn. *Contracaecum magnicollare* n. sp. (North-West Islet, Great Barrier Reef, Qld.).

CONTRACAECUM SPICULIGERUM (Rud.)

Fig. 1-2

We have identified this species from *Phalacrocorax carbo* (Eidsvold, Qld.; Lower Hawkesbury River, N.S.W.; Tailem Bend, S. Aust.); *P. sulcirostris* (Adelaide, S. Aust.; Thompson R., Qld., coll. Dr. Mackerras); *P. melanoleucus* (Encounter Bay, S. Aust., coll. Dr. Cleland; Orroroo, S. Aust., coll. J. T. Gray; Hawkesbury River, N.S.W., coll. Dr. Cleland; Thompson River, Qld., coll. Dr. Mackerras; Adelaide); *P. fuscescens* (American River, Kangaroo Island); *Notophoyx pacifica* (Thompson River, Qld., coll. Dr. Mackerras); *N. novae-hollandiae* (N.S.W.); *Botaurus poeciloptilus* (Orroroo, S. Aust., coll. J. T. Gray); *Nycticorax caledonicus* (Tailem Bend, S. Aust.). Some broken specimens from *Phalacrocorax varius* from Perth, W. Aust., are also assigned to this species.

This species was described very briefly by Rudolphi (1809). Schneider, in 1886, gave a longer illustrated account, but omitted measurements except the total length of the worm. Since then the parasite has been recorded from many different species of birds from various parts of the world. One of us recorded it from *Phalacrocorax sulcirostris* (Johnston 1912, 74; 1912 b, 108; 1916, 49) from Southern Queensland; and as *Ascaris spiculigera* ? (1912, 75) from *P. carbo* from Sydney. *Ascaris* sp. of Johnston (1912 b, 108) from *P. carbo* from N.S.W. is the same species. The presence in *Pelecanus conspicillatus* from Sydney of parasites, apparently referable to the species, was also mentioned (Johnston, 1912, 74); and these nematodes were also quoted as *Ascaris spiculigera* ? (Johnston, 1912 b, 108), but our re-examination of the material indicates that they belong to a closely related new species, *C. bancrofti*. *Ascaris spiculigera* of Johnston (1912, 74; 1912 b, 108; 1916, 49) from *Plotus novae-hollandiae*, Burnett River, Queensland, has been re-examined and is now identified as a very closely allied new species, *Contracaecum sinulabiatum*, together with *C. tricuspe* (syn. *Ascaris* sp. Krefft, 1873).

C. spiculigerum appears to us to be one of several very closely related species formerly confused under that name. Rudolphi's type (1809) of *Ascaris spiculigera* came from a pelican, *Pelecanus onocrotalus*, but in 1819 he recorded it from *Pelecanus carbo*, *P. cristatus*, and *P. pygmaeus* (p. 290), as well as from *P. brasiliensis* and *P. aquila* (p. 662). Most of the identifications made subsequently have been based on specimens from cormorants and other birds. The re-examination of Rudolphi's type material would be necessary to determine the true *C. spiculigerum*. The available descriptions are, however, few and incomplete and the following account based on Australian material is offered.

Length varying greatly, even among adult specimens. Males, 14-26 mm.; females, 16-55 mm. Body tapering in anterior third. Head narrower than succeeding part of body. Lips as described by Schneider (1866), with characteristic antero-lateral projections and without lateral cuticular flange. No dentigerous ridge seen, though figured by Linstow. Interlabia nearly as long as lips, sometimes with bifid tips. Annular striations forming marked "collar" at base of lips. Oesophagus 1:4·6-8·8 of body length, generally 1:7. Oesophageal appendix and intestinal caecum respectively 1:3-5 (usually 1:3·7) and 3:4 of length of oesophagus. Nerve ring about midway between head and anterior end of caecum; cervical papillae just behind that level.

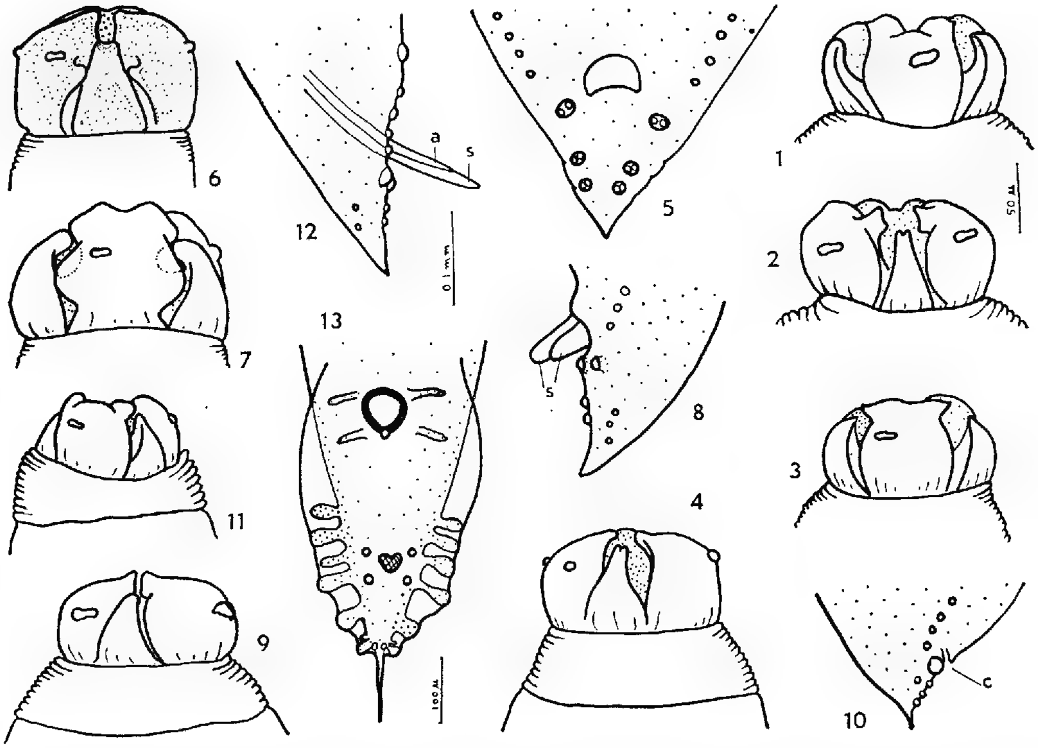

Fig 1-2—*Contracaecum spiculigerum:* two views of head. Fig. 3-5—*Contracaecum bancrofti:* 3 and 4, two views of head; 5, male tail. Fig. 6-8—*Contracaecum sinulabiatum:* 6 and 7, two views of head; 8, male tail. Fig. 9-10 - *Contracaecum clelandi:* 9, head; 10, male tail. Fig. 11-12—*Contracaecum magnicollare:* 11, head; 12 male tail. Fig. 13—*Heterakis chenonettae,* ventral view of male tail. Fig. 1 and 2 to same scale; fig. 3 to 12 to same scale. a, alae; c cloaca; s. spicule.

Male—Arrangement of caudal papillae exactly as described and figured by Schneider; in a few specimens the arrangement of the three pairs of lateral postanal papillae varied slightly. Spicules usually 1:3·6 to 1:4·2 of body length. In one collection from *Phalacrocorax carbo* (Tailem Bend), and in the material from *Notophoyx novae-hollandiae* the spicules were as short as 1:7 body length, but in the appearance of the head and in the other ratios these specimens agreed with *C. spiculigerum.*

Female—Vulva between a third and a quarter body length from head end.

Contracaecum bancrofti n. sp.

Fig. 3-5

From *Pelecanus conspicillatus* from Burnett River, Queensland, type locality (coll. Dr. Bancroft); Thompson River, Queensland (coll. Dr. Mackerras);

Morgan, South Australia (coll. Dr. Walker); and from Sydney Zoological Gardens, from New South Wales. Males up to 24 mm. long; females to 30 mm. Lips with short antero-lateral projections. Interlabia nearly as long as lips; with bifid ends. Head narrower than body succeeding it; striated cuticular "collar" well developed.

Male—Breadth ·64 mm.; oesophagus 3·2 mm. long, 1:6 body length; oesophageal appendix 1:5, and intestinal caecum 3:4·8 of oesophageal length, nerve ring ·48 mm. from head in 20 mm. long worm; cervical papillae at same level. Spicules 2·2-2·8 mm. long, 1:7-9 body length, alate, with blunt tips. Tail ·18-·2 mm. long, conical. Three pairs double postanal papillae and about twenty-three pairs preanal papillae, latter arranged in a straight row on either side of ventral surface, the first two pairs adanal, and the first ten papillae on each side larger and closer together than the remainder.

Female—Oesophagus 1:7-10 body length; intestinal caecum 3:3·7-4·5, and oesophageal appendix 1:4 of oesophageal length. Tail conical, ·34 mm. long. Vulva at 4:9 body length from head. Eggs subglobular, about 54 μ by 58 μ.

The male tail of this species most closely resembles that of *C. micropapillatum* (Stoss.), but the species differs in the length of spicules, size of eggs, and position of the vulva. *C. bancrofti* differs from *C. spiculigerum* in the shape of the lips (antero-lateral projection not so marked in the former), in the length of the spicules and in the arrangement of male papillae.

Contracaecum clelandi n. sp.

Fig. 9-10

From *Pelecanus conspicillatus* from Perth, West Australia, coll. Dr. Cleland. Males, 27-30 mm. long; females, 32 mm. Head much wider than long, interlabia about three-quarters length of lips; papillae on lips just below level of anterior ends of interlabia. Body following head much wider than head. Oesophagus 1:6·1-1:7·5 body length, oesophageal appendix 1:3·5-5, and intestinal caecum 1:1·2-1·3, of oesophageal length. Nerve ring ·44 mm. from head, just in front of cervical papillae.

Male—Tail tapering suddenly, ·8 mm. long; a pair large postanal caudal papillae, followed by four pairs, as in fig. 10; over twenty pairs preanal. Spicules 1·3-1·4 mm. long, broadly alate.

Female—Vulva 12 mm. from head, at 1:2·7 body length.

The species is distinguished from *C. bancrofti* and *C. spiculigerum* by the relative breadth of the head, the shortness of the spicules, as well as the number and arrangement of male caudal papillae.

Contracaecum sinulabiatum n. sp.

Fig. 6-8

From a darter, *Plotus novae-hollandiae* (type host) from Burnett River (coll. Dr. Bancroft), and Thompson River, Queensland (coll. Dr. Mackerras); from *Phalacrocorax carbo* from Eidsvold, Queensland (coll. Dr. Bancroft); and *P. melanoleucus*, Tailem Bend, South Australia.

Males, 14-16 mm. long; females, 18-20 mm. Head about same width as succeeding body. Each lip with antero-lateral ear-like projections; in addition, below these, prominent lateral cuticular flanges. Interlabia broad; tip widened and frequently bifid, reaching between antero-lateral projections and lateral flanges of adjacent lips. Head about three-quarters as long as wide. Papillae on lips at level of anterior ends of interlabia. Oesophagus 2·08-2·24 mm. long in male, and 2·36 mm. in female, 1:7-8·6 body length; intestinal caecum 3:4 and oesophageal appendix 1:2·9-3·7 of oesophageal length. Nerve ring ·44-·48 mm. from head, just anterior to cervical papillae.

Male—Tail conical, ·15 mm. long; spicules 1:8·3-9·5 of body length, with blunt tips. Between twenty and thirty pairs preanal papillae and seven pairs postanal, arranged as in *C. spiculigerum*.

Female—Tail conical. Vulva at 1:4·4-4·5 body length.

The species differs from *C. spiculigerum* chiefly in the possession of lateral flanges on the lips, in the shortness of the spicules, and in the more anterior position of the vulva.

Contracaecum magnicollare n. sp.

Fig. 11-12

From a noddy, *Anous stolidus*, from North-West Islet, Capricorn Group, Great Barrier Reef, Queensland. Four worms present, two young males 8-11·6 mm. long, and two young females 9·7-10·2 mm. long. Head about twice as wide as long, and rather narrower than succeeding body. Lips with anterolateral projections but no lateral flanges. Papillae on lips just below level of tips of interlabia; latter four-fifths length of lips. Annulated "collar" following lips well developed, even in young specimens. Oesophagus 1:4·8-6·1 body length; intestinal caecum 3:4·2, and oesophageal appendix 1:3·5 oesophageal length. Nerve ring ·35 mm. from head, just anterior to cervical papillae.

About twenty to twenty-two pairs of preanal papillae in male, the four most posterior papillae of each side closest together. Six pairs postanal papillae, their arrangement resembling that in *C. microcephalum*. Vulva 1:2·2-1:2·5 body length from head. Both females young, ripe eggs not present.

The species resembles *C. microcephalum* and *C. punctatum* in the male tail, but differs from both in length of the spicules.

CONTRACAECUM MICROCEPHALUM (Rud. 1809)

This species was taken from the caecum of a domestic duck, *Anas bochas*, from Lord Howe Island; and from a black duck, *Anas superciliosa*, from New South Wales.

Male 18 mm., females 18-25 mm. Head half as long as wide, slightly narrower than succeeding body. Lips with wide earlike antero-lateral projections. Interlabia bifid in all specimens, three-quarters length of lips; papillae on lips at level of tips of interlabia. Oesophagus 1:7-7·5 body length; interstinal caecum 1:1·4 and oesophageal appendix 1:6 oesophageal length. Spicules 1:7 body length. Vulva a third body length from head.

CONTRACAECUM TRICUSPE (Gedoelst 1916)

From *Plotus novae-hollandiae* from the Burnett River (coll. Dr. Bancroft) and from the Australian Museum (coll. Krefft, also from Burnett River). Krefft (1873) had recorded it as *Ascaris* sp. Spicules in our specimens about 1:4·7 body length, instead of 1:3 as given by Gedoelst, and the two pairs of small papillae figured by that author just posterior to the cloaca are in our single male specimen merged into one pair of very large papillae. In other respects our specimens agree closely with those described by Gedoelst.

CONTRACAECUM spp., larvae

(1) From the jabiru, *Xenorhynchus asiaticus*; length 24 mm., width ·8 mm.; no lips present, larval tooth prominent. Oesophagus 3·2 mm. long, intestinal caecum 2·56 mm., oesophageal appendix ·56 mm. Tail ·24 mm. long.

(2) From the egret, *Egretta alba* (Tailem Bend, S. Aust.). Length 8-10 mm.; larval tooth and three low lips present; oesophagus ·88-1·6 mm.; oesophageal appendix ·4-·52 mm., and intestinal caecum ·56-1·12 mm. in length.

(3) From *Pelecanus conspicillatus* (Tailem Bend, S. Aust.). Length 8·2 mm., width ·4 mm.; three low lips present. Oesophagus 1·04 mm.; intestinal caecum ·72 mm., and oesophageal appendix ·64 mm. in length. Tail ·12 mm. long.

(4) Larval *Contracaecum* spp. were also obtained from *Notophoyx novae-hollandiae* (Tailem Bend, S. Aust.; and from *Eudyptula minor* (Brighton, S. Aust.), latter worms 2 mm. in length.

Contracaecum spp.

Worms and parts of worms unidentifiable specifically were taken from *Pelecanus conspicillatus* (Perth, W. Aust., coll. Dr. Cleland); *Notophoyx pacifica* (Thompson River, Queensland, coll. Dr. Mackerras); *Notophoyx novae-hollandiae* (Tailem Bend, S. Aust.) and *Plotus novae-hollandiae* (Australian Museum, from Queensland).

Porrocaecum reticulatum (Linst. 1899)

Material consists of two females; one 80 mm. long, from *Notophoyx pacifica* from Eidsvold, Queensland (coll. Dr. Bancroft), and the other 65 mm. long, from the same host species from the Thompson River, Queensland (coll. Dr. Mackerras); also a male 35 mm. long from *Egretta alba*, Thompson River, Queensland. We find on the male tail six pairs of preanal papillae and three pairs postanal, the most anterior of the latter group having (as described by Hsü, 1933) double nerve endings. Spicules in our male ·41 mm. long, gubernaculum ·1 mm.

Heterakis chenonettae Johnston 1912
Fig. 13

Several worms belonging to this species were obtained from the caecum of a wood duck, *Chenonetta jubata*, from New South Wales (Sydney Zoological Gardens). A re-examination of the type material shows that a revised description of the male tail is necessary.

Spicules equal, ·4-·42 mm. long; sucker ·8 mm. diameter, posterior border ·2 mm. in front of cloaca; cloaca ·25 mm. from tip of tail. Alae commencing just anterior to sucker, extending to within ·11 mm. of posterior end of body, leaving narrow spine-like tail. Two pairs pedunculated papillae at level of sucker; two pairs sessile adanal papillae; eight pairs pedunculate papillae in alae, arranged as in fig. 13.

In other features our specimens agree with the original description (Johnston 1912). The species differs from *H. altaica* Spaul 1929 in being smaller, in having a rather longer oesophagus and relatively shorter spicules, and in the arrangement of papillae on the male tail. It most closely resembles *H. papillosa* Bloch, differing chiefly in the shape of the alae and sucker, and in the number of papillae on the male tail.

Heterakis isolonche Linstow 1906

Several specimens agreeing closely with *H. isolonche* Linst., as described and figured by Li (1933), were taken from the caecum of a domestic duck, *Anas boschas*, from Lord Howe Island. Baylis (1939) has recorded this species from Brisbane, where it was taken from a crested pheasant, *Chrysolophus amherstiae*, an introduced bird.

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RESULTS OF THE HARVARD-ADELAIDE UNIVERSITIES ANTHROPOLOGICAL EXPEDITION, 1938-39 ANALYSIS OF AN AUSTRALIAN ABORIGINAL'S HOARD OF KNAPPED FLINT

By NORMAN B. TINDAL and H. V. V. NOONE

Summary

The following is a contribution to the results of the Harvard-Adelaide Universities Anthropological Expedition of 1938-39, which was made possible by a generous grant from the Carnegie Corporation of New York.

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By Norman B. Tindale and H. V. V. Noone

[Read 12 June 1941]

The following is a contribution to the results of the Harvard-Adelaide Universities Anthropological Expedition of 1938-39, which was made possible by a generous grant from the Carnegie Corporation of New York.

The 74 pieces (A. 27556 in the South Australian Museum) of light brown and grey flint dealt with in this analysis were found in June 1939 by D. M. Tindale on an aboriginal site of recent occupation among coastal dunes near Eucla, a telegraph repeating station, now abandoned, situated where the eastern border of Western Australia meets the shore of the Great Australian Bight. The pieces had been buried under blown sand of the coastal dunes but were lying in such a position that evidently they formed, at one time, a compact parcel which for some reason had been abandoned. This fact and the semi-finished appearance of most of the flakes, together with their presence in that particular locality, indicated that the collection was a hoard or trade parcel which was in transit from the known flint sites on the coastal cliffs one day's journey to the East. These deposits, exposed by the weathering away of the cliff face of the Miocene limestone beds of the Nullarbor Plain, provide nodules of an excellent grade of flint in a fresh or "green" condition.

From the cultural point of view the Mirning, the present-day aborigines of the locality, are amongst the most primitive of the people in Australia, their habitat being about 750 miles south-westward beyond regions where edge-ground stone axes are made, and at least 500 miles away from areas where even "traded" axes of that kind have penetrated. As the find apparently represents a collection of material made during a flint knapper's expedition, it was expected that such an unique opportunity as was presented by these specimens would reveal interesting characteristics of the technique practised on flint material by a people living at what might be termed a palaeolithic-level of culture.

Here it is perhaps as well to emphasise that during the semi-developed stages of a stone industry the tools produced are, for several reasons, restricted to a few types which serve many purposes. Pieces, therefore, which we term "scrapers," "adzes," "points," etc., in this survey are only named as such for convenience and in order to conform to established classification. Two typical worked stone tools of the Eucla area, of types in use up to the present day are shown as fig. 1. They are made of similar flint to that found in the hoard. An example made of material similar to that of this hoard has been found 180 miles away to the north at Wardaruka (Boundary Dam), and other examples have been noted at Ooldea (200 miles east).

The notes below are the result of our preliminary analysis of the pieces. The accompanying diagrams, fig. 2, will serve, we hope, as a guide to the nomenclature employed.

Description

Viewed as a whole, the 74 specimens appear the product of knapping at least four nodules of flint—light brown, reddish brown, grey and blackish grey pieces being distinguishable. Two of the pieces are "flake implements." There are no cores or coroid implements, and the parcel consists of flakes—a few reaching the "blade" category—but two specimens are actually more in the nature of blocks. A few pieces have been crackled by heat.

Twelve of the pieces are really large fragments, as they lack the platform and bulb end. One of these shows a certain amount of trimming at one end, approaching the shape of an "ogival" or nosed-scaper. Some of them are such as would be handy pieces mounted in gum for cutting purposes. Eight of the flakes show a certain amount of trimming on the platform. These last, as well as the two implements, will be referred to separately in more detail.

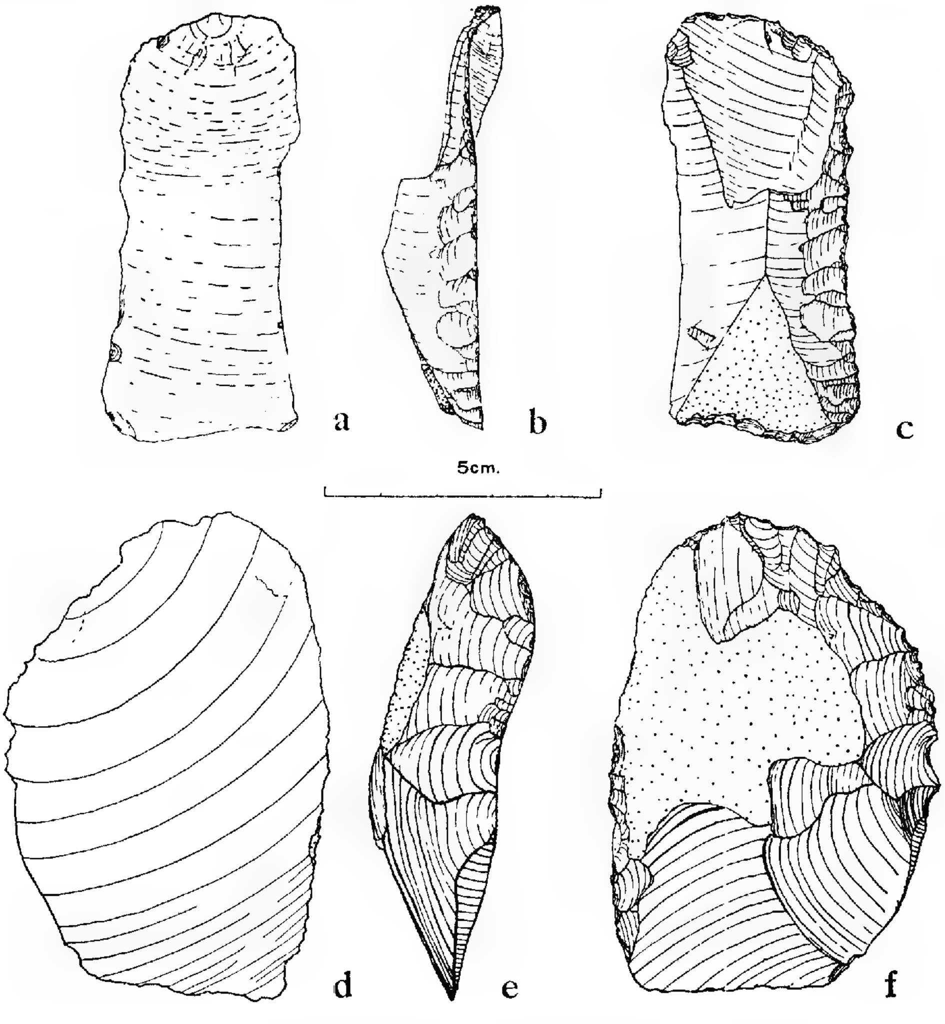

Fig. 1

a-c, flint implement from Eucla (A. 27550 in S.A. Museum); d-f, ditto from hoard of knapped flint (A. 27556).

Flake Analysis

There are left 52 pieces which bear the platform intact, and are thus suitable material for analysis. Some 19 of this group show trimming, or squilling of sorts at one or other part of the margin, and a few of them may have been called into use or more likely touched up during the knapping operation, but they are included in this group to provide a more adequate sample for study, the secondary attention not having been sufficient to obscure the characteristic major features of the flakes. There are, however, four specimens with smashed bulbs and seven pieces with snapped-off ends—as also one with heat-crackled tip—which are in consequence not included in some of the analyses.

Platform—A simple prepared, that is a flattened, platform was usually employed. There is only one instance of the impact spot being on the crust. Very little crushing of the comparatively brittle cortex has taken place. The bulb on this specimen is of the diffused form. On the other hand, some 13 flakes show bruising or pulverising at the impact spot, or at the intersection of the platform and bulb, *i.e.*, the bulb-top. Of the other 38 pieces, 22 show clean and unmarked platforms, and 16 bear small arc-shaped cracks at the impact spot forming what may be described as a ghost, or incipient, cone (fig. 3a). There were no genuine examples of the platform with several facettes.

As regards the depth of the platform, *i.e.*, the distance between the inner face edge at the bulb-top and the outer face edge which is directly opposite, this reaches 1·6 cm. in one case whilst in one or two specimens it is too small for

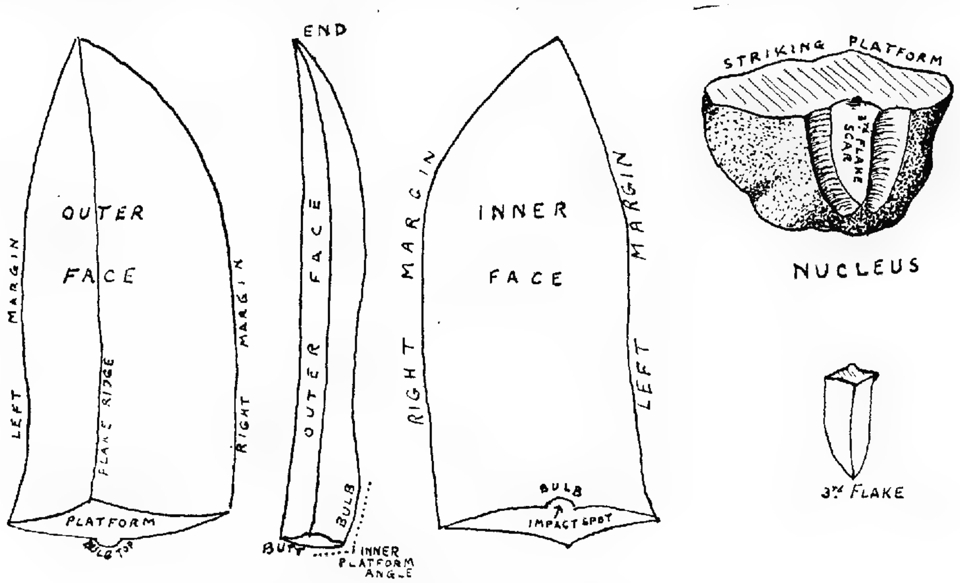

Fig. 2

Diagrams illustrating nomenclature employed.

ordinary measurement. A division showed 17 flakes with depth of platform at 5 mm. or under, and 35 at over 5 mm.

The above evidence suggests an absence of regular procedure as to the treatment and form of the platform, except that a plain (simple) levelled platform over 5 mm. in depth was more frequent.

Inner Platform Angle—Taking the angle between the plane of the platform at impact spot and the plane of the adjacent bulbar, or inner face, to a length of 2·5 cm., it was found that six pieces showed an angle below 100° (low), while 32 were from 100° to 115° (medium), and 10 above 115° (high), the highest being 125°. The deepest platform of 1·6 cm. mentioned above was at a low angle.

The evidence shows that, except for most of the work being done at an angle between 105° and 115°, the worker knapped off any angle within a range of some 35°, and had no particular rule.

Bulbs—It was found that the more or less curved edge which intersects the bulb and the platform, where the fracturing that separated the flake from the nucleus commenced, was of large radius (diffused, fig. 3 b) on 21 pieces and of small radius (salient, fig. 3 c) on 27. These forms of bulb-top do not show any dependence on the angle of the platforms, as of 32 pieces of medium angle platform, 15 have diffused and 17 salient bulbs, while of the high angles three were diffused and seven were salient. The salient bulb is in a slight majority, nearly 60%, but is not characteristic of the worker.

Multiple Bulbs, etc.—Multiple bulbs occur in five pieces and are salient except in one case. Three pieces bear more of a pyramidal than a conic form of bulb.

Eraillures (chafed or scarred marks on bulb) are comparatively plentiful, being found clearly on 23 pieces.

Conchoidal ripples, as also fissures on the bulb, are not much in evidence.

Six of the pieces show checked (step, resolved) flake scars at the butt on the outer surface (fig. 3 e). These may be the result of ineffective blows due to clumsiness, irregularity of material or unfavourable surface contour.

Six flakes end with a hinge fracture.

Dimensions—The length of the flakes ranges from 3·5 cm. to 8·5 cm. The commonest lengths are, respectively, 5 cm., 7 cm. and 6 cm., and these three sizes comprise nearly 60% of the total number of complete flakes

Measuring the greatest width of each piece the range is found to be 2·5 cm. to 7·5 cm., and the majority (nearly 60%) are between 3·5 and 5 cm. In this connection it should be borne in mind that we are here concerned with selected flakes, rejections having been left on the working site, and it must be assumed that the above show the dimensions of pieces thought suitable for tool production.

Secondary Working

Two pieces which are definite flake implements have been mentioned. One has a truncated isosceles triangular outline and the appearance of an end-scraper, the wings of which were the working edges. Its dimensions are 7·5 cm. long by 5·5 cm. at the scraper end. The narrower butt-end has been worked by long retouches, and the striking off of the platform and bulb has been done by one blow. Some rough white cortex occupies about one-fifth of the outer face.

The other implement (fig. 1 d-f) appears to be a form of large flake adze such as would be mounted axially in gum at the end of a wooden haft and is roughly a semi-disc in outline, being 9 cm. x 6 cm.. The marginal shaping and trimming has in its course removed the platform and most of the bulb. About one third of the outer face retains the rough white cortex.

Both implements are made on stout flakes of dull brown flint, and in fact the material is so similar in texture that they appear to be off the same nucleus. The outstanding attention given to these implements, as if they were one of the main reasons for the knapping, coupled with the likelihood that they were derived from the same nucleus and the fact that they still retain a fair proportion of the nodule crust, warrants the deduction that their maker was a rapid and deft stone worker.

In addition to these two implements there are eight flakes which show more or less trimming of the platform (fig. 3 d), and these bear definite signs that this work was done after detaching the flake from the nucleus. In appearance they are somewhat similar to the "facetted butts" of Europe which are said to be the peculiar product of the "tortoise core." These eight flakes, however, cannot be thus explained, the facetting either being subsequent to, or, where the impact spot is plain and intact, independent of the knapping. We therefore view these pieces as (1) possibly providing a working edge which had been trimmed on the butt because of its suitable formation; or (2) as having been semi-trimmed about the time of knapping with a view to making them into more definite tools when required.

The above 10 pieces show the secondary work and trimming to have been done by the removal of bold and well-placed shaping scales followed by chipping and a longish retouch. There are few signs of a "step" (or "checked") retouch having been employed, and none of the abrupt or the pressure trimming kind. It should not be overlooked, however, that the nature of the find is such as to imply that the pieces are incompletely finished material.

Discussion on Knapping Technique Employed

Thirty-four specimens of the flakes are found to be thinner at end than at butt, and taking into account the seven snapped pieces, as also six which end with a hinge fracture, a thin-ended flake may be taken as the usual result of this knapper's work. Twenty-one of the specimens show some form of median ridge on the outer face, but only 12 of these end in anything approaching a

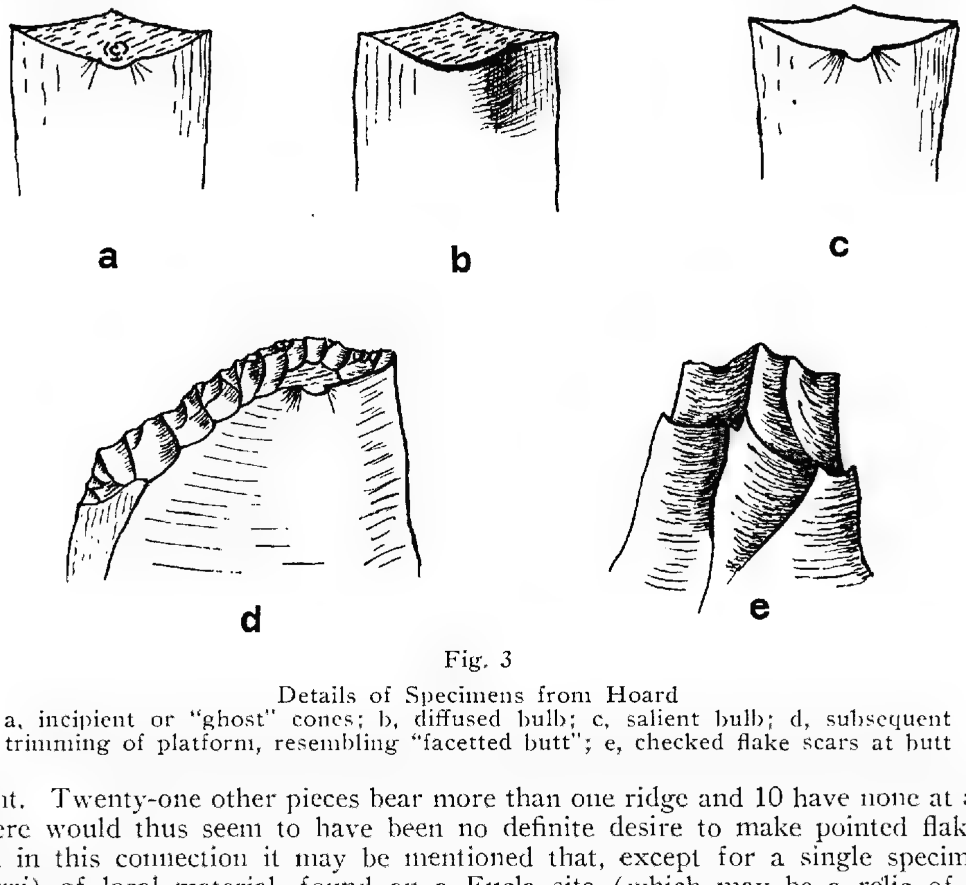

Fig. 3

Details of Specimens from Hoard

a, incipient or "ghost" cones; b, diffused bulb; c, salient bulb; d, subsequent trimming of platform, resembling "facetted butt"; e, checked flake scars at butt

point. Twenty-one other pieces bear more than one ridge and 10 have none at all. There would thus seem to have been no definite desire to make pointed flakes, and in this connection it may be mentioned that, except for a single specimen (*pirri*) of local material found on a Eucla site (which may be a relic of an earlier period), such implements as points are not now used in the Eucla territory. In regard to what is achievable with pointed flakes in the more advanced northern culture areas, it may not be out of place to mention that we have seen one magnificent single-ridged specimen from Wave Hill, North Australia. It is in a very pale rose quartzite of a length of 27 cm. (actually about 27·5 cm. as tip is broken off) of almost perfectly flat lanceolate shape and obtuse triangular transverse section, the width near butt being 6·3 cm. This is a triumph of Australian knapping, as no trimming was necessary to make the shape perfect. The inner platform angle is 110°. The source of the material from which such blades are made is known to be in the Katherine area of North Australia, but the technique has not yet been studied. Motion picture studies of such workmanship as this, with, just as important, running commentaries by experienced eyewitnesses, as also of hammer-dressing, polishing, "pressure" denticulating edge, and each tribe's knapping technique are highly desirable. Australia's unique preservation of so many different methods of stone working will not last much longer.

Careful inspection of the direction of the knapping blows that detached the earlier flakes from each of the 52 pieces, as shown by the flake scars on the outer face, reveals that on 25 pieces all the blows were delivered from the same direction, whilst 26 bear scars showing that the blows were from more than one direction. One piece is all crust on the outer face.

The above facts would seem to show that the Eucla worker (or workers) did not aspire to the making of long flakes, but the 25 pieces each worked in the same direction not only imply an appreciation of a common platform but the realisation that a carefully shaped face on a nucleus, bearing the right ridges and contour, is the major essential to successful knapping. This is further borne out by the fact that most of the flakes are practically free of cortex, and that no less than 21 of the pieces show a median ridge. It is unfortunate that no nucleus is included in the hoard. Whilst the evidence of a repeatedly used prepared simple platform suggests that a sort of prismatic nucleus was eventually formed, the number of flakes with diversely produced ridges, assuming they do not all represent preliminary dressing, should mean the formation of globular or polyhedral cores also. The use of a common platform and the production of thin-ended flakes entails: (a) some dressing of the nuclear face; (b) simultaneous use of more than one platform on the nucleus; or (c) commencement of the work on a high-angled platform or conically dressed nucleus in order to counteract the consequent sub-pyramidal form that the nucleus assumes after several flakes have been removed.

Stone was probably used as the knapping and trimming tool. One cannot definitely say that comparatively soft material was not also employed. We expect that a granite pebble or a flint nodule was used, as these are the only kinds of suitable stone material available within a radius of 250 miles.

It will be noticed that we have not made use of the platform analyses in our above remarks. Our experience in experimental knapping, as also that gained by one of us of stone work done during his sojourns amongst the aboriginal tribes still using stone, has led us to believe that, provided the impact point on a nucleus of good material offers sufficient obstruction (a correctly delivered blow suitably placed being assumed), little else but a favourable range of angularity is required of the platform. The shape of the knapping tool at the spot where it comes into contact with the nucleus is apparently a more intimate influence on the nature of the fragment detached. The careful selecting of the exact portion of the hammer that is to come into contact with the nucleus immediately before the blow is struck is a noticeable characteristic of present-day aboriginal knapping. There is also a freedom from working restrictions which is also revealed by the analyses given above in regard to bulbs and platforms, and this exposes the minor part actually played by the platform. The major factor in knapping technique is shown to be the contour and ridging of the face of the nucleus from which the desired fragment is detached—together with the position of the point of impact in regard to same, these being the main controlling factors of block, flake or blade form.

Conclusions

We class the Eucla work in flint as that of a developed flake industry producing good flakes at the "incipient blade" stage, and we consider the parcel the product of one or more practised specialists, who could work on a platform angle range of 35°.

Simple flat platforms were prepared but no strict rule of detached platform angle was followed beyond 60% ranging between 105° to 115°, and as to platform size, except that it was usually over 5 mm. This contrasts with the finding of one of us (Tindale 1937) amongst Tasmanian implements, where the angle is usually over 110°, and commonly even 120° in the case of the most recent.

Preparation by decortication of the nodule was effected to produce a good nucleus. The face of the nucleus was prepared and a common platform utilised, though this higher technique was not improved to a full development. A salient bulb, 60%, and *craillures* are to some extent characteristic. Thin-ended flakes ranging from 5·0 to 7·0 cm. long by 3·5 to 5·0 cm. wide are to a slight extent, 60%, characteristic. It would seem that though not entirely dependent on secondary work to obtain the desired tool shape, its employment was still to a fair extent necessary to complete the tool. In trimming well-placed shaping scales were followed by finer chips and the long retouch. There are no signs of pressure trimming.

It may not be out of place here, in order that the workmanship of the hoard should be appreciated, to draw attention to the great irregularities, almost amounting to inconsistencies in some modern aborigines' treatment of stone for their requirements. Any random piece of suitable stone may at times be used without further treatment and, if at all trimmed, this may in some cases be actually done with the teeth. What might be described as professional work may be found alongside examples of very indifferent work in the same group, or even done by the same person. When a cutting chip of sorts is required, such as in the blood-letting ceremony, the procedure may be little more than hitting one stone with another and selecting from the sharpest fragments so obtained. A suitable piece with sharp edge, as knapped, is brought straight into use, and what might be scientifically classed as "secondary work" or "trimming" is actually re-edging. This re-edging, moreover, may be done with the teeth, stones, a spear-thrower, a throwing stick, or any other convenient article such as a hunting boomerang, if hard enough. As to the aboriginal use of the re-edged tool, the plain face used as the platform upon which is applied the re-edging blow or force, is invariably the face nearest to the material worked upon when chopping or scraping. Some favourite tools are so repeatedly re-edged that the working edge faces are at a marked obtuse angle, whilst a few others are so often used as to show a distinct polishing of the working edge. In one case, a pebble chopper (A. 28408) from a Murundian site, at Moana, South Australia, the obtuse angle shown by the faces forming the working edge, was as high as 140° when discarded.

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AN EXAMINATION OF SOME SOILS FROM TROPICAL AUSTRALIA

By J. A. PRESCOTT and H. R. SKEWES, Waite Agricultural Research Institute

Summary

Comparatively little information is generally available concerning the soils of tropical Australia, and until relatively recently few samples had been collected and little field work had been done. The present report is the result of an examination of samples collected during field work carried out in 1933 and 1937, following a preliminary visit to tropical Queensland in 1929.

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[Read 12 June 1941]

INTRODUCTION

Comparatively little information is generally available concerning the soils of tropical Australia, and until relatively recently few samples had been collected and little field work had been done. The present report is the result of an examination of samples collected during field work carried out in 1933 and 1937, following a preliminary visit to tropical Queensland in 1929.

For some years the Chief Chemist of the Queensland Department of Agriculture has published analyses of soil samples in his annual report, and some of these naturally relate to the tropical areas. Previous investigations on soils from the Northern Territory have been principally laboratory studies on samples collected by reporters on various parts of the Territory. Amongst these reporters under the South Australian administration were Brackenbury (1896) and Holtze (1911). Brackenbury's samples were analysed by Goyder, of the South Australian School of Mines, and commented upon by Lowrie. Holtze collected samples from Goulburn and other islands; these samples were examined and reported upon by Hargreaves, the government analyst in Adelaide.

Soil samples from the Territory have also been examined from time to time in the laboratories of the Queensland Department of Agriculture. A number of samples from the Pindan country of the Kimberleys was collected by Despeissis about 1911 and subsequently examined by the government analyst of Western Australia. More recently samples have been collected by the survey parties engaged in fixing the boundary between the Northern Territory and Western Australia.

In all these cases the analyses relate to the major plant nutrients, and little or no information is available regarding the field characteristics of the soils or their physical texture.

The samples dealt with in the present report are derived from three main areas. The first is the Kimberley region of Western Australia, the second is the western and accessible part of Arnhem Land, and the third is the cattle country of northern Queensland, west of Charters Towers. The alluvial soils of the Katherine and Daly Rivers, devoted to cultivation of the peanut, have already been described (Prescott, 1938).

From the field notes taken during the traverses and from other information, an attempt has been made to construct a picture of the character of the major soil zones and of their general distribution. The forces at work in the determination of the soil zones will also be discussed.

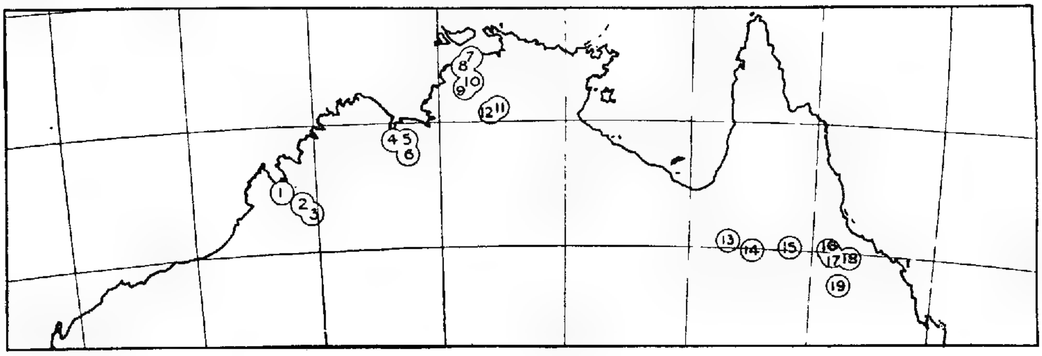
The soils of the Dutch East Indies, which have been described by Mohr (1933, 1934), should afford a useful parallel. Generally speaking, however, those of Australia's nearest neighbours, Dutch Timor and Dutch New Guinea, are relatively little known, and Mohr emphasises climatic conditions and parent rocks rather than the soils themselves. Dutch Timor, with a rainfall varying from 37 to 79 inches and with annual drought periods of from eight months to two months, should afford a better parallel with Australia within these limits of rainfall than does New Guinea.

SOIL-FORMING PROCESSES AND THE CLIMATIC FACTOR

In considering the principal climatic factors responsible for the soil-forming processes in tropical Australia, it has been found necessary to emphasise three factors:

(1) Amount of rainfall and its efficiency as controlled by evaporation.
(2) Intensity and length of the drought period.
(3) Intensity of daily rainfall.

The first factor, the actual amount of the rain and its efficiency as determined by evaporation, is probably best considered on a monthly basis rather than on an annual basis. The degree of leaching to which the soil may be subject is determined by the balance between rainfall and the loss of soil water by direct evaporation, the transpiration of plants and percolation through the soil. A complicating factor in tropical Australia is the high proportion of run-off, with the result that local topography and micro-relief may be very important in determining the



Map 1

MAP 1 KEY TO LOCALITIES

Site Number		Soil Sample Numbers
1	Yeeda	5183, 5184
2	Liveringa	5178, 5179, 5180, 5181, 5182
3	Noonkanbah	5186, 5187, 5188, 5189, 5190, 5177
4	Wyndham	5215
5	Ivanhoe	5210, 5211
6	Argyle	5214, 5216, 5218, 5212
7	Darwin-Koolpinyah	5229, 5230, 5231, 5236, 5237, 5238
8	Batchelor	5239, 5240, 5241
9	Stapleton	5244, 5245, 5246, 5247, 5249
10	Adelaide River	5253, 5254, 5256, 5257
11	Katherine	5259, 5261, 5262
12	Manbulloo	5267, 5268, 5269
13	Millungera	3466, 3467, 3468, 3469
14	Saxby Downs	3460, 3461, 3462, 3463
15	Chudleigh Park	3455, 3456, 3457, 3465
16	Myola	3446, 3447, 3448, 3449
17	Barrington	3443, 3444, 3445
18	Cardigan	3439, 3440, 3441, 3442
19	Mirtna	3470, 3471, 3472, 3473

character of the drainage through the soil. Quite a number of soils examined were associated with ironstone gravels, and these probably with lateritic parent materials which do not show the same obvious tendency to podsolisation as do more normal soils. Therefore, in spite of relatively high rainfalls for three or four months of the year, only the leaching out of calcium carbonate is completed, and full leaching with the removal of exchangeable calcium and mobilisation of iron oxides is restricted to swampy areas. If the pH values of the samples recorded later are taken as indices of the degree of leaching, it will be seen that on the whole only a mild degree of podsolisation is achieved.

The second factor, the length and intensity of the seasonal drought, must be considered also in this connection. It is quite possible that the prevailing redness of soils under Mediterranean and monsoonal conditions may be determined by this drought period which dehydrates the free iron oxides in the soil, and this protects them from leaching during the wet season. For maps illustrating the monthly climatic indices expressed in terms of the ratio of rainfall to saturation deficit, and for details of the lengths of the wet season and drought periods, reference may be made to a previous publication in these Transactions (Prescott, 1938).

The intensity of the rainfall itself, expressed most simply in terms of the amount of rainfall per rainy day, is a very important factor in the tropics in determining the degree of soil erosion. If reference be made to fig. 6 in the Bulletin "The Soils of Australia in Relation to Vegetation and Climate" (Prescott, 1931), the minimum intensity of rainfall in Australia is seen to be of the order of 0·15 inches per wet day, and the maximum intensity is 0·60 inches per wet day. This high value is at some distance inland from the northern coast and must play an important part in determining the character and amount of the run-off in these parts of Australia. The rivers running into the Indian Ocean, the Timor Sea and the Gulf of Carpentaria are essentially storm-water drains, many of them of very large size but dry, except for waterholes and certain reaches, for the greater part of year. Generally speaking, an average intensity of 0·30 inches per wet day is required before drainage lines develop in southern Australia. The intensity of rainfall in Timor and Dutch New Guinea ranges from 0·53 to 0·83 inches per wet day. In the mandated territory of New Guinea the range is from 0·33 to 0·71.

It is generally recognised that the most erosive rains are those immediately following a dry period, and it is to be expected therefore that opportunities for such erosion under natural conditions will be very common in northern Australia.

THE SOIL ZONES OF TROPICAL AUSTRALIA

The major soil zones in tropical Australia may be divided into nine groups. Each group of soils is associated with a characteristic native vegetation, frequently with indicator species of plants, a feature which assists materially in interpreting the reports of other observers when the correlations have once been worked out by investigations in the field. The distribution of these main soil groups will be found in the accompanying map, in which subdivision of some of the groups has made possible the recognition of twelve principal groups of soils.

1 *Desert sandhills.*

The only part of the Australian sandy deserts occupying any portion of tropical Australia belongs to the northern part of the Great Sandy Desert of Western Australia, the boundaries of which have been more accurately defined in recent years by the aerial reconnaissances of the Mackay expeditions, particularly that of 1933. An outlier of this desert lies between Tanami and Tennant's Creek. This was traversed by Davidson (1905) in 1900 and by Chewings (1930) in 1909. The sandhills have an east-west trend and are parallel. The principal vegetation consists of species of *Triodia.* Generally speaking, the colour of the sandhills is fiery red and in parts they are very close together, particularly to the north-west of Lake Mackay. The red colour of these desert sands shows a higher degree of saturation than can be matched by means of the Munsell colour disks as standardised and recommended for use with soils.

2 *Soils of the desert and semi-desert other than sandhills*

The soils of the semi-desert country, characterised by an *Acacia* grassland including mulga (*Acacia aneura*) in the central area and gidgea (*Acacia Cambagei*, and *Georginae*) towards the Queensland border, have not been investigated in any detail. The plains are intersected by ranges and by channel country in the south. Samples of soils from the country between the Granites and Lake Mackay have been previously reported upon (Prescott and Skewes, 1938), and there is no reason to believe, from the degree of acidity of this group of soils and from the presence of ironstone gravels, that they are residual from a former wet climatic period. In this area, instead of a mulga savannah or mulga scrub, the plant association, according to Professor J. B. Cleland,[1] is one of *Triodia* with small trees and shrubs. These latter include the mallees, *Eucalyptus gamophylla, pachyphylla* and *odontocarpa*, several species of *Hakea*, of which *H. lorea* is common, and a number of acacias, including *A. coriacea* and *notabilis*. The association is very similar to that recorded by Blake (1938) for the sand plains of south-western Queensland. These soils may be separated for mapping purposes into two groups—the desert loams and the desert sand plains.

3 *Stony tablelands and ranges*

It has been emphasised above that the character of the rainfall in tropical Australia is favourable to a much greater degree of erosion than is common in southern Australia. This erosion is the result of the more torrential character of the rainfall, and is probably most active following upon the long winter drought and the firing of the dried grass which has been practised by the aboriginal population for many centuries.

The importance of this aspect of erosion in monsoonal regions cannot be over-emphasised, and the key to the soil-forming processes may well lie in its recognition. It is worth while to quote from two other observers of this phenomenon. Gautier (1935) vividly describes the process in French West Africa in the following terms:

> "The rains are concentrated into a few months; there is a long dry season, at the end of which the country is scorched, naked, powdery. This alternation is obviously favourable to the progress of erosion. The desiccated rock material offers a minimum resistance to the torrential downpour of the equatorial rains."

Similarly Voisey (1939), in his summary of the stratigraphy of the Northern Territory, says:

> "Alluvial flats occupy large areas of country and separate rocky hills. This alluvium has accumulated during the present cycle of erosion owing to the action of heavy monsoonal rains. Disintegrated rock material has been washed off the hills and deposited in the valleys, so that even small creeks have wide flood plains which end abruptly against hills of almost bare rock."

Under these conditions, generally speaking, two types of country may be recognised in Australia—the steep-sided ranges and the tablelands associated either with horizontally bedded rocks or with cappings of ironstone or laterite. Some areas may be practically devoid of soil, particularly in the north-west region of Western Australia in the Nullagine, Hamersley and Ashburton soil provinces of Teakle (1938), but elsewhere there may be a thin cover, or on gentle slopes somewhat deeper soils which are very stony. Apart from the north-west region just mentioned, important areas include the Kimberley region between the King Leopold Range and the Carr Boyd Range, the eastern section of Arnhem Land and the mining country of the eastern half of Cape York Peninsula and to the west of the Atherton Tableland.

The vegetation carried by these ranges is usually a savannah woodland of scattered eucalyptus and poor grasses. If the drought season is at all lengthy species of *Triodia* become dominant. In the Nullagine-Hamersley country of Western Australia *Triodia* dominates the landscape and trees are few. In the rugged country of the Cloncurry-Mount Isa district of Queensland, with somewhat better rainfall, the community is one of mountain gum and spinifex (*Eucalyptus pallidifolia—E. leucophylla—Triodia*) and has been described by Blake (1938). This and related communities on stony country extend into the

[1] Privately communicated.

Northern Territory to the north of the Barkly Tableland and beyond the McArthur River. *Triodia* communities also occur on the ranges and tablelands in the vicinity of the Victoria River. The vegetation of ranges in the higher rainfall areas of the Kimberleys has been described by Gardner (1923), who distinguishes between basaltic savannahs and sandstone savannahs. In neither case is *Triodia* present, the wet season being of sufficiently long duration to ensure the permanence of better grasses.

4 *Brown soils of light texture*

The soils immediately on the wetter side of the desert areas belong to the group of brown soils. They are associated either with an open grassland or savannah or with a savannah woodland of low trees, the association depending upon the texture and level of fertility of the soil itself. The marked difference in general character and manner of use of the two main groups of light-textured and heavy-textured types, makes it worth while to separate them in any discussion. The light-textured types, including sands and sandy loams, are important pastorally in the Kimberleys and occur also in Queensland. They have a temperate parallel in the mallee soils of the south, but differ from them in so far as they are relatively free from salt and are free from calcium carbonate except possibly in the very deep horizons.

The Pindan country of Western Australia, which includes areas near Broome and Derby, and the sandy country between the alluvial plains of the Fitzroy and the King Leopold Range are very characteristic. The Warralong province of the north-west of the same State may be included. The Cockatoo Sands across the Ord River from Ivanhoe Station afford another example, and the country between Victoria River Downs and Daly Waters should probably be included. In Queensland an area between the Downs country and the mining belt at Croydon has been noted and sampled on Saxby Downs. Owing to the light texture of these soils the rains penetrate easily and leaching is possible during the wet season. The soils are in consequence neutral to somewhat acid in reaction and accumulations of calcium carbonate in the profile have not been observed, although such accumulations are common in the case of heavier soil types in the same localities. In some cases ironstone gravels are associated with these soils, as on Saxby Downs, and this suggests that in such cases they may be derived from older and leached soils. The Warralong province of Western Australia has been described by Teakle (1938); here the monsoonal trees, whitewood (*Atalaya hemiglauca*) and *Bauhinia Cunninghamii* are associated with the kanji (*Acacia pyrifolia*), corkwood (*Hakea lorea*) and other small trees of the semi-desert region. The grasses include species of *Triodia, Triraphis, Eragrostis* and *Chrysopogon*.

Gardner (1923) has described the vegetation of the Pindan country. A characteristic tree is the Pindan wattle (*Acacia tumida*). Small trees mentioned by him as being prominent include a bloodwood (*Eucalyptus pyrophora*), *E. miniata*, *E. papuana* and *Erythrophleum Laboucheri*. The shrubs include the Konkerberry (*Carissa lanceolata*), *Melaleuca alsophylla* and two species of *Terminalia*. The grasses are usually coarse and *Andropogon affinis*, speargrass or sugargrass, is very common.

The Pindan sands like the mallee sands frequently take the form of low sandhills having an east-west trend, suggesting that they are possibly a vegetated extension of the sandy desert which lies to the south and east.

Pastorally the main value of these sandy soils is best achieved in combination with the heavier soil types. These latter are usually very boggy in the wet season and the sandy country on the higher level is usually safe for cattle and sheep at this period. The sands respond quickly to rain, but the fertility level and carrying capacity are low. They can only be reasonably managed when heavy soils and flood plains are readily accessible.

The general character of these soils may be gathered by reference to Table 1. Descriptions of full profiles are not generally available.

The samples from Saxby Downs include surface scrapings consisting of a coarse sand containing about 3% of fine gravel. The colour is somewhat pinkish as a result of the intense insolation during the dry season, in marked contrast with the brownish colour of the true soil immediately below. In undisturbed soils in these practically uninhabited regions, this thin surface layer is very characteristic. It is washed almost free from clay by the rains.

Generally speaking, these sandy soils are deficient in plant foods, particularly in phosphates. There is, however, a scale of fertility level even here, and as in the desert soils previously described (Prescott and Skewes, 1938) this low fertility level is associated with *Triodia* as the main perennial grass.

5 *Brown soils of heavy texture.*

The most important pastoral soils in tropical Australia are brown soils of heavy texture carrying an open grassland in which Mitchell grasses (*Astrebla* spp.) and Flinders grasses (*Iseilema* spp.) are important and characteristic.

TABLE 1 – ANALYTICAL DATA RELATING TO CHARACTERISTIC BROWN SOILS OF LIGHT TEXTURE.

Profile No.	1		2		3		4			
Locality	Liveringa		Yeeda		Ivanhoe		Saxby Downs			
Sample No.	5178	5179	5183	5184	5210	5211	3460	3461	3462	3463
Horizon	A	B	A	B	A	B	A_0	A	B	BC
Depth (inches)	0–5	5–14	0–10	10–20	0–6	6–18	0	0–10	10–30	30–36
Colour *	RB	RB	RB	R–RB	RB	R	LRB	B–GB	BYB	DYB
Reaction (pH)	6.8	6.9	6.6	6.7	6.7	6.7	6.3	5.8	5.5	6.1
Mechanical Analysis:	%	%	%	%	%	%	%	%	%	%
Coarse sand	42.4	41.6	20.4	20.8	40.1	45.0	87.7	55.5	53.8	55.1
Fine sand	45.0	44.3	72.0	69.8	51.4	44.1	11.1	35.0	35.5	35.8
Silt	4.4	3.7	1.8	1.2	2.2	2.0	0.4	2.1	2.1	2.1
Clay	7.4	10.2	5.7	8.1	6.0	8.9	1.0	7.0	8.3	7.3
L. on acid treatment	0.3	0.4	0.3	0.2	0.2	0.2	0.0	0.1	0.1	0.0
Moisture	0.5	0.4	0.2	0.3	0.2	0.2	0.1	0.4	0.4	0.3
Chemical Analysis										
L. on ignition	1.4	1.5	1.2	1.2	1.3	1.4	0.6	1.2	1.2	1.0
Nitrogen (N)	0.018	0.013	0.018	0.011	0.015	0.010	0.009	0.014	0.011	0.010
Phosphoric acid (P_2O_5)	0.019	0.016	0.005	0.007	0.007	0.008	0.005	0.014	0.012	0.010
Potash (K_2O)	0.19	0.22	0.10	0.12	0.06	0.08	0.03	0.09	0.08	0.07
Soluble salts	0.007	0.005	0.005	0.004	0.006	0.005	0.005	0.004	0.005	0.005

* Key to soil colours in this and subsequent tables: R = red; B = brown; L = light; D = dark; Y = yellow; G = grey; Bl = black; W = white; Ch = chocolate.

Profile No. 1—Paradise Section of Liveringa, West Kimberley, W. Aust. Pindan country with red anthills and *Triodia*. Rainfall, 22 inches. Length of season, 3·5 months.

Profile No. 2—Yeeda, West Kimberley, W. Aust. Sandy coastal pindan country. Rainfall, 24 inches. Length of season, 4·1 months.

Profile No. 3—Ivanhoe, East Kimberley, W. Aust. Cockatoo Sands. A savannah woodland with tall grasses. Rainfall, 33 inches. Length of season, 4·4 months.

Profile No. 4—Saxby Downs, Nth. Queensland, south of Saxby River, 13 miles north-east of homestead. The vegetation consists of a savannah woodland with low trees and some tall "spear grass," probably *Andropogon* and a little *Triodia*. The trees include *Bauhinia*, sandalwood, various acasias and beefwood (*Grevillea*). Rainfall, 20 inches. Length of season, 3·1 months.

Many of these are alluvial soils on the desert margins, watered to a certain extent by flood waters, and would include the plains of the Fortescue and possibly the plains of the Sturt Creek. The alluvial country of the Fitzroy and Ord Rivers is important also, but there are also heavy soils at higher levels derived from suitable rocks, such as basalt, which tend to be stony but which are very important pastorally, particularly in the valleys of the Ord and Victoria Rivers.

Further east the Barkly Tableland and the Queensland Downs between Cloncurry and Hughenden afford characteristic examples. The soils are usually brown in colour, cloddy in texture and contain calcium carbonate and frequently gypsum in the profile. The colour range varies, however, from dark grey to chestnut.

The pastoral country of the Barkly Tableland is a complex of Mitchell grass downs, *Bauhinia* savannahs, and low lying, heavy country subject to flood, which is not at all well understood and does not appear to have been visited by any ecologist. The pastoral community recognises grass country and desert country, the latter being used in the wettest part of the season or again as reserve country during drought.

TABLE 2 - ANALYTICAL DATA RELATING TO SOIL PROFILE FROM NCONKANBAH, W.AUST.

Depth (inches)	0	0-5	5-17	17-35	35-48
Reaction (pH)	7.2	7.7	8.8	9.1	7.9
Mechanical Analysis:	%	%	%	%	%
Coarse sand	9.9	10.4	10.4	10.5	9.1
Fine sand	52.3	46.7	45.7	45.6	41.7
Silt	9.8	8.8	8.1	8.3	7.7
Clay	22.8	30.1	31.3	28.6	28.4
L.on acid treatment	1.4	1.0	1.9	3.8	8.7
Moisture	2.9	3.9	4.1	4.0	5.2
Chemical Analysis:					
L. on ignition	5.5	3.6	3.7	3.9	3.6
Calcium carbonate	0.03	0.01	0.73	1.37	1.46
Calcium sulphate	-	-	-	0.03	5.81
Total soluble salts	0.04	0.01	0.03	0.04	-
Organic carbon (C)	1.73	0.41	0.22	-	-
Nitrogen (N)	0.118	0.034	0.024	-	-
Phosphoric Acid (P_2O_5)	0.036	0.020	0.018	-	-
Potash (K_2O)	0.43	0.41	0.39	-	-
Exchangeable Bases:					
Total (m.e.per 100 gms.)	-	19.6	18.0	12.2	-
Proportion as: Ca	-	76	79	65	-
Mg	-	20	18	27	-
K	-	3	2	2	-
Na	-	1	1	4	-

Locality: Noonkanbah; Terrace of Fitzroy alluvium near homestead. Pure stand of *Triodia*. Rainfall, 20 inches. Length of season, 3·0 months.

Description of profile:

Sample No. 5186: surface half-inch—Dust mulch round clumps of *Triodia*; brown to grey-brown.

Sample No. 5187: 0–5 inches—Nutty structure, brown to grey-brown.

Sample No. 5188: 5–17 inches—Cloddy structure, with white flecks of calcium carbonate. Brown to dark grey-brown.

Sample No. 5189: 17–35 inches—Cloddy structure, white flecks increasing. Brown to dark grey-brown.

Sample No. 5190: 35–48 inches—Cloddy structure, gypsum, increasing with depth.

Samples of these soils have been collected on the Fitzroy and on Argyle Downs in the Kimberleys and have been examined at Victoria River Downs and at several points in the Queensland areas. Samples from a profile on Millungera Station in North Queensland are described below.

The vegetation varies from almost pure grassland to open savannah; the texture, fertility level, degree of stoniness, and amount of flooding determine the vegetation. The heaviest and low-lying soils are associated with the guttapercha, *Excaecaria parvifolia,* which is to be found from Western Queensland to the Kimberleys in quite restricted habitats on dark soils. Analyses of samples from two profiles are given in Tables 2 and 3.

TABLE 3 - ANALYTICAL DATA RELATING TO SOIL PROFILE FROM MILLUNGERA, N.QUEENSLAND.

Sample No.	3466	3467	3468	3469
Depth (inches)	0-12	12-24	24-36	36-42
Reaction (pH)	8.0	8.6	9.1	9.3
<u>Mechanical Analysis:</u>	%	%	%	%
Coarse sand	38.1	37.7	36.3	36.7
Fine sand	12.4	10.1	10.2	9.9
Silt	10.0	9.5	9.3	9.3
Clay	36.5	38.6	39.1	38.9
L.on acid treatment	0.8	1.2	1.4	2.0
Moisture	3.4	3.9	4.0	4.1
<u>Chemical Analysis:</u>				
L.on ignition	3.7	3.8	4.3	4.3
Calcium carbonate	0.17	0.28	0.49	0.84
Total soluble salts	0.02	0.03	0.05	0.07
Nitrogen (N)	0.025	0.016	0.014	0.017
Phosphoric acid (P_2O_5)	0.017	0.012	0.011	0.011
Potash (K_2O)	0.04	0.03	0.03	0.03

Locality: Millungera, clean skin paddock, 26 miles by road from homestead. Open savannah with a few bloodwoods and whitewood *(Atalaya).* Rainfall, 20 inches. Length of season, 3·1 months. Heavy grey soil (very dark grey-brown to brown) throughout profile.

The two profiles selected are of relatively low fertility but quite characteristic. Teakle (1938) also quotes data for a greyish-chocolate heavy soil from Ivanhoe, carrying a Mitchell grass—*Bauhinia* savannah, very similar in character to the above. An interesting feature brought out is the very low salt content and absence of solonisation, in marked contrast to conditions in similar soils in southern Australia. Information regarding other heavy-textured soils from the Kimberleys is given in Table 4. The soils from Liveringa and Noonkanbah are on Fitzroy alluvium. All are associated with grasslands.

TABLE 4 - ANALYTICAL DATA RELATING TO HEAVY-TEXTURED BROWN SOILS FROM THE KIMBERLEYS.

Soil No.	Colour	Depth (inches)	Locality	Clay %	$CaCO_3$ %	N %	P_2O_5 %	K_2O %	Total salts %	Reaction pH
5214	Cn.	0-9	Argyle.Newry Gate	48	0.11	0.095	0.038	1.39	0.02	7.9
5216	v.DG	0-6	Argyle.Rosewood Gate	50	5.61	0.056	0.020	0.60	0.04	8.8
5218	v.DG	0-4	Argyle	54	0.16	0.043	0.028	0.89	0.02	8.6
5212	Ch.	0-7	Argyle-stony soil	49	0.01	0.074	0.043	0.58	0.02	7.0
5182	DGB	0-6	Upper Liveringa	48	-	0.034	0.042	0.98	0.01	7.9
5181	DB-GB	0-6	Upper Liveringa	44	-	0.056	0.050	0.87	0.04	6.9
5180	DGB	0-6	Upper Liveringa	38	-	0.038	0.041	0.83	0.01	7.6
5177	B	0-12	Noonkanbah	39	-	0.037	0.030	0.83	0.10	7.5

6 *Black earths, modified black earths of the brigalow scrubs, and rendzinas.*

The belt of true black earths in Queensland does not extend very far north into the tropics and is closely associated with scrubs or low forests in which brigalow (*Acacia harpophylla*) is frequently an important constituent. The black earths proper carry an open grassland in which the important species is bluegrass (*Dichanthium sericeum*). The analyses of characteristic examples have already been recorded by Hosking (1935).

The northern limit of these soils is in the neighbourhood of Natal Downs and extends down the valley of the Suttor towards the Burdekin. The associated brigalow has been observed as far north as Mirtna, where the soil profile was examined and samples taken. There is evidence generally in Queensland that the brigalow is tending to invade the open grasslands even where the soils are quite

TABLE 5 - ANALYTICAL DATA RELATING TO SOIL PROFILE FROM MIRTNA, N.QUEENSLAND.

Depth (inches)	0–4	4–5	5–13	13–25
Reaction (pH)	6.1	6.6	7.6	8.0
<u>Mechanical Analysis:</u>	%	%	%	%
Coarse sand	27.7	27.4	20.4	23.4
Fine sand	34.8	38.9	29.3	32.0
Silt	13.2	13.5	11.7	11.2
Clay	20.6	18.3	34.7	29.0
L.on acid treatment	0.8	0.6	1.1	1.0
Moisture	2.1	1.6	4.1	3.9
<u>Chemical Analysis:</u>				
L.on ignition	4.6	2.5	3.8	3.1
Calcium carbonate	0.01	-	0.01	0.10
Total soluble salts	0.01	0.01	0.07	0.32
Nitrogen (N)	0.10	0.05	0.05	0.03
Phosphoric acid (P_2O_5)	0.04	0.02	0.02	0.01
Potash (K_2O)	0.25	0.19	0.32	0.31
<u>Exchangeable Bases:</u>				
Total(m.e. per 100 gm.)	8.8	-	15.5	15.1
Proportion as: Ca	64	-	40	27
Mg	28	-	44	45
K	6	-	2	1
Na	2	-	14	27

Locality: Mirtna, Nth. Qld., near homestead. Brigalow scrub. Rainfall, 22 inches. Length of season, 4·8 months.

Description of profile:

Sample No. 3470: 0–4 inches, grey sandy loam.

Sample No. 3471: 4–5 inches, light grey fine sand showing signs of hardpan formation.

Sample No. 3472: 5–13 inches, grey-brown heavy clay.

Sample No. 3473: 13–25 inches, whitish clay.

heavy, and there is further evidence that salt is present in many of these soils and that they are subject to some degree of solonisation. The occurrence of such salt lakes as Lake Buchanan is of some possible significance.

This belt of country is in the path of the easterly winds from the Pacific Ocean and may be subject to accessions of cyclic salt such as are known to occur in southern Australia. Some confirmation is obtained from the analysis of the samples from Mirtna, recorded in Table 5, which shows evidence of solonisation.

Throughout tropical Australia there occur many scattered examples of rendzinas, black soils derived from highly calcareous parent materials. The samples from Chudleigh Park, analysed and recorded by Hosking (1935), are from an undoubted rendzina formed on a local deposit of limestone possibly of tertiary age.

A very characteristic rendzina on limestone has been observed covering a fairly extensive area on Elsey Station in the Northern Territory. This soil was found to be relatively shallow, the vegetation was a savannah woodland which included nutwood (*Terminalia* sp.) and anthills were frequent and quite black in colour.

7 *Red soils, including red loams, residual red earths and red-brown earths.*

Soils with a predominantly red or red-brown colour are characteristic of much of tropical Australia receiving a reasonably high rainfall marked by a seasonal incidence in which the drought period is characterised by high midday

TABLE 6 — ANALYTICAL DATA RELATING TO RED-BROWN EARTHS.

Profile No.	1				2		
Locality	Cardigan, N.Q.				Manbulloo, N.T.		
Sample No.	3439	3440	3441	3442	5267	5268	5269
Horizon	A	B	BC	BC	A	B	BC
Depth (inches)	0-8	8-15	15-24	24-40	0-8	8-28	28-42
Colour	B-GB	DRB	LB	LB	RB	R-LRB	R-LRB
Reaction(pH)	7.0	6.7	7.5	7.9	5.9	5.6	5.9
Mechanical Analysis:	%	%	%	%	%	%	%
Coarse sand	48.4	29.4	31.2	45.0	67.6	64.5	56.5
Fine sand	33.6	30.5	30.6	34.3	23.2	23.0	24.8
Silt	5.7	5.3	9.2	6.7	1.1	0.5	0.9
Clay	11.4	30.3	25.7	11.8	7.0	11.0	17.1
L.on acid treatment	0.5	0.7	1.1	1.3	0.2	0.2	0.2
Moisture	0.7	2.0	2.4	1.7	0.4	0.3	0.4
Chemical Analysis:							
L.on ignition	2.5	5.0	4.6	2.6	2.1	1.8	-
Calcium carbonate	0.003	0.004	0.004	0.004	-	-	-
Nitrogen (N)	0.035	0.040	0.019	0.008	0.027	0.014	-
Phosphoric acid(P_2O_5)	0.019	0.020	0.032	0.046	0.008	0.007	-
Potash (K_2O)	0.22	0.37	0.48	0.32	0.030	0.035	-
Soluble salts	0.02	0.03	0.02	0.01	0.01	-	-

Profile No. 1—Cardigan Station, near Charters Towers. Sandy soil over granite. Savannah woodland with ironbark and bloodwood. Rainfall 26 inches. Length of season, 5·0 months.

Profile No 2—An example of a light textured soil carrying cypress pine *(Callitris)*, Manbulloo, near Katherine, N.T., along the road towards Victoria River Downs. Rainfall, 38 inches. Length of season, 4·7 months.

temperatures accompanied by relatively high rates of evaporation, particularly in autumn and spring. It appears probable that the prevailing redness of soils in regions having either a Mediterranean or monsoonal climate is associated with this drought period, during which the iron oxides are dehydrated to such an extent that mobility during the wet season, unless accompanied by waterlogged conditions, is non-existent. Where the parent materials are predominantly ferruginous, as in many soils of lateritic origin, the rainfall needs to be high and persistent before any degree of podsolisation becomes evident. Such soils may be called "ferromorphic," just as rendzinas may be referred to as being "calci-

TABLE 7 - ANALYTICAL DATA RELATING TO RED EARTHS ASSOCIATED WITH LATERITIC PARENT MATERIAL.

Profile No.	1				2				3			4		
Locality	Myola, N.Q.				Chudleigh Park, N.Q.				Darwin, N.T.			Batchelor, N.T.		
Sample No.	3446	3447	3448	3449	3455	3456	3465	3457	5229	5230	5231	5239	5240	5241
Depth (inches)	0-8	9-21	21-32	32-42	0-9	9-18	18-27	27-40	0-6	6-19	19-27	0-9	9-24	24-36
Ironstone gravel as percentage of original sample	8.5	10.0	18.4	19.9	14.8	25.9	24.2	17.7	17.8	15.7	34.0	7.9	10.9	17.9
Colour of fine earth	Ch	DRB	RB-DRB	RB	vDB	DB-DYB	DYB	DYB	DYB-DRB	R-RB	R	Ch-DB	CH	DB
Reaction (pH)	6.8	6.9	6.8	6.5	6.8	7.1	7.0	7.1	6.2	5.7	5.8	5.6	6.0	6.1
<u>Mechanical Analysis:</u>	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Coarse sand	23.4	21.4	22.6	20.7	30.0	28.0	19.1	18.3	14.4	14.4	23.8	13.5	13.2	12.8
Fine sand	15.0	7.3	4.8	5.0	20.3	16.0	12.2	13.5	48.9	44.1	40.8	36.7	31.7	31.5
Silt	16.8	10.5	7.4	8.1	13.6	9.5	10.0	11.3	7.0	6.7	6.6	13.9	13.1	14.9
Clay	37.9	52.4	58.2	58.3	30.1	40.8	54.2	51.7	25.5	32.6	27.1	33.8	39.6	39.6
L.on acid treatment	1.2	5.5	5.1	4.9	0.7	0.6	0.5	0.5	1.2	1.1	0.9	0.3	0.3	0.2
Moisture	4.2	4.9	4.5	4.5	4.2	5.0	5.5	5.8	1.3	1.2	1.2	2.0	1.8	1.8
<u>Chemical Analysis:</u>														
L.on ignition	8.9	8.9	9.4	9.5	7.0	7.8	9.8	10.1	7.6	7.1	7.4	4.7	4.7	4.6
Calcium carbonate	-	-	-	-	0.015	0.014	0.030	0.044	-	-	-	-	-	-
Nitrogen (N)	0.089	0.047	0.032	0.022	0.066	0.041	0.027	0.030	0.061	0.029	0.018	0.048	0.027	-
Phosphoric Acid (P_2O_5)	0.127	0.075	0.087	0.100	0.094	0.071	0.082	0.092	0.038	0.033	-	0.029	0.027	-
Potash (K_2O)	0.22	0.21	0.18	0.14	0.28	0.28	0.29	0.28	0.04	0.03	-	0.73	0.72	-
Soluble salts	0.021	0.018	0.018	0.016	0.015	0.011	0.014	0.016	0.010	0.009	0.005	0.027	0.009	0.006
<u>Exchangeable Bases:</u>														
Total (m.e. per 100 gms)					15.1	13.7	13.4							
Proportion as: Ca					62	58	53							
Mg					30	35	39							
K					7	6	7							
Na					1	1	1							

Profile No. 1—Myola, *via* Balfe's Creek, Nth. Qld., near homestead, 15 chains south of Lolworth Creek. A red soil associated with basalt. Native vegetation is a savannah woodland of cabbage gum, yellow bloodwood, ironbark, with *Themeda* and *Heteropogon*. Rainfall, 26 inches. Length of season, 4·8 months.

Profile No. 2—Chudleigh Park, Nth. Qld., ½ mile from George's well. A dark brown soil over basalt with ironstone gravel on the surface and in the profile. Native vegetation is a savannah woodland with *Eucalyptus papuana* and *E. crebra*. Rainfall, 26 inches. Length of season, 3·8 months.

Profile No. 3—Darwin, N.T., 6 miles south along the main road towards Adelaide River. Native vegetation is a sclerophyll forest with *Eucalyptus miniata*, *E. tetradonta*, *E. microtheca*, Pandanus, cycads, *Heteropogon*, *Themeda*. Profile bottoms on decomposing rock below 27 inches. Rainfall, 60 inches. Length of season, 6·5 months.

Profile No. 4—Batchelor, N.T. In abandoned and grassed orchard of former Government Farm. Rainfall, 58 inches. Length of season, 6·4 months.

morphic." The main characteristic of these soils is that, although rainfall is sufficient to wash down a proportion of the clay to form a subsoil heavier than the surface soil, conditions are not favourable for the mobilisation of free iron oxide, except such as is associated with the clay fraction. Calcium carbonate may or may not be present in the illuvial horizons, depending on its presence or absence in the parent materials.

In tropical Australia there are many lateritic areas, of which those in Western Queensland have recently been described and mapped by Whitehouse (1940). To the north-west of Charters Towers occurs an extensive area of red soils associated with the basaltic flow known as the "great basalt wall." These appear to be residual soils associated with a peneplain some 1,100 feet above sea level and they are characterised by heavy ironstone gravel. In all probability this area is related to the Alice Tableland, somewhat to the south, and described by Whitehouse (1940), on which the soils, similarly residual, are more podsolic in character.

TABLE 8 – ANALYTICAL DATA RELATING TO RESIDUAL AND LATERITIC PODSOLIC SOILS.

Locality	Barrington			Stapleton				
Sample No.	3443	3444	3445	5244	5245	5246	5247	5249
Gravel in original sample %	4.2	32.6	41.6	11.2	6.1	9.7	45.8	22.4
Horizon	A	B	B	A	AB	B	B	BC
Depth (inches)	0-12	12-36	36-42	0-6	6-12	12-28	28-36	36-42
Colour	DG	W-LG	W-LG	vDGB	B	B-DYB	RB	RB-R
Reaction (pH)	6.7	6.8	5.8	6.6	6.4	5.7	5.6	5.5
<u>Mechanical Analysis:</u>	%	%	%	%	%	%	%	%
Coarse sand	73.4	64.7	59.7	35.2	31.0	20.5	21.3	23.9
Fine sand	17.5	23.6	20.6	42.5	36.8	24.5	21.3	19.8
Silt	4.9	7.0	11.0	7.4	6.8	9.7	10.3	11.5
Clay	3.7	4.8	8.5	12.0	23.2	42.4	44.2	42.1
L.on acid treatment	0.1	0.1	0.2	0.4	0.3	0.4	0.4	0.3
Moisture	0.2	0.2	0.5	1.0	1.3	2.7	2.7	2.9
<u>Chemical Analysis:</u>								
L.on ignition	1.1	0.8	2.0	3.9	4.7	8.4	9.1	8.9
Nitrogen (N)	0.021	0.010	0.011	0.072	0.048	0.028	-	-
Phosphoric acid (P_2O_5)	0.011	0.007	0.007	0.013	0.014	0.026	-	-
Potash (K_2O)	0.05	0.05	0.11	0.07	0.09	0.13	-	-
Soluble salts	0.021	0.005	0.010	0.013	0.011	0.006	0.006	0.006

Profile from Barrington, Nth. Qld., at junction of Lolworth-Balfe's Creek Road with Allendale-Toomba road. Twenty-four miles from Allendale. Vegetation consists of a low tree savannah woodland of wattle, silver-leaved ironbark, broad-leaved yellow jacket and speargrass. A coarse grey sand with superficial layer of very coarse sand or fine gravel. The gravel is quartz. Rainfall, 26 inches. Length of season, 4·8 months.

Profile from near Stapleton, N.T., at the junction of the Stapleton, Brock's Creek and Daly River roads. A savannah woodland with box, ironwood and bloodwood with ironstone gravel in the profile. Rainfall, ca. 50 inches. Length of season, 5·5 months.

At a somewhat higher elevation on Chudleigh Park similar red soils occur associated with heavy ironstone gravel. In the immediate vicinity of Darwin and for some distance to the south, soils rich in ironstone gravel or associated with massive laterite give rise to similar red and red-brown soils.

Red loams over deeply weathered basalt are characteristic of the Atherton Tableland. Many typical red loams have been described previously (Prescott and Hosking, 1936). Bryan (1938) considers that many such red loams are residual in character and should be described as residual red earths. It is probable that a detailed study of the Atherton Tableland would reveal some relationships between soil types and late geological history. Soils derived directly under current climatic conditions from parent rock occur generally as red-brown earths, and it is probable that the alluvial soils on the Katherine in the Northern Territory are immature variants of the group.

The vegetation under these groups is nearly always savannah woodland with eucalypts of various species as the dominant trees. The grasses include both *Themeda* and *Heteropogon Contortus*, the latter being associated probably more with podsolised soils. In the wetter areas sclerophyll forest, as near Darwin, or rain forest, as near Atherton, may be associated with these red soils.

Both these examples show a degree of eluviation with an accumulation of clay in the subsoil. In addition, the profile from Cardigan shows an increasing degree of base-saturation in the deeper horizons, although calcium carbonate is not actually present in quantity.

8 *Podsolised soils.*

There are two main groups of podsolised soils in tropical Australia, a group near the coast and in regions of high rainfall which may be considered as of normal occurrence, and another inland group which may be considered as residual from a former wet cycle and which are generally associated with lateritic formations. The northern margins of the Alice Tableland to the south-west of Charters Towers afford good examples of this latter group.

Two examples are given in Table 8 of a residual podsol from the Balfe's Creek district in Queensland and of a podsol derived from lateritic material in

TABLE 9 - ANALYTICAL DATA RELATING TO PODSOLIC SOILS.

Locality	Adelaide River, N.T.				Katherine, N.T.		
Sample No.	5253	5254.	5256	5257	5259	5261	5262
Horizon	A	B	BC	BC	A	AB	B
Depth (inches)	0-3	19-24	24-34	34-42	0-9	9-20	20-32
Colour	LG	LB-LYB	LYB	LY-LYB	LGB-GY	LY	YB
Reaction (pH)	5.9	6.5	7.9	8.7	6.3	6.1	6.4
Mechanical Analysis:	%	%	%	%	%	%	%
Coarse sand	20.3	14.7	11.6	11.6	62.1	61.0	55.0
Fine sand	49.6	31.4	21.7	23.2	28.2	23.7	24.2
Silt	18.6	24.3	27.2	25.7	5.4	6.0	7.0
Clay	10.9	28.8	39.1	37.8	3.7	7.8	13.6
L.on acid treatment	0.1	0.1	0.2	0.9	0.4	0.4	0.6
Moisture	0.4	1.0	1.6	1.1	0.1	0.3	0.5
Chemical Analysis:							
L.on ignition	2.2	3.7	5.0	5.1	1.1	1.2	1,7
Nitrogen (N)	0.045	0.023	-	-	0.020	0.014	-
Phosphoric acid (P_2O_5)	0.008	0.009	-	-	0.012	0.015	-
Potash (K_2O)	0.50	1.08	-	-	0.12	0.18	-
Soluble salts	0.004	0.006	0.012	0.018	0.004	0.003	0.004

Profile from just south of Adelaide River, level country with chiefly *Melaleuca* sp. and very large anthills. Hardpan was present in the B. horizon. Rainfall, 55 inches. Length of season, 5·4 months.

Profile sampled 16 miles north of Katherine in granitic country—a single layer of fine white gravel covered the surface with nearly 50% of granitic gravel throughout the profile; a savannah woodland with ironwood, stringybark and a little bloodwood. Rainfall, 40 inches. Length of season, 4·7 months.

the vicinity of Stapleton in the Northern Territory. In Table 9 are given data relating to examples of podsolised soils from the Territory.

9 *Swamps and marshes.*

A factor of importance in tropical Australia in determining the character of some of the coastal districts, which is unfamiliar in the south, is the high tidal range along the coast which determines the character of the lower reaches of many of the rivers and which results in the periodic inundation of wide stretches of coast, resulting in extensive marshes and mangrove belts. Possibly the high erosive power of the early monsoonal rains is responsible also for extensive coastal plains and shallow off-shore belts, particularly around the shores of the Gulf of Carpentaria. These coastal marshes are, or have been, used for salt reclamation near Burketown and at the mouth of the Roper River. They are extensive near Wyndham and Derby, where they may be covered only by the highest tides or during the wettest part of the monsoon. Only one of these areas was sampled, near Wyndham. The relevant information is tabulated below.

TABLE 10—ANALYTICAL DATA RELATING TO SAMPLE OF SOIL FROM A MARSH NEAR WYNDHAM, W.A. (BETWEEN 9-MILE AND WIRELESS HILL)

Sample No. 5215:

pH	7·0
Total salts %	2·24
Nitrogen (N) %	0·052
Phosphoric acid (P_2O_5) %	0·048
Potash (K_2O) %	1·35
Clay %	39·5

Elsewhere local permanent springs give rise to swamps associated with jungle forests or reeds, according to the degree of drainage available. Peats may occur under these conditions even under a relatively dry climate. At Saxby Downs a burnt-out peat swamp was observed which had probably been fed from artesian springs. These peaty areas are important in the Northern Territory for market gardening—there is a well-known one near Pine Creek and another on the King River, near Marranboy.

The lower reaches of the Adelaide and Alligator Rivers, east of Darwin, are associated with extensive areas of low-lying flooded country with permanent swamps. On Koolpinyah Station near Darwin the flood plains of the Adelaide River are relatively accessible and the soil profile was examined in a locality on the swamp, four miles west of the river itself. The area is regularly flooded in summer and was still wet in the subsoil when sampled in August. The swamp carried tall grass, useful as cattle fodder and affording protection to the water buffalo which is now wild in these areas. In Table 11 are given data relating to this profile. The heavy texture, acidity of the subsoil, high salt content and high loss on acid treatment due to the presence of gypsum is to be noted. The clay was highly plastic, and in the third depth was grey with red and yellow mottlings and inclusions of gypsum.

SOME GENERAL CONSIDERATIONS

Reaction.

The reaction of the soil expressed in terms of the pH value is generally a fair index of the degree of leaching. The soils examined do not show a very wide range in this respect, and the position is further complicated by the fact that many of the soils are associated with lateritic parent material and with ironstone gravels.

The most acid soils encountered were a deep subsoil on the flood plain of the Adelaide River, sampled on Koolpinyah (pH 4·1) and a swamp in the Botanic Gardens in Darwin (pH 4·5). The most alkaline soils are those belonging to the heavy-textured grey and brown group, which may reach over pH 9 in the subsoils. Some, but not all, of the residual soils or soils derived from lateritic parent material showed an increase of acidity with depth, a feature of these soils which

TABLE 11 - ANALYTICAL DATA RELATING TO A SWAMP SOIL ON KOOLPINYAH, N.T.

Sample No.	5236	5237	5238
Depth (inches)	0-12	12-24	24-30
Colour	Bl	DG	G
Reaction (pH)	6.8	6.6	4.1
Mechanical Analysis:	%	%	%
Coarse sand	0.3	0.2	0.2
Fine sand	2.4	2.5	2.8
Silt	14.6	12.2	10.9
Clay	65.0	68.2	66.5
L.on acid treatment	3.2	6.5	6.9
Moisture	8.9	9.8	10.0
Chemical Analysis:			
L.on ignition	14.8	9.2	7.1
Nitrogen (N)	0.405	0.111	-
Phosphoric acid (P_2O_5)	0.074	0.038	-
Potash (K_2O)	0.55	0.72	-
Soluble salts	0.074	0.938	0.943
Sodium chloride	0.010	0.007	0.007

has been noted in other countries. The range of pH values observed in the surface soils of the several groups has been:

Brown soils of light texture - - -	5·8 – 6·8
Grey and brown soils of heavy texture -	6·9 – 8·8
Red earths and red-brown earths:	
(a) ordinary - - - -	6·0 – 7·0
(b) lateritic - - - -	5·6 – 6·8
Podsolised soils - - - -	5·8 – 6·7
Alluvial soils of Daly and Katherine Rivers -	6·4 – 8·5

Teakle (1938) has already pointed out the acidic character of the brown soils occurring under the relatively arid conditions of the north-western soil provinces of Western Australia.

Fertility Levels

The unimproved pastoral or forest value of any soil under a given set of climatic conditions is frequently found to be a function of the level of natural soil fertility. Frequently a scale of fertility can be expressed in terms of phosphate alone, and there is frequently also a correlation between nitrogen content and phosphate content. The samples secured and examined are too scattered and inadequate to enable a final opinion to be expressed on tropical Australia as a whole, but generalisations with respect to specific localities may prove possible. The chemical fertility will depend to a great extent on the geological source of the soil material, and this will apply particularly to the phosphate content. The potash content will, in addition reflect the climatic history of this material Little more can be done, therefore, than to group soils together from specific localities for this comparison. The comparison has been restricted to surface soils. In the case of potash the comparison is made on the basis of the ratio of K_2O to the clay content.

Generally speaking, it may be said that the analyses do not reveal any soils of strikingly high fertility except that those derived from basalt are, as usual, relatively rich in phosphate. The youngest soils, those derived from recent alluvium, show the highest ratio of potash to the clay content. Many of the others, particularly those associated with ironstone gravels, show low ratios for potash. In the immediate neighbourhood of Darwin relatively high values for

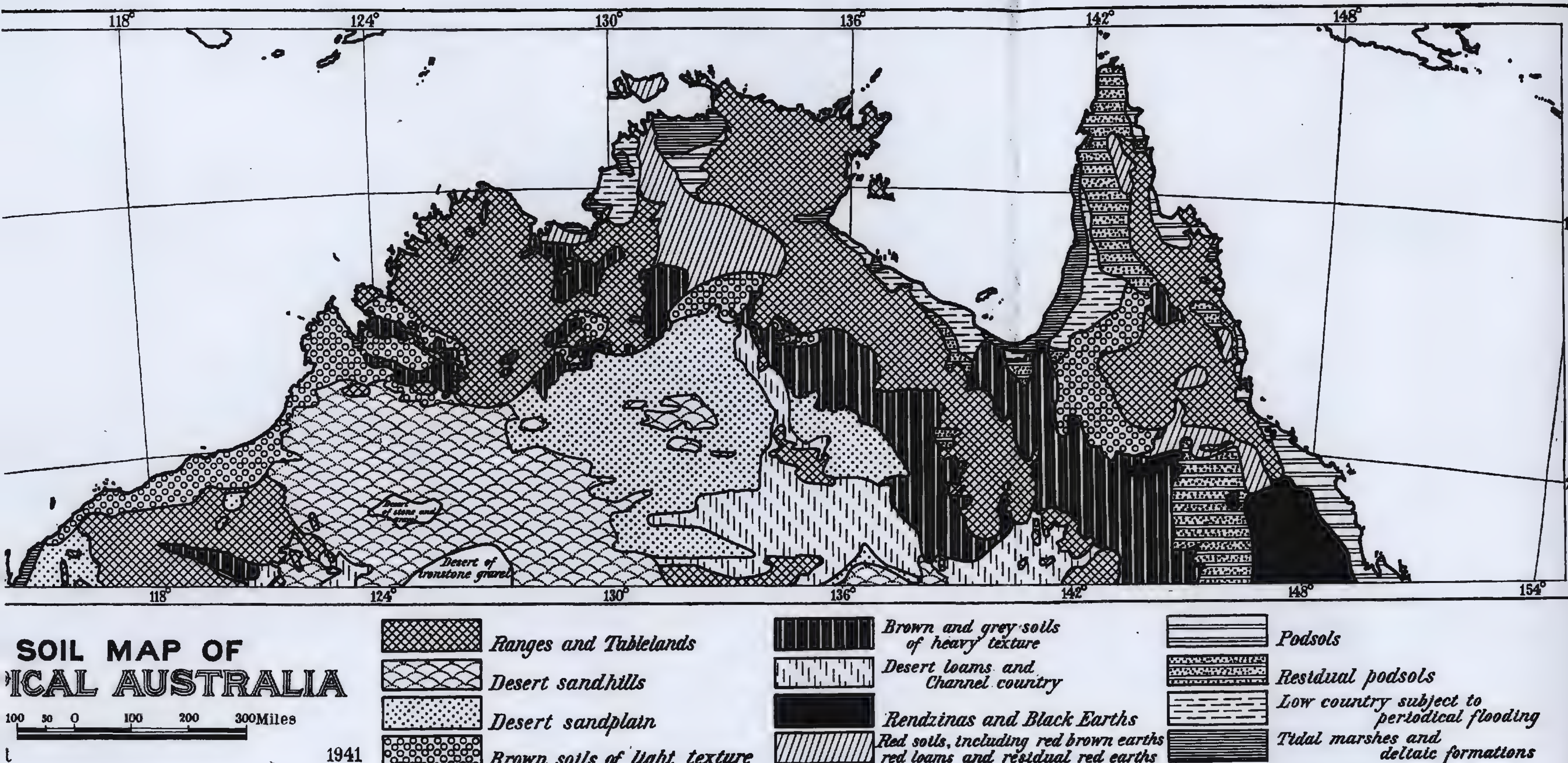
TABLE 12 - SUMMARY OF INFORMATION REGARDING PLANT-FOOD STATUS OF SOME SOILS FROM TROPICAL AUSTRALIA.

	Nitrogen (N) %	Phosphate (P_2O_5) %	Potash (K_2O) per 100 gms. clay
Alluvial Soils:			
Fitzroy	0.034 - 0.056	0.030 - 0.050	2.06 - 2.19
Daly	0.020 - 0.047	0.017 - 0.045	3.31 - 3.86
Katherine	0.027 - 0.102	0.021 - 0.045	4.58 - 6.80
Kimberleys:			
Light - textured brown soils	0.012 - 0.018	0.005 - 0.019	1.00 - 2.57
Heavy soils, E.Kimberley	0.043 - 0.095	0.020 - 0.043	1.19 - 2.89
Northern Territory:			
Darwin and Bathurst Island	0.056 - 0.156	0.028 - 0.086	0.22 - 1.49
Batchelor to Katherine	0.020 - 0.072	0.008 - 0.029	0.43 - 4.59
North Queensland:			
Basaltic red earth residuals	0.089,0.168,0.066	0.127,0.351,0.094	0.58,0.78,0.93
Charters Towers to Millungera	0.021 - 0.104	0.011 - 0.082	(0.11) 1.22 - 1.93

phosphate of the order of 0·08% have been noted. One of the basaltic soils quoted above has a very high value for phosphate (0·351%). This is from an old cow-yard growing molasses-grass and is a good example of localised man made fertility. Another exceptional soil, not quoted elsewhere in this paper, was a highly calcareous coastal soil near Darwin derived from fragments of shell and carrying a dense jungle forest situated between the mangrove belt of the coast and the sclerophyll forest of the inland ironstone country. Values of 0·252% were found for nitrogen and 0·258% for P_2O_5.

Salinity.

There is very little evidence of salinity in any of the samples examined except where associated with the sea-coast or with tidal marshes. In the Kimberleys and the north-west of Western Australia the provision of salt licks for stock, particularly for sheep, is regarded as essential. Only the sample from Mirtna on the northern fringe of the brigalow country of Queensland shows any degree of solonisation, and it is interesting to compare the values for exchangeable bases in the three profiles specifically examined and quoted elsewhere in this paper, namely those at Chudleigh Park and Mirtna. In heavy soils gypsum may be encountered, but this is rarely associated with chlorides.


SOIL MAP OF
ICAL AUSTRALIA
100 50 0 100 200 300Miles
1941
118° 124° 130° 136° 142° 148° 154°
14° 20°
Desert of stone and gravel
Desert of ironstone gravel
Ranges and Tablelands
Desert sandhills
Desert sandplain
Brown soils of light texture
Brown and grey soils of heavy texture
Desert loams and Channel country
Rendzinas and Black Earths
Red soils, including red brown earths red loams and residual red earths
Podsols
Residual podsols
Low country subject to periodical flooding
Tidal marshes and deltaic formations

MAPS

Two maps are published with this account: the first is a guide to the sites from which the soil samples described have been obtained.

The second map represents the senior author's interpretation of all the data so far examined, based on personal traverses and on a re-examination of records of exploration and geological reports. The two volumes, "Northmost Australia," by R. Logan Jack (1921), have proved to be a useful guide to exploration in the Cape York Peninsula. The recent works by Blake (1938), Bryan (1938) and Whitehouse (1940), of the University of Queensland, have provided much new material. In this map twelve zones have been recognised:

1 Ranges and tablelands
2 Desert sandhills
3 Desert sandplain
4 Brown soils of light texture
5 Brown and grey soils of heavy texture
6 Desert loams and channel country
7 Rendzinas and black earths
8 Red soils, including red-brown earths, red loams and residual red earths
9 Podsols
10 Residual podsols
11 Low country subject to periodical flooding
12 Tidal marshes and deltaic formations

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LIFE CYCLE OF THE TREMATODE, DIPLOSTOMUM MURRAYENSE J. & C.

By T. HARVEY JOHNSTON and L. MADELINE ANGEL, University of Adelaide

Summary

In 1938 was published an account of *Cerearia murrayensis*, a common furcocercaria occuring in *Limnaea lessoni* in the swamps of the Lower Murray River (Swan Reach and Tailem Bend), infection being observed from December to May, the infection rate varying from 6 to nearly 50% (Johnston and Cleland, 1938). Its similarity to C. *flexicauda* Cort and Brooks from North America was noted. The parasite was allotted to the *Proalaria* group (*Proalaria* is now considered a synonym of *Diplostomum*), and its next larval stage, a *Diplostomulum*, was stated to occur in the eyes of freshwater fish. The sporocyst stage was also described.

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By T. Harvey Johnston and L. Madeline Angel, University of Adelaide

[Read 12 June 1941]

In 1938 was published an account of *Cercaria murrayensis*, a common furcocercaria occuring in *Limnaea lessoni* in the swamps of the Lower Murray River (Swan Reach and Tailem Bend), infection being observed from December to May, the infection rate varying from 6 to nearly 50% (Johnston and Cleland, 1938). Its similarity to *C. flexicauda* Cort and Brooks from North America was noted. The parasite was allotted to the *Proalaria* group (*Proalaria* is now considered a synonym of *Diplostomum*), and its next larval stage, a *Diplostomulum*, was stated to occur in the eyes of freshwater fish. The sporocyst stage was also described.

Next year an account was given of the metacercaria, *Diplostomulum murrayense*, obtained from the lens of various species of fish in about six weeks after experimental infections with cercariae taken from October to April. The infection route was traced and found to be similar to that described by Van Haitsma (1931) for *D. flexicaudum*. A review of the literature relating to the occurrence of similar parasites in the eyes of freshwater fish in Europe and North America was also given. These parasites were stated to be of considerable economic importance because heavy infection, in the case of very young or small fish, commonly resulted in high mortality (Johnston and Simpson 1939).

Freshwater fish reported capable of being infected experimentally with *C. murrayensis* were golden carp (*Carassius auratus*), rice fish (*Oryzias latipes*), congolli (*Pseudaphritis urvillei*), *Pseudomugil signifer* and *Melanotaenia nigrans*, the last three being native fish. Natural infection was reported to have been observed in the lens of larger specimens of the golden carp, Murray cod (*Maccullochella macquariae*), callop (*Plectroplites ambiguus*), and Murray bream (*Therapon bidyana*), all from Tailem Bend. Attempts to obtain the adult stage by feeding diplostomula to laboratory-bred white rats and to muscovy ducklings led to negative results. It was believed that the adult would be found in gulls or terns; most probably the silver gull, *Larus novaehollandiae*.

Later experience led us to regard the marsh tern, *Chlidonias leucopareia*, as the probable host, because of abundance of that bird on the swamps from late spring to autumn, its food consisting mainly of dragonfly larvae, prawns and small fish. Thanks to the assistance of Messrs. G. and F. Jaensch and L. Ellis, we were able to examine some of these birds, finding minute diplostomes in four out of nine of them, taken during the period November to March, some of the parasites being very young and similar in size and anatomy to the parasites from fish eyes. On one occasion fish lenses were also present in the digestive tract, and, on another, abundant remains of very small fish were seen along with various stages in the development of the trematode from the diplostomulum stage to the adult.

Since the original account was published, we have found in twelve collections of *Limnaea lessoni* taken at Tailem Bend during the summer months 1938-41, infection varying from 0 to 25%, *C. murrayensis* being identified from 68 out of 680 snails, *i.e.*, in 10% of the total examined during the period.

Eggs from adult diplostomes taken from a marsh last December were added to a small aquarium containing laboratory-bred *L. lessoni*, cercariae (*C. murrayensis*) being noticed 36 days later. Fish (*Gambusia affinis*) were subjected to infection by these cercariae, many fully developed diplostomula (fig. 5) being recovered from the lenses four weeks after the earliest infection; hence the minimum period may be less than that observed. Daily attempts were made to infect tadpoles of *Limnodynastes tasmaniensis*, but this seems to be a refractory host, since the parasites found in the lens had not passed beyond the tail-less cercaria stage even after six days from the commencement of infection.

Since the original account of the diplostomulum stage was published, we have found it occurring under natural conditions during the summer 1940-41 in the following fish in the Murray River or swamps at Tailem Bend and Murray

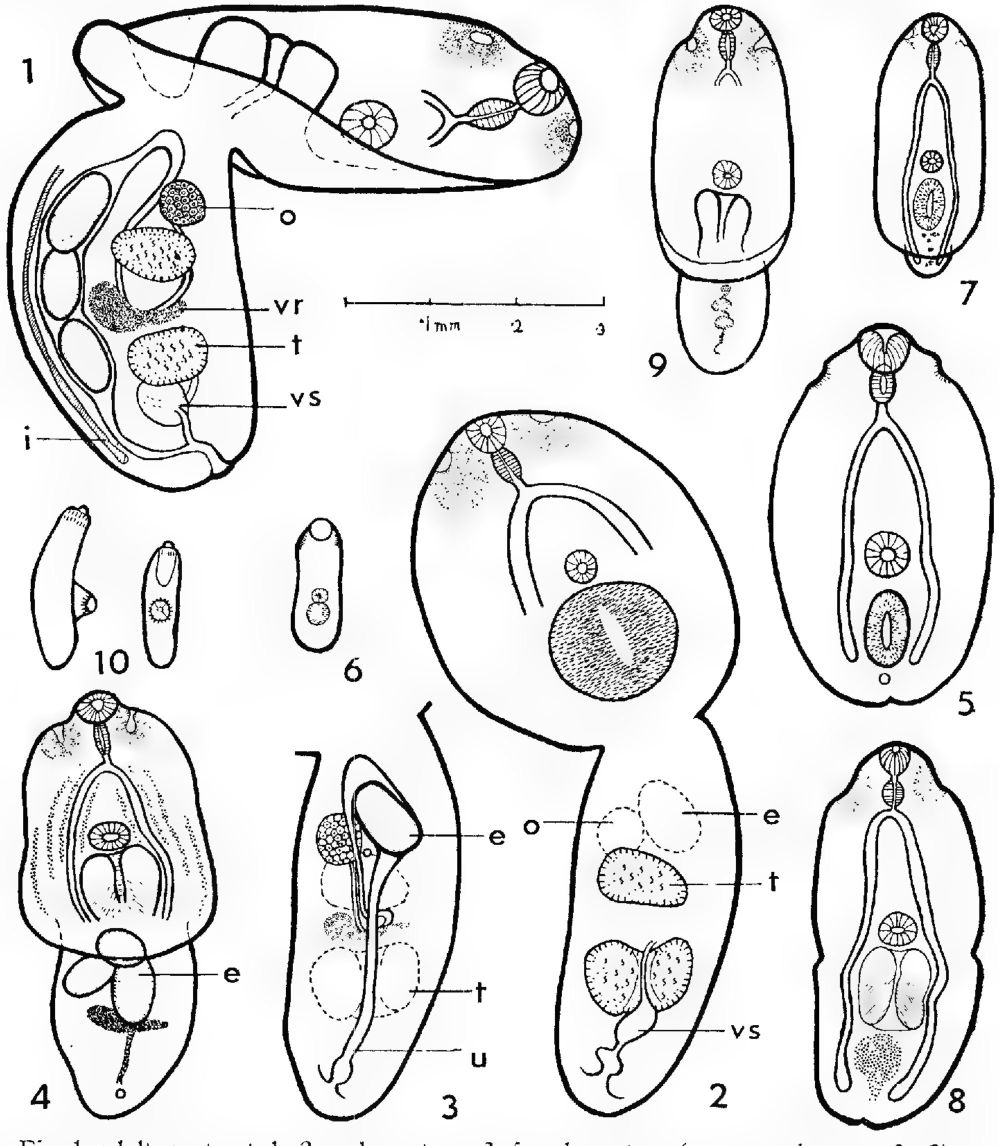

Fig. 1, adult, contracted; 2, male system; 3, female system (same specimen as fig 2); 4, adult; 5, 6, diplostomula from *Gambusia;* 7, 8, 9, successive stages of development in *Chlidonias;* 10, youngest stages seen in *Gambusia.* All figures were drawn to same scale. e, egg; i, intestine; o, ovary; t, testis; u, uterus; vr, vitelline reservoir; vs, vesicula seminalis.

Bridge: *Retropinna semoni, Carassiops klunzingeri, Melanotaenia nigrans, Nannoperca australis, Pseudaphritis urvillei, Crateroccphalus fluviatilis, Mugilogobius galwayi, Philypnodon grandiceps, Mogurnda adspersa, Percalates colonorum* and *Carassius auratus;* and from *Galaxias attenuatus* and *G. olidus* from other South Australian localities. Our records indicate that *Cercaria murrayensis* has been observed each month from November (rarely October) to

May inclusive, and that the diplostomulum stage has been collected from the lens of fish in the same locality (Lower Murray) each month from November to May inclusive, but not in those taken in June, August and October. These observations indicate that snails (unless the infection has survived the winter) may become infected in September or October by eggs which have passed through the winter in the swamp or which have been present in the faeces of the earliest terns to arrive in the spring. By October cercariae have become available to infect fish in which fully developed diplostomula may be present in November when the terns may become infected. Our original observation that infection, if present, was always light in the case of large fish, can be explained by the habit of such fish, since they rarely visit the shallow swamps (where small species and the young of all species are to be found), but live in the river and deeper channels where the food plants on which *Limnaea lessoni* feeds, do not find a suitable environment for their growth.

We have now recorded the occurrence of the diplostomulum stage in the lens of fifteen species of native freshwater fish and one introduced species from South Australia, as well as (experimentally) from two exotic fish (*Oryzias* and *Gambusia*) commonly kept in aquaria. The extensive range of the species of fish concerned and the wide variety of orders and families involved suggest that the parasite may be expected to be able to infect additional species. Dubois (1938, 192) listed over forty species of freshwater fish from the northern hemisphere recorded by various observers as hosts for the diplostomulum stage of an allied *Diplostomum* (*D. spathaceum*) which occurs in gulls in Europe and North America.

The length of egg-bearing specimens of *Diplostomum murrayense*, lying flat in fluid, without compression, ranged from ·5 to 1 mm. The total length of nine such worms, the length and breadth of the fore- and hind-body respectively, and the approximate ratio of the length of the post-body to the fore-body, were as follows: (1) ·5 mm., (·28 × ·22 + ·22 × ·154), 1:·78; (2) ·5 mm., (·26 × ·24 + ·24 × ·16), 1:·9; (3) ·54 mm. (·25 × ·19 + ·29 × ·13), 1:1·16; (4) ·67 mm., (·36 × ·36 + ·31 × ·18), 1:·86; (5) ·67 mm., (·33 × ·28 + ·34 × ·23), 1:1; (6) ·85 mm., (·4 × ·35 + ·45 × ·19), 1:1·12; (7) ·88 mm., (·47 × ·43 + ·41 × ·29), 1:·87; (8) ·89 mm., (·53 × ·3 + ·36 × ·21), 1:·68; (9) 1 mm. (·5 × ·42 + ·5 × ·23), 1:1. Most adults seen were ·5 to ·7 mm., few between ·7 and ·9, and extremely few measured 1 mm. in length. The breadths and relative lengths of the two parts of the body varied, but the post-body was usually approximately equal to, or slightly greater than, the fore-body in length.

A few strongly contracted specimens with the hind-body lying at right angles to the fore-body were also measured (seen in lateral view) in fluid: (1) estimated total length ·84 mm., fore-body (including its posterior region projecting beyond the hind-body) ·55 mm. long, hind-body ·55 mm. with a maximum dorso-ventral diameter ·26 mm.; (2) ·80 mm., ·67 mm., ·3 (markedly arched ventrally), and ·34 respectively; (3) ·88, ·65 (with depth ·2 mm.), ·42 and ·32 mm. respectively.

Anterior sucker ·04-·06 mm. diameter, rounded or slightly longer than wide. Ventral sucker about same size, outline circular or slightly broader than long, anterior border (in fully adult specimens) distant from the anterior end of the worm 44 to 47%, occasionally 50%, of length of fore body. Anterior glands each between ·05 and ·06 mm. long, with definite cavity directed antero-laterally or almost forwards. Holdfast (tribocytic) organ about ·1-·12 mm. long, about ·1-·15 broad, sometimes round; projecting prominently (especially in strongly contracted worms); often overlapping part of ventral sucker, but more usually a slight interval between the two organs; opening slightly longitudinal, with short groove leading into a canal surrounded by deeply-staining tribocytic glands;

breadth of organ about ·43 mm. or less, under half maximum breadth of fore-body. Genital pore dorsal, about ·04-·05 mm. from posterior end; excretory pore a short distance behind it.

Anterior sucker directed more or less ventrally; prepharynx very short, ·01 mm. long, above end of oral sucker; pharynx elongate, ·04-·06 mm. long, ·02-·03 mm. wide; oesophagus short, ·01 mm. long; caeca extending back close to base of tribocytic organ and almost reaching end of worm.

The reproductive system has the same general disposition as in *D. flexicaudum*, *D. spathaceum*, *D. huronense* and *D. indistinctum*. The testes have the form usual in the genus. The front of the anterior testis lies at about ·13 mm. behind the junction of the fore- and hind-body (*i.e.*, at less than 30% of the length of the hind-body), and adjacent to, or partly above, the posterior edge of the ovary. Its length is about ·05 mm., and the breadth ·1 mm. It is longer directly behind the ovary and tapering somewhat towards the opposite side of the body. The second testis, measuring ·07 by ·13 mm., is curved in transverse section, with its limbs directed ventrally, and with its front edge just behind (55-64%) half the total length of the post-body. The vasa deferentia were not traced fully but they pass back between the limbs of the second testis. The large rounded vesicula seminalis lies just behind, and partly below, the arch of the second testis. The narrow ejaculatory duct enters the genital atrium above the uterus.

The spherical ovary, ·05 mm. diameter, lies dorsally, immediately in front of the first testis and may be partly overlapped by it. The anterior end of the organ is at about ·07 mm. (at 15% of the total length of the hind-body). The oviduct travels back above part of the anterior testis to pass through Mehlis's gland lying dorsally between the two testes. The yolk reservoir is ventral and transversely placed, entering the ootyp from below. The uterine duct passes downwards and curves so as to lie antero-ventrally from, and parallel with, the ootyp, and then forwards as the ascending uterus below the anterior testis, extending into the region of the junction of the fore- and hind-body. It then curves back, traversing the ventral region below the testes and ootyp to reach the genital atrium. Laurer's canal is short and opens dorsally between the ovary and the anterior testis. Yolk glands extend forwards into the region just in front of the ventral sucker. The follicles obscure most of the organs in the hind-body, except in the vicinity of the genital atrium. There are 1 to 12 large eggs, usually 3 or 4, in the uterus; they measure ·072-·1 mm. by ·04-·06 mm., generally ·09 by ·06.

D. murrayense differs from *D. flexicaudum* as figured by Van Haitsma (1931), and *D. spathaceum* as figured by Krause (1914), Fuhrmann (1928), and Dubois (1938), in its dimensions, body ratios, position of the ovary and number of eggs. It closely resembles *D. huronense* La Rue (1927) and especially *D. indistinctum* Guberlet (1923, syn. *D. confusum* Gub. 1922) in the disposition of its organs, but differs in the detailed measurements of them and particularly in the size of the worms.

Some very young stages of the parasite were recovered from two marsh terns. For comparison with the youngest obtained, we mention the dimensions (in μ) of the diplostomulum stage (killed with boiling formalin) as given in the original account: body length 231-392 (mean 296); breadth 154-215 (177); anterior sucker 22-43 (34) long by 42-51 (47) broad; ventral sucker 30-37 (34) long by 34-47 (39) broad; holdfast 71 long by 79 broad. The largest specimens we obtained from *Gambusia* were rather larger than those described but were somewhat swollen by postmortem changes in the dead fish before we found them, the normal dimensions having probably become slightly increased—measurements in mm.: ·4-·44 long, ·2-·25 broad; anterior sucker ·05 by ·05-·06; ventral sucker ·05 diameter; holdfast ·09 by ·06 and ·07 by ·07. The smallest found in the bird host measured ·3 mm. long by ·12, with fore-body ·28 long and a minute post-body ·02 long by ·05; anterior sucker ·035 by ·03; ventral sucker ·035 by ·025;

glandular areas (head) ·015-·02 long; holdfast ·04 by ·018 (grooved portion), ·06 by ·04 if glandular region be included; pharynx ·025 by ·013; oesophagus ·01 long; genital anlagen represented by relatively few deeply-staining cells in the fore-body behind the holdfast and by cells in the post-body indicating the differentiating genital ducts and pore. Another was slightly larger but did not exhibit any differentiation into fore- and post-body. Its dimensions were: ·45 mm. long, ·19 broad; anterior sucker ·04 by ·03; posterior sucker ·035 by ·04; glandular areas ·055; holdfast ·09 broad; pharynx ·03 by ·02; genital anlage pyriform, much larger than in the preceding specimen but not differentiated, situated in the posterior ·12 mm. behind the deeply-staining paired holdfast glands. In its characters it resembled closely the diplostomulum stage. Another young worm, ·44 mm. long, possessed the following features: fore-body ·3 by ·16; post-body ·14 by ·1; anterior sucker ·03 by ·035; ventral sucker ·03 by ·03; holdfast prominent, ·06 by ·06, with well marked groove and two deeply staining glandular masses; pharynx ·03 by ·02; genital anlagen in three masses representing ovary, anterior testis and posterior testis, also a cord of cells representing the terminal portions of the differentiating uterus and seminal vesicle. A specimen ·4 mm. long, with fore-body ·3 by ·19 and hind-body ·1 by ·11, exhibited a similar stage of reproductive development as seen in the preceding worm. Yolk glands seem to be fully differentiated before the sex organs become functional, the latter occurring when the parasites have become about ·5 mm. in length.

In addition to the diplostomula, already referred to above, taken from *Gambusia,* we obtained from the same fish several very early stages, also from the lens. Some of these were practically tail-less cercariae (fig. 10) measuring from ·14 by ·04 to ·19 by ·05, with the anterior organ still persisting and with rows of spines around the head end, as well as a prominent row surrounding the projecting ventral sucker. A minute diplostomulum (fig. 6) was also obtained, measuring ·15 mm. long, ·05 broad; with an anterior sucker ·02 mm. long by ·024 mm.; a posterior sucker ·02 by ·02 mm.; a tribocytic organ immediately behind the latter and provided with a deep groove; and head glands like those of older diplostomula; but all spines had disappeared from the body and from the ventral sucker. These various stages from *Gambusia* were obtained as a result of submitting the fish to infection at short intervals by a very small number of cercariae.

Diplostomum murrayense is the first Australian Strigeate trematode whose complete life cycle is known, and is the first member of the genus, as now restricted, to be described from the Commonwealth.

Type material of the various stages is deposited in the South Australian Museum, Adelaide. Acknowledgment is made of the generous assistance rendered by Messrs. G. and F. Jaensch and L. Ellis of Tailem Bend in regard to material; and by the Commonwealth Research Grant to the University of Adelaide.

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REPORT ON FORAMINIFERAL SOUNDINGS AND DREDGINGS OF THE F.I.S. "ENDEAVOUR" ALONG THE CONTINENTAL SHELF OF THE SOUTH-EAST COAST OF AUSTRALIA

By FREDERICK CHAPMAN, A.L.S., Hon. F.R.M.S.

Summary

The material described was collected by the "Endeavour' about the year 1912. Captain Dannevig forwarded it to me through the late Robert Etheridge., Jnr., together with a schedule of the samples dated 23 June 1913. Two other samples of soundings, collected about the same time, and included in this schedule, have already been described.[1] Unavoidable delay in carrying out further descriptions of this interesting material has been due to stress of official and private work prior to my retirement as First Commonwealth Palaeontologist.

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By Frederick Chapman, A.L.S., Hon. F.R.M.S.

[Read 10 July 1941]

Plates VII, VIII, IX

INTRODUCTORY

The material described was collected by the "Endeavour" about the year 1912. Captain Dannevig forwarded it to me through the late Robert Etheridge, Jnr., together with a schedule of the samples dated 23 June 1913. Two other samples of soundings, collected about the same time, and included in this schedule, have already been described.[1] Unavoidable delay in carrying out further descriptions of this interesting material has been due to stress of official and private work prior to my retirement as First Commonwealth Palaeontologist.

SCOPE OF INVESTIGATION

The present Report relates to the soundings marked E 3915 to E 3923, comprising all those samples located towards the eastern end of Bass Strait, near the boundary of Victoria and New South Wales, chiefly east by south from Green Cape; east from Babel Island; and on the eastern edge of Bass Strait.

As these soundings range from 65 to 505 fathoms, the results have a direct bearing on the form and contour of the continental shelf around the south-eastern coastline of Australia, in which the late Capt. Dannevig was so keenly interested. (See Biol. Res. F.I.S. "Endeavour," VII—The Continental Shelf of the East Coast of Australia, **3**, (6), 1915). The remainder of the Samples included in this collection, reserved for a further Report, were chiefly obtained from localities centred about the Great Australian Bight, off Eucla.

These Reports have been made possible through the courtesy of Sir David Rivett, K.C.M.G., F.R.S., and Dr. H. Thompson, Chief of Division of Fisheries, C.S.I.R. The writer is also indebted to Mr. S. Fowler, of the same Department, for facilities in consulting the charts of the area investigated.

DESCRIPTION OF SAMPLES AND THEIR CONTENTS

Sample E 3915

Loc.—East from Babel Island (east of Flinders Island), 65 fathoms. 28 October 1912. *Dried Material*—Grey foraminiferal and shelly ooze, with a greenish tinge. *Coarse Siftings* contain many larger Foraminifera, as *Lenticulina, Saracenaria, Dentalium, Eponides, Elphidium, Pyrgo, Pelosina, Haplophragmoides, Dorothia* and *Textularia*. Also abundant tube-building Worms, Polyzoa, Brachiopoda, many Mollusca and Ostracoda.

[1] Biol. Res. "Endeavour," **1**, (3), 309-311, 1912. Also Report of the Foraminifera and Ostracoda obtained by the F.I.S. "Endeavour" from the East Coast of Tasmania and off Cape Wiles, South Australia, **3**, (1), 1915, 1-51, pls. i-iii.

POLYZOA

Order CHEILOSTOMATA

Caberea grandis Hincks 1881

Hincks 1881, Ann. Mag. Nat. Hist., (5), **8**, 50, pl. iii, fig. 4; MacGillivray, 1895, Trans. Roy. Soc. Vict., **4**, 25, pl. iii, fig. 9; Stach, 1935, Proc. Roy. Soc. Vict., **47**, (2), n.s., 342, pl. xii, fig. 3.

Common and typical. This species first appears as a fossil in the Lower Miocene of Balcombe Bay, Flinders, the Moorabool Valley, Muddy Creek and the Mitchell River, Bairnsdale; also in the Lower Pliocene (Kalimnan) at MacDonald's, Muddy Creek and in the Sorrento Bore at 726 feet. In the living condition it has been found on the cable in Bass Strait, at Western Port, Lakes Entrance, Port Phillip Heads, 22 miles east of Port Jackson at 80 fathoms and at Darnley Island, Torres Strait (10-30 fathoms), as recorded by L. W. Stach.

Caberea darwinii Busk 1884

Busk 1884, Chall. Rep. Polyzoa, pt. i, 29, pl. xxxii, fig. 6; MacGillivray (in McCoy), Prod. Zool. Vict., 1887, dec. xiv, 141, pl. cxxxvii, fig. 1-5; *Ibid.*, 1895, Trans. Roy. Soc. Vict., **4**, 25, pl. iii, fig. 10, 11.

Rare. The original, living, forms were described from New Zealand. Those from Victoria were from Port Phillip Heads (MacGillivray) and Portland (Maplestone). The fossil specimens are noted from the Tertiary of Muddy Creek near Hamilton.

Cellaria gracilis (Busk 1852)

Salicornaria gracilis Busk 1852, Brit. Mus. Cat., pt. i, 17.

Cellaria gracilis (Busk), MacGillivray, 1895, op. cit., 30, pl. iii, fig. 26.

Common and typical. Fossil specimens have been recorded from the Lower Miocene of Balcombe Bay and Muddy Creek. As a living species MacGillivray notes it from Queenscliff and Sealers' Cove, Wilson's Promontory.

Cellaria rigida var. venusta MacGillivray 1895

MacGillivray 1895, op. supra cit., 30, pl. iii, fig. 24.

Very abundant. Found fossil in the Lower Miocene of Balcombe Bay, Muddy Creek and Bairnsdale, Victoria. Living, Australia.

Cellaria tenuirostris (Busk 1852)

Salicornaria tenuirostris Busk 1852, op. cit., 17.

Cellaria tenuirostris (Busk), MacGillivray (in McCoy), 1880, Prod. Zool., Vict. dec. v, 49, pl. xlix, fig. 3.

Very abundant. This species was collected by Baron v. Mueller from Queensland, Sealers' Cove and Cape Le Febre (det. by MacGillivray).

Conescharellina biarmata (Maplestone 1909)

Bipora biarmata Maplestone, Rec. Aust. Mus., **7**, (4), 1909, 268, pl. lxxv, fig. 1 *a*, *b*.

Frequent. Previously recorded 22 miles east of Port Jackson in 80 fathoms, H.M.C.S. "Miner."

Conescharellina philippinensis (Busk 1854)

Lunulites philippinensis Busk, Brit. Mus. Cat., pt. ii, 1854, p. 101.

Bipora philippinensis (Busk), MacGillivray, 1895, Trans. Roy. Soc. Vict., **4**, 89, pl. xii, fig. 2.

Occasional specimens. Found fossil in marls of Lower Miocene age at Balcombe Bay and Muddy Creek. Abundant in borings at Lakes Entrance, in beds of the same age (Imray Bore and others). Living off the coast of New South Wales.

CELLEPORA FOSSA (Haswell 1881)

Sphaerophora fossa Haswell, Proc. Linn. Soc. N.S.W., 1881, 5, 42.

Cellepora fossa (Hasw.), MacGillivray, op. cit., 1895, 108, pl. xiv, fig. 8-10.

Rare. Found fossil in most Lower Miocene marls in Victoria. Living around the Australian coast. C. M. Maplestone records it from 22 miles east of Port Jackson (80 fathoms).

Retepora babelensis sp. nov.
Pl. vii, fig. 1-3

Description—Holotype specimen. Zoarium slender, ramose, branching twice. Length, 5·5 mm. Zooecial tubes comparatively long and prominently recurved, as in *R. fissa* and *R. schnapperensis*. Margin of zooecial tubes ragged, often spinous and frequently everted, sometimes with a notch on the lower edge. Diameter of zooecial tubes, 0·19 mm. Zooecial tubes three or four in a more or less oblique series. Avicularia as a minute oval or longitudinal slit. Ovicells with a transverse slit-like opening.

The reverse face shows a rectangular or irregularly hexagonal areolation, as in *Retepora fissa* MacGillivray.

East from Babel Island, 65 fathoms. Rare.

Order **CYCLOSTOMATA**

CRISIA SCALARIS MacGillivray 1895

MacGillivray, op. cit., 1895, 119, pl. xvi, fig. 1.

Common. Hitherto found fossil in the Lower Miocene of Corio Bay, Geelong.

IDMONEA MILNEANA d'Orbigny 1839

d'Orb., Voy. dans l'Amér. Mérid., 1839, pt. v, 20. MacGillivray (in McCoy), 1882, Prod. Zool. Vict., dec. vii, 29, pl. lxviii, fig. 1. *Id.*, 1895, Trans. Roy. Soc. Vict., op cit., 124, pl. xvii, fig. 1, 2.

Abundant. Fossil records in Victoria are: Lower Miocene of Muddy Creek and Bairnsdale. As a living form this widely distributed species is known from South America, Florida and from Australian waters. All Australian examples, fossils and recent, seem to be typical.

Mecynoecia (Entalophora) dannevigi sp. nov.
(Pl. vii, fig. 4)

Description of Type—Zoarium dendroid, slender, once-branched and slightly curved. Length, 14 mm.; breadth of stipe, 0·4 mm. Zooecia long, tubular and irregularly disposed but sometimes double or nearly adjacent, length of tubes circ. 0·8 mm., diameter 0·22 mm. The wall of the zoarium is somewhat densely punctate. The zooecia are comparatively smooth but for the presence of fine longitudinal grooves. Colour of this recent zoarium is of a delicate plum-brown tint.

Species abundant in this sample.

A closely related species is *Mecynoecia proboscidea* (Milne Edwards) which, by the way, has a cosmopolitan distribution both in time and space. It ranges from the Cretaceous to Recent in America and Europe, whilst it is common in the Lower Miocene of Gippsland. The present specimens are of a more tenuous structure and have no cortical thickening of the wall. *Entalophora australis* (Busk) of the Lower Miocene of Muddy Creek lives also in Australian seas, but is a distinctly incrassate form with fewer and larger zooecia.

MOLLUSCA

In checking and identifying the names of these, and of the Brachiopoda, I have had the expert assistance of my friend, Mr. C. J. Gabriel. A small proportion of species were recorded by the late Charles Hedley, from "Endeavour" dredgings off Cape Wiles, South Australia.(2) These are indicated by an asterisk.

PELECYPODA

Poroleda spatulata Hedley (c.); *Sarepta tellinaeformis* Hedley (v.r.); *Arcoperna recens* Tate (v.r.); *Chlamys famigerator* Iredale (cf. **C. anti-australis* Hedley) (r.); *Myodora* aff. *antipodum* Smith (v.r.); **Venericardia amabilis* (Deshayes) (v.r.); *Myrtaea gabrieli* sp. nov. (r.) (vide infra); *Diplodonta globulosa* A. Adams (v.r.); **Cardium pulchellum* Gray (ab.); *Macrocallista planatella* (Lamarck) (v.r., juv.).

SCAPHOPODA

Dentalium spp. (fragments, indet.).

GASTEROPODA

**Turritella atkinsoni* Tate and May (c.); **Vermicularia flava* Verco (f.); *Nassarius semigranosus* (Dunker) (f.); *Marginella inconspicua* Sow. (f.); *M. gatliffi* May (v.r.); *Cylichnella protumida* Hedley (v.r.); *Retusa* cf. *cumieri* Crosse and Fischer (v.r.); **Mitra* cf. *stadialis* Hedley (v.r.); *Crassispira* cf. *lacteola* Verco (v.r.); ? *Filodrillia* sp. (v.r.).

BRACHIOPODA

**Campages jaffaensis* (Blochmann) (r.).

NOTE—The Foraminifera and Ostracoda found in the foregoing and succeeding samples are collected in the Table of Distribution at the end of the Description of the Dredgings and before the Systematic portion of the work dealing with the above-named groups. The abundance of the species in the Samples is indicated in the Table by the relative and not actual number of examples, and elsewhere in the text by small letters, as follows: Very Rare, 1 (v.r.); Rare, 2-3 (r.); Frequent, 4-7 (f.); Common, 8-16 (c.); Very Common, > 16 (v.c.).

SAMPLE E 3916

Loc.—33 miles east by south from Green Cape, north of the Victorian border. From anchor. *Dried Material*—A pale grey, tenacious, calcareous mud. *Finest Washings* contain an abundance of coccoliths, denoting a rich plankton in this area. These coccoliths are of great interest from a palaeontological point of view, for they are structurally similar and of the same dimensions as those found in the Upper Oligocene marls of the Lakes Entrance borings East Gippsland. The richness of this planktonic sediment is a good indication of its suitability as a fishing ground. The remainder of the finest sediments of this sample consists of a few minute shell fragments, some minute Foraminifera (cf. *Discorbis*) and occasional siliceous sponge spicules and stellate spicules of

(2) Hedley, C., 1911, Zool. Results, F.I.S. "Endeavour," **1**, (1), 91-96. Idem, *ibid.*, 1914, **2**, (1), 65-70. See also Iredale, T., 1925, Rec. Austr. Mus., **14**, No. 4, 249-270, pls. xli-xliii.

Tunicates. *Medium Fine Siftings* comprise numerous echinoid (salenid) spines, siliceous sponge spicules (cf. *Tethys*), abundant spicules of Tunicates (*Leptoclinum*) and molluscan bivalved shells in the neanic stage (cf. *Lissarca*). The Foraminifera and Ostracoda here belong especially to thin-shelled forms, indicating a pelagic and nektic fauna.

SAMPLE E 3917

Loc.—Eastern edge, Bass Strait. 140 fathoms. 12 December 1912. *Dried Material*—Cream-coloured, fine-grained calcareous mud. *Finest Washings* consist largely of minute crystallised rhombs of calcite, comprising about 40% ; also minute molluscan shell-fragments and Foraminifera. A minute quantity of angular quartz grains present. The crystalline calcitic rhombs mentioned are so sharply defined that they suggest dolomite at first sight, but when treated with cold HCl they dissolve almost entirely, leaving a thin trace of ferruginous residue. (See Note below.) *Medium Siftings* contain a fair number of echinoid spines (salenids), frequent valves of Ostracoda and abundant Foraminifera, together with some fragments of Polyzoa. Floatings contain an abundance of *Globigerina, Lagena* and *Bolivina.* Amongst the larger fragments, after washing, there is a somewhat decomposed shell, with united valves, of *Cardium pulchellum,* measuring 15 mm. in length and 12 mm. in height; also fragments of *Dentalium* and *Turritella.*

The following POLYZOA also occurred in this sample: *Cellaria rigida* var.; *venusta* MacGill; *Crisia acropora* Busk and *Mecynoecia dannevigi* sp. nov.

NOTE ON THE OCCURRENCE OF CRYSTALS OF CARBONATE OF LIME IN BOTH RECENT AND FOSSIL DEPOSITS, AND THE PROBABLE CONDITIONS UNDER WHICH THEY WERE FORMED

During the past few years, whilst examining Lower Miocene marls from deep borings in East Gippsland, I have repeatedly met with rhombohedral crystals of Calcite in the finer washings.

At first they seemed to be possibly referable to dolomite, on account of the sharpness of their outlines. This doubt was solved, however, by their complete disappearance when treated with cold hydrochloric acid, thus proving them to be calcite crystals.

Whilst examining the recent deposits of the present series from Bass Strait, and particularly that of E 3917, from the eastern edge of Bass Strait, at 140 fathoms, I was struck with the large proportion of these calcitic crystals. They brought to mind the fact of their previous occurrence in the washings of the fossiliferous marls of Lower Miocene age in Gippsland, which sediments were deposited in an ancient trough formerly contiguous with the Southern Ocean.

In both fossil and recent sediments these calcite crystals are of somewhat variable size, but generally much larger in ancient Miocene deposits than in Recent. In the Miocene marls of the Imray Well in East Gippsland, for example, the average diameter is 0·04 mm., whilst from Recent soundings only 0·006 mm. In Miocene examples I have sometimes detected the "nail-head" termination on an occasional prism.

It is somewhat remarkable that there are so few references to the occurrence of free Calcite in descriptions of present-day sediments of the ocean. Murray and Renard[3], in their "Deep Sea Deposits," p. 204-5, have recorded such an occurrence from "a highly characteristic Radiolarian ooze," taken at 4,475 fathoms, Sta. 225, lat. 11° 24′ N., long. 143° 16′ E, between New Guinea and Japan, which contains "some very peculiar white-coloured aggregations composed

[3] Report, "Challenger," Deep Sea Deposits, 1891.

of minute rhombohedral crystals, which when treated with dilute acid decompose with liberation of carbonic acid, but a flocculent residue is left behind, as well as microscopic granules; we are inclined to consider these crystals as calcite or dolomite."

The crystals referred to by Murray and Renard are shown on pl. xxvii, fig. 5, of their Report, where it can be seen that they have exactly half the diameter (0·003 mm.) of the crystals occurring in the present sounding (E 3917).

The minute crystals of hydrated calcium oxalate which Earland found in the deposits from the Weddell Sea ("Scotia" Exped. 1902-4) [4] cannot easily be mistaken for the present ones, for they are tetragonal bipyramids and show an "envelope" structure of the facets; moreover, they are ten times the diameter.

As regards the probable cause of the deposition of Calcite crystals in marine sediments, this is not far to seek. The normal calcium carbonate, as found in marine shells, is very slightly soluble, and average sea water contains only 0·12 parts per thousand. After remaining in contact with the same substance in a state of exceedingly fine division, the sea water may "take up as much as 0·65 parts per thousand (see "The Ocean" by Sir John Murray, p. 214. Home University Library).

It is known that polar waters contain a minimum of calcic carbonate, hence the thin-shelled faunas of those regions; and that by a rise in the temperature of oceanic waters increased solution is induced. It follows then, that, as in the warmer waters of Bass Strait, where oceanic currents are prevalent, the supersaturated water, meeting with colder flows, will consequently yield up this dissolved calcic carbonate, down to its normal saturation point. Thus the presence of these calcitic rhombs points directly to an area of sedimentation over which currents of varying temperatures are passing.

Sample E 3918

Loc.—"Lat. 37° 21′ 20″ S., long. 150° 24′ 25″ E. Foraminiferal sand. 2 October 1912. Washings of mud from Agassiz Trawl. Depth, 505 fathoms. F.I.S. 'Endeavour'." *Dried Material*—Greenish-grey shelly (chiefly foraminiferal), loose, calcareous marl. *Fine Washings* show abundant angular quartz, a large proportion of tetractinellid sponge spicules and numerous coccoliths. Also occasional minute Foraminifera, chiefly *Discorbis*. In the *Medium Washings* Foraminifera and Ostracoda are abundant; tetractinellid sponge spicules occasional; ovoid mud pellets (excreta) in great profusion. *Coarse Siftings* contain, besides abundant ovoid mud pellets and occasional polished quartz grains, the following organisms: Foraminifera—Large forms, especially arenaceous ones. Echinodermata—Spines of spatangoid sea-urchins and of one of the Centrechinoida (purplish red, hollow and with oblique rings of spinules). Polyzoa—Rare; represented chiefly by *Crisia acropora* Busk, *Cellaria gracilis* (Busk) and *C. rigida* MacGill. var. *perampla* Waters. Mollusca—Among these are: *Sarepta obolella* (Tate); *Nuculana pala* (Hedley); *Lissarca rubricata* Tate; *Philobrya pectinata* Hedley; cf. *Carditella; Creseis virgula* Rang; *Clio pyramidata* Linn.; *Limacina inflata* d'Orb.; *Volvula rostrata* (A. Adams). This latter species was recorded by Chas. Hedley from dredgings by the "Thetis" at 63 to 75 fathoms off Port Kembla, New South Wales (Sci. Res. Mem. Aust. Mus., **4**, No. 6, 1903, p. 394.

Also Pisces—Otoliths of fish, indet.

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(4) Discovery Reports, pt. iv, 1936. Foraminifera. Additional Records, A. Earland. With a Report on some Crystalline Components of the Weddell Sea Deposits, F. A. Bannister and M. H. Hey.

SAMPLE E 3919

Loc.—"Lat. 37° 21′ 20″ S., long. 150° 24′ 25″ E. Depth, 505 fathoms. Washing from mud brought up in Agassiz Trawl." *Dried Material*—Greenish-grey fine shelly and foraminiferal mud. *Fine Washings,* rich in plankton (coccoliths, etc.); numerous broken siliceous sponge spicules; a small proportion of fine angular quartz sand and other terrigenous material. Ostracods chiefly in these siftings. *Medium Washings* with a large pelagic foraminiferal fauna. Also numerous ovoid mud pellets. *Coarse Siftings* contain tetractinellid sponge spicules, echinoid spines (spatangoid).

POLYZOA include *Cellaria gracilis* Busk, *Caberea grandis* Hincks, *Conescharellina philippinensis* (Busk), and *Crisia acropora* Busk. MOLLUSCA—*Nuculana pala* (Hedley), *Poroleda ensicula* (Angas), *Syrnola* spp., *Turritella sinuata* Reeve, *Nassarius tasmanicus* (T. Woods), *Clio* sp. and *Dentalium* sp.

A large proportion of this residue is composed of ovoid mud pellets. There are also some fish otoliths present.

SAMPLE E 3920

Loc.—"Lat. 37° 21′ 20″ S., long. 150° 29′ 25″ E. 33 miles east by south from Green Cape, 470 fathoms." Mud with a greenish-grey tinge; also rubbly rock with corals. *Fine Washings*—Containing few coccoliths, broken sponge spicules and some angular quartz sand. Also minute Foraminifera, as *Discorbis.* Floatings with numerous Lagenae. *Medium Siftings*—Rich in echinoid spines (spatangoid), alcyonarian spicules, tetractinellid sponge spicules, as well as Foraminifera and Ostracoda. A fair proportion of the washings, about 10%, consist of ovoid mud pellets. *Coarse Siftings* contain abundant echinoid spines and plates, alcyonarian spicules, polyzoa and small mollusca.

The coarser rubbly element consists largely of coral fragment, *Solenosmilia.*

HEXACORALLA—Abundant fragments of *Solenosmilia variabilis* Duncan occur in the present sample. This deep water coral was not noted by the "Challenger" from the present region, but Professor Moseley records it from various stations in the South Atlantic which seem to have been at one time outposts of the more extensive Antarctic Continent. Thus three localities are given for this coral—Tristan da Cunha at 1,000 fathoms, Prince Edward Island at 310 fathoms and from Ascension at 420 fathoms. Off Green Cape it occurs in great profusion. OCTOCORALLA—*Melitodes* sp. cf. *rugosus.* Numerous fragments.

POLYZOA—*Catenicella* sp.; *Cellaria gracilis* (Busk); *Crisia acropora* Busk. All of these in abundance.

MOLLUSCA

Nucula obliqua Lamarck; *Myrtea* gabrieli sp. nov. (*vide infra*); *Turritella sinuata* Reeve; *Pyrene* sp.; *Nassarius tasmanicus* (T. W.); *Cavolina telemus* (Linn.); cf. *Haminoea* sp.; *Clio pyramidatus* Linn.; *Diacria trispinosa* (Blainville).

Fam. LUCINIDAE

Genus MYRTEA Turton 1822

Myrtea gabrieli sp. nov.

(Pl. ix, fig. 7 *a, b*)

Description—Type specimen, subquadrate; ventral border deeply convex, meeting the dorsal slope at a decided angle, the latter almost straight. Beak small, prominent, sharply recurved anteriorly, almost subcentral, with a narrow, excavated lunule. Surface of valves inflated, more depressed in the younger stages;

older forms as in the type specimen, depressed anteriorly and posteriorly, having an undulate depression from behind the umbo to the ventral. Concentric ribs close together in the neanic stage, becoming much more widely spaced proportionately in fully grown shells, numbering about 60 in the type.

Height of holotype, 25·5 mm.; length, 32 mm.; thickness of united valves, 12 mm.

Comparisons—Another species, *Myrtea bractea*, has been described and figured by Charles Hedley from Cape Wiles Sta. ("Endeavour"), from 95-100 fathoms.[5] It differs in the more subcircular outline, the less prominent umbo, which in *M. gabrieli* is almost falciform, the subrounded concentrics (more scaly in our species), and the evenly curved shell-surface, which in *M. gabrieli* is depressed in the anterior and posterior area. From *Myrtea mayi* (Gatliff and Gabriel) the species is essentially different in the absence of radial striae on the shell surface.

Accompanying these shells, from 33 miles east by south from Green Cape at 470 fathoms, are some smaller forms of this genus, which are probably referable to *M. botanica* Hedley. *M. gabrieli* also occurs in E 3915.

PISCES—Otoliths (indet.), common.

SAMPLE E 3921.

Loc.—"Foraminiferal sand. 33 miles east by south from Green Cape. Lat. 37° 21′ 20″ S., long. 150° 24′ 25″ E., 505 fathoms. (Washings of mud from Agassiz Trawl.)" Fine and coarse, yellowish-brown foraminiferal mud, with Pteropoda (*Cavolina inflexa* Lesueur) and corals (*Solenosmilia variabilis* Duncan, *Melitodes* and alcyonarian spicules).

SAMPLE E 3922

Loc.—"Foraminiferal sand. 33 miles east by south from Green Cape, 470 fathoms."

NOTE—Although this sample bears the same locality data as E 3920, the material has a very different appearance. It is a coarse rubbly and concretionary mud accumulation, with the larger particles, obtained by washing, stained with iron oxide. This concretionary material is, however, largely calcareous, for when treated with weak hydrochloric acid, it falls to pieces with strong effervescence, leaving a small residue of quartz sand, some siliceous sponge spicules and few ferruginous particles.

With such unpromising material it is surprising to find how numerous are the microzoa, the species of which are fairly common to both samples, E 3920 and E 3922.

The finer siftings, after washing, contain a fair proportion of ovoid mud pellets, echinoid spines, alcyonarian spicules and a few fish otoliths.

SAMPLE E 3923

Sample number only; no locality. A fine, grey, foraminiferal sand. The washings show the same general characters, as regards organisms, as samples east of Babel Island and west of Flinders Island, Tasmania, referred to as E 3915. The present one probably came from east of Babel Island but at a greater depth. It shows a fair proportion of ovoid mud pellets, abundant echinoid spines of both cidaroid and spatangoid types and numerous tetractinellid sponge spicules.

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(5) Zool. Results, "Endeavour," 1, (1), 1911, 99, pl. xvii, 5-8.

FORAMINIFERA and OSTRACODA are abundant, the former chiefly represented by the genera *Uvigerina, Cassidulina, Cibicides, Globigerina, Orbulina, Globorotalia, Planispirina* and *Quinqueloculina;* the latter by *Bairdia, Cythere* and *Cytherella;* POLYZOA, *Cellaria, Crisia* and *Mecynoecia;* MOLLUSCA, *Sarepta obolella* (Tate), *Cerithiopsis* sp., *Rissoa verconiana* Hedley; *Diacria trispinosa* (Blainville), *Clio pyramidatus* Linn., *Cavolina* sp. and *Limacina inflata* d'Orbigny.

TABULATION OF FORAMINIFERA IN THE FAUNULES OF EACH SAMPLE*

Species — Sample / Depth	3915 65 fm.	3916 anch.	3917 140	3918 505	3919 505	3920 470	2921 505	3922 470	3923 65
1 *Spirillina inaequalis* Brady	—	—	—	1	—	—	—	—	—
2 *Lenticulina clericii* (Forn.)	—	—	1	—	—	—	—	—	—
3 *L.* sp. aff. *convergens* (Born.)	2–3	—	—	—	—	—	—	—	—
4 *L. cultrata* (Montf.)	8–16	—	—	—	1	—	—	—	—
5 *L. gibba* (d'Orb.)	2–3	—	—	—	—	—	—	—	—
6 *L. rotulata* Lam.	—	—	—	1	—	—	—	1	—
7 *L.* sp. aff. *articulata* (Reuss)	2–3	—	—	—	—	—	—	—	—
8 *L.* sp. aff. *orbicularis* (d'Orb.)	4–7	—	1	1	—	—	—	—	—
9 *L.* sp. aff. *subalata* (Reuss)	1	—	—	—	—	—	—	—	—
10 *Planularia australis* sp. nov.	—	—	—	—	1	—	—	—	—
11 *Saracenaria italica* Defr.	2–3	—	1	—	—	—	—	—	—
12 *S. navicula* (d'Orb.)	2–3	—	—	—	—	—	—	—	—
13 *Astacolus crepidulus* (F. & M.)	—	—	1	—	—	—	—	—	—
14 *Marginulina glabra* d'Orb.	2–3	—	1	—	—	1	—	—	1
15 *Vaginulina legumen* (Linn.)	1	—	—	1	1	—	—	—	—
16 *Dentalina communis* d'Orb.	1	—	—	—	—	—	—	—	—
17 *D. fistuca* (Schwager)	—	—	—	—	—	1	—	—	—
18 *D.* sp. aff. *consobrina* (d'Orb.)	2–3	—	—	—	—	—	1	—	—
19 *D. soluta* Reuss	1	—	—	—	—	—	—	—	—
20 *Nodosaria catenulata* Brady	1	—	—	—	—	1	—	—	—
21 *N. calomorpha* Reuss	—	—	—	—	—	—	—	1	—
22 *N. pyrula* d'Orb.	—	—	—	—	—	—	—	—	1
23 *N. pyrula* var. *semirugosa* d'Orb.	—	—	1	—	1	—	—	—	—
24 *N. vertebralis* (Batsch)	—	—	—	—	—	—	—	2–3	—
25 *Lagenonodosaria scalaris* (Batsch)	>16	—	2–3	2–3	4–7	4–7	2–3	2–3	2–3
26 *L. scalaris* var. *separans* Br.	1	—	—	—	—	—	—	—	1
27 *L. scalaris* var. *seminuda* nov.	—	—	—	—	—	—	—	1	—
28 *Lagena annectens* Bur. & Hol.	—	—	—	—	1	—	—	—	—
29 *L. apiculata* (Reuss)	—	—	—	—	—	—	1	—	—
30 *L. clavata* d'Orb.	—	—	1	—	1	—	—	—	—
31 *L. costata* (Will.)	—	—	—	—	1	—	—	—	—
32 *L. crenata* P. & J.	—	—	—	—	1	1	—	—	—
33 *L. distoma* P. & J.	—	—	—	—	—	1	—	—	—
34 *L. globosa* (Montagu)	—	—	—	—	1	—	—	—	—
35 *L. hexagona* (Will.)	—	—	—	—	1	—	—	—	—
36 *L. hispida* Reuss	—	—	—	—	1	—	—	—	—
37 *L. lacunata* Bur. & Holl.	—	—	—	—	1	—	—	—	—
38 *L. lagenoides* (Will.)	—	—	—	—	—	1	—	—	—
39 *L. marginata* Walker & Boys	—	—	1	—	1	—	—	—	—
40 *L. melo* (d'Orb.)	—	—	1	—	2–3	4–7	—	1	—
41 *L. orbignyana* (Seg.)	—	—	—	—	2–3	1	—	—	—
42 *L. striata* (d'Obr.)	—	—	2–3	—	2–3	1	1	—	—
43 *L. sulcata* (W. & J.)	—	—	—	—	1	1	—	—	—
44 *L. variata* Brady	—	1	—	—	—	—	—	—	—
45 *Pseudoglandulina rotundata* (Rss.)	2–3	—	—	—	—	—	—	—	—
46 *Guttulina communis* (d'Orb.)	1	—	—	—	—	—	—	—	—
47 *G. lactea* (Walker & Jacob)	—	—	—	—	2–3	—	—	—	—
48 *G. problema* d'Orb.	2–3	—	2–3	2–3	—	—	—	—	—
49 *G. regina* (Br. P. & J.)	1	—	1	1	—	—	—	—	—
50 *G. yabei* Cushm. & Ozawa	2–3	—	—	—	—	—	—	—	—
51 *Globulina gibba* d'Orb. var. *globosa* (Münster)	—	—	—	—	—	—	—	—	1
52 *Glandulina laevigata* d'Orb.	—	—	—	—	2–3	—	—	—	—

* Numbers in Table relative and not actual. See p. 148.

TABULATION OF FORAMINIFERA IN THE FAUNULES OF EACH SAMPLE

Species	Sample Depth	3915 65 fm.	3916 anch.	3917 140	3918 505	3919 505	3920 470	2921 505	3922 470	3923 65
53 *Buliminella* sp.		1	—	—	—	—	—	—	—	—
54 *Bulimina aculeata* d'Orb.		—	—	—	—	—	—	—	1	—
55 *B. elegans* d'Orb.		—	—	—	—	—	8–16	4–7	4–7	—
56 *B.* sp. aff. *marginata* d'Orb.		2–3	1	1	—	1	2–3	—	4–7	—
57 *B. notovata* sp. nov.		—	—	—	2–3	—	—	—	—	—
58 *Virgulina subsquamosa* Egger		—	—	—	—	4–7	—	—	—	2–3
59 *Bolivina alata* (Seguenza)		—	4–7	1	—	2–3	4–7	—	2–3	—
60 *B.* sp. aff. *hentyana* Chap.		>16	—	1	2–3	—	—	—	—	—
61 *B. beyrichi* Reuss		8–16	2–3	1	4–7	1	4–7	4–7	>16	—
62 *B. limbata* Brady		—	—	—	—	—	—	1	—	2–3
63 *B. punctata* d'Orb.		—	—	—	—	1	—	—	—	—
64 *B. robusta* Brady		—	—	—	—	—	8–16	1	4–7	—
65 *Rectobolivina bifrons* (Brady)		—	—	1	—	—	—	—	—	1
66 *Loxostomum karrerianum* (Br.)		1	—	4–7	—	—	—	—	—	—
67 *Bifarina fimbriata* (Millett)		—	—	—	—	—	—	—	1	—
68 *Uvigerina* sp. aff. *pigmea* (d'Orb.)		>16	8–16	1	8–16	8–16	2–3	1	8–16	4–7
69 *Trifarina bradyi* Cushman		—	—	—	—	—	1	—	—	—
70 *Cassidulina crassa* d'Orb.		—	—	2–3	—	—	—	—	—	—
71 *C. laevigata* d'Orb.		—	—	—	—	1	>16	1	>16	—
72 *C. subglobosa* Brady		—	—	—	—	—	2–3	—	1	4–7
73 *C. subglobosa* var. *producta* Chapman and Parr		—	—	—	—	—	1	—	—	1
74 *Ellipsolagena schlichti* (Silv.)		—	—	—	—	1	2–3	—	—	—
75 *Bolivinita quadrilatera* (Schw.)		—	—	—	8–16	1	2–3	1	>16	1
76 *B. quadrilatera* var. *tortilis* nov.		—	—	—	—	—	4–7	1	4–7	—
77 *Bolivinella folium* (P. & J.)		—	—	—	2–3	—	—	—	—	—
78 **Parafrondicularia helenae* sp. nv		—	—	—	—	—	—	—	4–7	—
79 *Nodogenerina bradyi* Cushm.		—	—	—	—	—	—	—	1	—
80 *N. insolita* (Schwager)		—	—	1	—	—	—	—	—	—
81 *Patellina corrugata* Williams		—	—	—	—	—	—	—	—	1
82 *Patellinella inconspicua* (Br.)		—	—	—	—	2–3	—	—	—	—
83 *Discorbis australis* Parr		1	—	—	—	—	—	—	—	—
84 *D. bertheloti* (d'Orb.)		—	2–3	2–3	2–3	—	2–3	—	—	—
85 *D. dimidiatus* (J. & P.)		—	—	—	—	2–3	—	—	—	2–3
86 *D. disparilis* (H. A. & E.)		—	—	1	—	—	—	—	—	—
87 *D. opercularis* (d'Orb.)		—	2–3	—	—	—	—	—	—	2–3
88 *D. orbicularis* (Terq.)		—	—	—	1	—	—	—	—	2–3
89 *D. rarescens* (Brady)		—	—	—	1	—	—	—	—	2–3
90 *D. rosacea* (d'Orb.)		—	—	—	1	1	—	—	—	—
91 *D. rugosa* (d'Orb.)		—	—	—	—	—	—	—	—	1
92 *D. globularis* (d'Orb.)		—	—	—	>16	—	—	—	—	—
93 *Eponides karsteni* (Reuss)		—	—	—	—	—	—	—	1	2–3
94 *E. repandus* (F. & M.)		2–3	—	—	—	—	—	—	—	—
95 *Streblus beccarii* (Linn.)		8–16	—	2–3	2–3	—	1	—	1	—
96 *Notorotalia clathrata* (Brady)		—	—	—	—	—	1	—	1	—
97 *N. decurrens* sp. nov.		2–3	—	1	4–7	—	—	—	—	—
98 *Epistomina elegans* (d'Orb.)		8–16	—	2–3	2–3	1	—	—	4–7	—
99 *Mississippina concentrica* (P. & J.)		—	—	—	—	2–3	—	—	—	—
100 *Cancris auricula* (F. & M.)		—	1	—	—	—	—	—	—	—
101 *Anomalina colligera* Chapm. & Parr		1	—	—	—	—	—	—	1	—
102 *A. glabrata* Cushm.		8–16	—	2–3	1	—	2–3	—	1	—
103 *A. globulosa* Chapm. & Parr		—	—	—	—	—	1	—	1	—
104 *A. polymorpha* Costa		—	—	1	1	—	—	—	—	1
105 *A.* sp. aff *rotula* d'Orb.		4–7	—	—	—	—	—	—	—	—
106 *A. vermiculata* (d'Orb.)		4–7	—	—	—	—	1	—	—	—
107 †*Planulina biconcava* J. & P.		—	—	—	2–3	—	—	—	—	—
108 *P. biconcava* var. *unguiculata* (Sidebottom)		—	—	—	—	—	—	—	1	—

* This species was originally placed in *Plectofrondicularia* but is now seen to be referable to the recently described genus *Parafrondicularia* Asano. To avoid much disturbance of proofs, its original position in the text is retained.

† Since made the genotype of *Planulinoides* Parr.

Tabulation of Foraminifera in the Faunules of each Sample

Species (Sample / Depth)	3915 65 fm.	3916 anch.	3917 140	3918 505	3919 505	3920 470	2921 505	3922 470	3923 65
109 *P. haliotis* (H. A. & E.)	—	—	—	—	—	—	—	1	—
110 *Cibicides aknerianus* (d'Orb.)	—	—	—	—	—	1	—	—	—
111 *C. lobatulus* (W. & J.)	—	2–3	2–3	2–3	2–3	—	1	4–7	—
112 *C.* sp. aff. *victoriensis* Ch., P. & C.	>16	—	1	2–3	4–7	1	—	—	—
113 *C. pseudoungerianus* (Cushm.)	4–7	—	—	8–16	1	—	—	4–7	4–7
114 *C. refulgens* Montfort	2–3	—	—	1	—	—	—	2–3	—
115 *C. wuellerstorfi* (Schwager)	—	2–3	—	—	2–3	4–7	4–7	4–7	4–7
116 *Dyocibicides biserialis* C. & V.	—	—	—	—	—	—	—	—	1
117 *Amphistegina lessonii* d'Orb.	—	—	—	—	1	—	—	—	—
118 *Chilostomella cushmani* sp. nov.	—	—	2–3	1	—	—	—	—	4–7
119 *Pullenia sphaeroides* (d'Orb.)	1	1	—	—	—	1	—	—	—
120 *P. subcarinata* (d'Orb.)	—	1	—	—	1	2–3	—	—	—
121 *Sphaeroidina bulloides* d'Orb.	1	—	2–3	—	2–3	1	—	1	—
122 *Globigerina bulloides* d'Orb.	2–3	8–16	4–7	>16	8–16	>16	4–7	>16	4–7
123 *G. conglomerata* Schwager	—	—	—	2–3	—	—	—	—	—
124 *G. dutertrei* d'Orb.	—	—	—	—	2–3	—	—	1	—
125 *G. inflata* d'Orb.	4–7	8–16	4–7	>16	8–16	>16	>16	>16	>16
126 *G. pachyderma* (Ehrenberg)	—	1	1	—	—	—	—	—	—
127 *G. subcretacea* Chapm.	—	—	—	2–3	2–3	4–7	—	—	8–16
128 *Globergerinoides trilobus* (Reuss)	—	4–7	2–3	—	—	8–16	—	1	—
129 *Globigerinella aequilateralis* (Br.)	—	—	—	—	1	—	—	—	—
130 *Orbulina universa* d'Orb.	4–7	—	2–3	>16	>16	>16	>16	8–16	4–7
131 *Pulleniatina obliquiloculata* (P.&J.)	—	—	—	8–16	1	—	1	2–3	—
132 *Sphaeroidinella dehiscens* (P. &J.)	—	—	—	—	1	—	1	2–3	—
133 *Globorotalia hirsuta* (d'Orb.)	1	—	2–3	8–16	8–16	>16	—	4–7	4–7
134 *G. scitula* (Brady)	—	—	—	—	—	—	—	4–7	1
135 *G. truncatulinoides* (d'Orb.)	—	4–7	2–3	>16	1	—	1	4–7	4–7
136 *Nonion depressulus* (W. & J.)	—	—	2–3	—	2–3	—	—	—	—
137 *N. grateloupi* (d'Orb.)	—	—	—	—	—	4–7	—	—	—
138 *N. scapha* (F. & M.)	—	1	—	2–3	—	—	—	—	—
139 *N. umbilicatulus* (Mont).	2–3	—	—	—	—	—	—	1	—
140 *Elphidium advenum* (Cushman)	8–16	1	1	4–7	2–3	—	—	1	1
141 *E. crispum* (Linné)	—	—	—	—	—	—	—	—	1
142 *E. imperatrix* (Brady)	2–3	—	—	4–7	4–7	—	—	—	—
143 *E. jenseni* (Cushman)	—	—	—	—	—	1	—	—	—
144 *E. lessonii* (d'Orb.)	—	—	2–3	1		—	—	4–7	—
145 *E. macellum* (F. & M.)	—	—	—	—	—	2–3	1	2–3	—
146 *E. poeyanum* (d'Orb.)	—	—	—	—	—	2–3	—	—	—
147 *E. verriculatum* (Brady)	>16	—	—	1	—	—	—	1	2–3
148 *Hyperammina novaezealandiae* H. A. & E.	—	—	—	—	—	2–3	—	—	—
149 *Saccammina sphaerica* G. O. Sars	1	—	—	—	—	—	—	—	—
150 *Pelosina cylindrica* Brady	4–7	—	—	—	—	—	—	—	—
151 ? *Brachysiphon corbuliformis* Chapman	2–3	—	—	—	—	—	—	—	—
152 *Technitella* cf. *legumen Norman*	1	—	—	—	—	—	—	—	—
153 *Rhabdammina discreta* Brady	—	—	—	4–7	1	>16	1	—	—
154 *R. irregularis* W. B. Carp.	—	—	—	—	—	1	—	—	—
155 *Cornuspira foliacea* (Philippi)	1	—	—	—	—	—	—	—	—
156 *C. foliacea* var. *expansa* Chap.	—	—	—	—	1	—	—	—	—
157 *C. lacunosa* Brady	1	—	—	—	—	—	—	—	—
158 *C. striolata* Brady	1	—	—	—	—	—	—	—	—
159 *Ophthalmidium circularis* (Ch.)	—	—	—	1	—	—	—	—	—
160 *Planispirina bucculenta* (Brady)	2–3	—	—	4–7	4–7	—	—	—	8–16
161 *P. bucculenta*, v. *placentiformis* Br.	—	—	—	2–3	—	—	—	—	8–16
162 *Quinqueloculina auberiana* d'Orb.	—	—	—	—	2–3	—	—	1	2–3
163 *Q. australis* Parr	—	—	—	—	2–3	—	—	—	—
164 *Q. crassa* d'Orb.	1	—	—	—	—	—	—	—	—
165 *Q. cuvieriana* d'Orb.	2–3	—	1	1	—	—	—	—	—
166 *Q. lamarckiana* d'Orb.	4–7	—	1	—	—	2–3	1	1	4–7
167 *Q. seminulum* (Linn.)	—	—	1	—	—	—	—	—	4–7
168 *Q. vulgaris* d'Orb.	8–16	1	—	8–16	8–16	2–3	—	1	2–3
169 *Spiroloculina canaliculata* d'Orb.	8–16	—	—	2–3	2–3	—	—	—	4–7
170 *Sigmoïlina latissima* sp. nov.	—	—	—	2–3	4–7	—	—	—	—

Tabulation of Foraminifera in the Faunules of each Sample

	Species	Sample / Depth	3915 65 fm.	3916 anch.	3917 140	3918 505	3919 505	3920 470	2921 505	3922 470	3923 65
171	*S. schlumbergeri* A. Silv.		—	—	—	—	—	—	—	1	1
172	*Ptychomiliola separans* (Brady)		2–3	—	—	—	—	—	—	—	—
173	*Triloculina chrysostoma* (Chap.)		—	—	—	—	1	—	—	—	—
174	*T. circularis* Born.		—	—	—	—	—	—	—	—	4–7
175	*T. quadrilateralis* d'Orb.		—	—	—	—	—	1	1	1	—
176	*T. tricarinata* d'Orb.		4–7	—	—	—	1	2–3	—	—	—
177	*T. trigonula* (Lamarck)		2–3	—	1	—	—	—	—	—	—
178	*T. oblonga* (Montagu)		1	1	—	1	—	—	—	1	—
179	*Pyrgo comata* (Brady)		—	—	—	—	1	—	—	—	—
180	*P. elongata* (d'Orb.)		—	—	—	—	1	1	1	—	1
181	*P. fornasinii* Chap. & Parr		4–7	—	—	1	—	—	—	—	—
182	*P. sarsi* (Schlumb.)		—	—	—	1	—	—	—	1	2–3
183	*P. vespertilio* (Schlumb.)		—	—	—	—	1	—	—	—	—
184	*Pyrgoella sphaera* (d'Orb.)		4–7	—	—	4–7	—	1	—	—	1
185	*Biloculinella globulus* (Born.)		4–7	1	—	—	1	—	—	—	—
186	*Haplophragmoides emaciatus* (Br.)		—	—	—	1	—	—	—	—	—
187	*H. grandiformis* Cushman		8–16	—	—	1	—	—	—	—	—
188	*Recurvoides contortus* Earland		—	—	—	—	—	—	—	2–3	—
189	*Ammobaculites agglutinans* (d'O.)		—	—	—	—	1	—	—	—	—
190	*Reophax dentaliniformis* Brady		—	—	—	—	2–3	—	—	—	—
191	*R. distans* v. *pseudodistans* Cush.		—	—	—	—	—	1	—	—	—
192	*R. scorpiurus* Montfort		—	—	—	2–3	—	—	—	—	—
193	*Textularia conica* (d'Orb.)		8–16	—	—	—	—	—	—	—	—
194	*T. corrugata* H. A. & E.		4–7	—	—	—	—	—	—	—	—
195	*T. pseudogramen* Chapm. & Parr		8–16	—	—	—	1	—	—	—	1
196	*T. sagittula* Defr.		2–3	—	1	2–3	2–3	—	—	—	4–7
197	*Trochammina planoconvexa* Ch.&P.		—	—	—	—	—	—	—	1	—
198	*Clavulina serventyi* Ch. & Parr		2–3	—	2–3	—	—	—	—	—	—
199	*Dorothia arenata* Cushman		8–16	—	—	—	1	—	—	—	—
200	*D. scabra* (Brady)		2–3	—	—	—	—	—	—	—	—
201	*Listerella* sp.		1	—	—	—	—	—	—	—	—
202	*Gaudryina robusta* Cushman		1	—	—	—	—	—	—	1	—
203	*G. triangularis* Cushman		4–7	—	—	—	—	—	—	—	—

Tabulation of Ostracoda in the Faunules of each Sample

	Species	Sample / Depth	3915 65 fm.	3916 anch.	3917 140	3918 505	3919 505	3920 470	2921 505	3922 470	3923 65
1	*Pontocypris bradyi* nom. mut.		—	1	1	2–3	—	1	—	—	—
2	*P. attenuata* G.S. Brady		—	—	—	—	2–3	—	—	—	—
3	*P. simplex* G. S. Brady		—	—	—	2–3	1	—	—	—	1
4	*P. subreniformis* G. S. Brady		1	1	—	1	—	—	—	—	—
5	*Argilloecia badia* G. S. Brady		1	1	—	1	—	—	—	—	—
6	*Macrocypris decora* (G. S. B.)		4–7	1	1	2–3	1	—	—	—	1
7	*M. setigera* G. S. Brady		4-7	—	1	—	—	—	—	—	1
8	*Bythocypris reniformis* G. S. B.		—	—	—	1	1	1	—	—	—
9	*Bairdia acanthigera* G. S. Brady		—	—	2–3	2–3	—	—	—	—	—
10	*B. amygdaloides* G. S. Brady		8–16	1	4–7	2–3	1	—	1	1	>16
11	*B. australis* Chapman		—	—	1	1	1	1	—	—	4–7
12	*B.* cf. *expansa* G. S. Brady		—	—	—	—	—	1	—	—	—
13	*B. foveolata* G. S. Brady		1	—	—	—	—	—	—	—	—
14	*B. fusca* G. S. Brady		—	—	2–3	—	—	—	—	—	—
15	*B. minima* G. S. Brady		—	—	1	—	4–7	—	—	—	—
16	*Cythere acerosella* sp. nov.		—	—	1	—	—	1	—	—	1
17	*C. canaliculata* Reuss		—	—	—	—	—	—	1	1	—
18	*C. crispata* G. S. Brady		—	—	—	—	—	1	—	—	1
19	*C. cristatella* G. S. Brady		2–3	—	—	—	—	—	—	—	—
20	*C. cytheropteroides* G. S. Brady		2–3	—	—	—	—	—	—	—	—
21	*C. dasyderma* G. S. Brady		—	—	—	1	—	—	—	—	—
22	*C. demissa* G. S. Brady		—	—	—	1	—	—	—	1	—
23	*C. dictyon* G. S. Brady		1	—	—	2–3	—	—	—	1	—
24	*C. exilis* G. S. Brady		—	—	—	—	—	—	—	1	—
25	*C. falklandi* G. S. Brady		—	—	—	—	2–3	—	—	—	—
26	*C. foveolata* G. S. Brady		—	—	2–3	—	1	—	—	—	—
27	*C. goujoni* G. S. Brady		—	—	—	—	1	—	—	1	—

TABULATION OF OSTRACODA IN THE FAUNULES OF EACH SAMPLE

Species	Sample / Depth	3915 65 fm.	3916 anch.	3917 140	3918 505	3919 505	3920 470	2921 505	3922 470	3923 65
28	*C. inconspicua* G. S. Brady ..	—	—	—	2–3	—	—	—	—	—
29	*C. irrorata* G. S. Brady	—	—	—	—	1	—	—	—	—
30	*C. militaris* (G. S. Brady) ..	—	1	—	—	—	—	—	—	—
31	*C. normani* G. S. Brady	1	—	—	—	—	—	—	—	—
32	*C. obtusalata* G. S. B. v. *tenuis* nov.	—	—	—	—	2–3	—	2–3	—	2–3
33	*C. ovalis* G. S. Brady	—	—	—	1	—	—	—	—	—
34	*C. postcaudispinosa* sp. nov. ..	—	—	1	—	—	—	—	—	—
35	*C. rastromarginata* G. S. Brady ..	—	—	1	—	—	1	—	2–3	—
36	*C. scutigera* G. S. Brady	—	—	—	—	—	—	—	—	2–3
37	*C. subrufa* G. S. Brady	—	—	—	—	—	—	—	—	1
38	*C. tetrica* G. S. Brady	—	—	—	—	—	1	—	—	—
39	*Eucythere declivis* (Norman) ..	—	—	—	1	1	—	—	—	—
40	*Krithe producta* G. S. Brady ..	4–7	—	—	1	—	—	—	—	—
41	*Loxoconcha australis* G. S. Brady	—	—	—	2–3	1	1	1	4–7	1
42	*L. avellana* G. S. Brady	—	—	—	2–3	—	—	—	2–3	—
43	*Xestoleberis curta* (G. S. Brady)	2–3	—	—	—	—	1	—	—	—
44	*X. davidiana* Chapman	—	1	2–3	—	—	—	—	—	—
45	*X. margaritea* (G. S. Brady) ..	—	—	—	—	—	—	—	—	1
46	*X. nana* G. S. Brady	—	—	—	—	—	—	—	—	2–3
47	*X. polita* G. S. Brady	—	—	—	—	—	—	—	—	1
48	*X. setigera* G. S. Brady	—	—	—	1	—	—	—	—	—
49	*X. variegata* G. S. Brady	—	—	—	—	—	—	—	—	1
50	*Cytherura costellata* G. S. B. ..	—	—	—	1	—	—	—	1	—
51	*C. cryptifera* G. S. Brady ..	—	—	—	1	—	—	—	—	—
52	*Cytheropteron assimile* G. S. B. ..	—	—	—	—	1	1	—	—	—
53	*C. dannevigi* Chapman	—	—	1	—	—	—	—	—	—
54	*C. hedleyi* sp. nov.	1	—	—	—	—	—	—	—	—
55	*Bythocythere arenacea* G. S. B. ..	—	—	—	1	—	—	1	—	—
56	*Pseudocythere caudata* G. O. S. ..	—	—	1	—	—	—	—	1	—
57	*P. fuegiensis* G. S. Brady ..	—	—	—	1	—	—	—	—	—
58	*Cytherella lata* G. S. Brady ..	—	—	—	—	—	—	—	1	—
59	*C. polita* G. S. Brady	—	—	2–3	—	—	—	—	1	—
60	*C. pulchra* G. S. Brady	—	1	2–3	1	—	—	—	—	—
61	*C. punctata* G. S. Brady	1	1	—	2–3	—	1	—	1	>16
62	*C. semitalis* G. S. Brady	—	—	—	1	—	—	—	—	—
63	*Cytherelloidea auris* sp. nov. ..	—	—	—	—	—	—	—	1	—

SYSTEMATIC

FORAMINIFERA

Superfam. SPIRILLINOIDEA

Fam. SPIRILLINIDAE

Genus SPIRILLINA Ehrenberg 1843

1 SPIRILLINA INAEQUALIS Brady 1879

Brady 1879, 278, pl. viii, fig. 25 *a*, *b*, 1884, 631, pl. lxxxv, fig. 8-11; Chapman, 1915, 28.

A well-known Pacific species. Previously noted from Sta. 36, east of Tasmania, 777 fathoms.

E 3918, v.r.

Fam. NODOSARIIDAE

Genus LENTICULINA Lamarck 1804

2 LENTICULINA CLERICII (Fornasini 1895)

Cristellaria clericii Fornasini 1895, text fig. 1901, 65, fig. 17.

This form belongs to the group of *L. vortex* (d'Orb.), *serpens* (Seguenza) and *orbicularis* (d'Orb.), in which the sutural lines are extremely angulate. Typical of South Pacific areas. This hitherto fossil form was described from a late Tertiary deposit (? Pliocene) of Italy.

E 3917, v.r.

3. LENTICULINA sp. aff. CONVERGENS (Bornemann 1855)

Cristellaria convergens Bornemann 1855, 337, pl. xiii, fig. 16. 17

The original species, with which the present is doubtfully identified, came from the Oligocene deposits of Hermsdorf, Germany. The "Challenger" examples came from the North and South Pacific (Brady 1884). E 3915, r.

4 LENTICULINA CULTRATA (Montfort 1808)

Robulus cultratus Montfort 1808, 215.
Cristellaria cultrata (Montf.), Brady, 1884, 550, pl. lxx, fig. 4-8.

A widely distributed species, both fossil and recent. The "Challenger" obtained it from the West Indies and Fiji. I have previously noted it from "Endeavour" material, east of Tasmania, 777 fathoms.

E 3915, c; E 3919, v.r. (deformed).

5 LENTICULINA GIBBA (d'Orbigny 1839)

Cristellaria gibba d'Orbigny 1839, 40, pl. vii, fig. 20, 21.

The "Challenger" figured specimens came from the West Indies. It is widely distributed both in fossil deposits and recent dredgings. E 3915, r.

6 LENTICULINA ROTULATA Lamarck 1804

Lamarck 1804, 183, No. 3; 1806, pl. lxii, fig. 11.

The "Challenger" figured specimens came from the West Indies. It is a widely distributed form. Previously noted by me from 40 miles south of Cape Wiles, 100 fathoms ("Endeavour"). E 3918, v.r.; E 3922, v.r.

7 LENTICULINA sp. aff. ARTICULATA (Reuss 1864)

Robulina articulata Reuss 1864, 53, pl. v, fig. 62 *a, b*, 63 *a, b*.

Recent forms, similar to the present material, found in southern waters, do not appear to be referable to the fossil species figured by Reuss from the *Septaria*-clays of Germany. The recent form is typical of the Australian region. Under the name of *Cristellaria articulata* I have noted it from 40 miles south of Cape Wiles, 100 fathoms. E 3915, r.

8 LENTICULINA sp. aff. ORBICULARIS (d'Orb. 1826)

Robulina orbicularis d'Orbigny 1826, 288, pl. xv, fig. 8, 9.

I have previously recorded this form as *Cristellaria orbicularis* d'Orb. from 40 miles south of Cape Wiles, 100 fathoms. E 3915, f; E 3917, v.r.; E 3918, v.r.

9 LENTICULINA sp. aff. SUBALATA (Reuss 1854)

Cristellaria subalata Reuss, 1854, 68, pl. xxv, fig. 13.

This, in common with many other recent forms, cannot be specifically identified with the Cretaceous and Tertiary fossils of Europe. E 3915, v.r.

Genus PLANULARIA Defrance 1824

10 **Planularia australis** sp. nov.

(Pl. ix, fig. 1)

Cristellaria tricarinella Chapman (non Reuss), 1915, 24, pl. i, fig. 6.

Description—Test subovate to elongate-arcuate. Surface complanate; dorsal edge thickened but not sharply tricarinate as in Reuss' figures. Seven arcuate chambers in type, forming a widely open spiral. A small subspherical proloculus at the origin of coil. Aperture dentate. Length of test, 0·7 mm.; greatest breadth, 0·38 mm.; thickness of test, 0·08 mm.

Comparisons—Differs from "*Cristellaria*" *tricarinella* Reuss and from *C. complanata* Reuss in having the sutures flush with the surface. Brady's specimens figured in the "Challenger" Report appear to be intermediate between the present and Reuss' form in showing some carination of the dorsal border. As *Cristellaria tricarinella*, variations of this form have been recorded from the Philippines and from the west coast of New Zealand. E 3919, v.r.

Genus SARACENARIA Defrance 1824

11 SARACENARIA ITALICA Defrance 1824

Defrance 1824, 177; Blainville, 1825, 370, pl. v, fig. 6.

The "Challenger" figured examples came from the West Indies and Fiji. The occurrence of this species is usually indicative of the presence of warm water.

E 3915, r.; E 3917, v.r.

12 SARACENARIA NAVICULA (d'Orb. 1840)

Cristellaria navicula d'Orb. 1840, 27, pl. ii, fig. 19.

A broad variation of the preceding species. It is typically a Cretaceous form, but seems to range, without any great difference, into recent times. E 3915, r.

Genus ASTACOLUS Montfort 1808

13 ASTACOLUS CREPIDULA (Fichtel and Moll 1798)

Nautilus crepidula Fichtel and Moll 1798, 107, pl. xix, *g-i.*

A widely distributed species, with many intergradations. Typical forms were found by the "Challenger" off the Ki Islands, Japan; at the Azores, the West Indies and the Bermudas. E 3917, v.r.

Genus MARGINULINA d'Orbigny 1826

14 MARGINULINA GLABRA d'Orbigny 1826

d'Orbigny 1826, Modèles, 55; Parker, Jones and Brady, 1865, 27, pl. i, fig. 36.

A common form, of wide distribution.

E 3915, r.; E 3917, v.r.; E 3920, v.r.; E 3923, v.r.

Genus VAGINULINA d'Orbigny 1826

15 VAGINULINA LEGUMEN (Linn. 1758)

Brady, 1884, 530, pl. lxvi, fig. 13-15.

A cosmopolitan species. Also found in the Philippines.

E 3915, v.r.; E 3918, v.r.; E 3919, v.r.

Genus DENTALINA d'Orbigny 1826

16 DENTALINA COMMUNIS d'Orbigny 1826

d'Orbigny 1826, 254, No. 35.

An arcuate form with oblique chambers. It agrees with those found by Brady, whose "Challenger" specimens came from the West Indies, Bermudas and Fiji. E 3915, v.r.

17 DENTALINA FISTUCA (Schwager 1866)

Nodosaria fistuca Schwager 1866, 216, pl. v, fig. 36, 37.

This finely hirsute form, having long ovoid chambers, was originally described from the Neogene fossil deposits of Kar Nikobar, south of the Andaman Islands. E 3920, v.r.

18 DENTALINA sp. aff. CONSOBRINA (d'Orb. 1846)

d'Orbigny 1846, 46, pl. ii, fig. 1-3.

Dentalina consobrina of d'Orbigny is chiefly known as a Tertiary fossil, and was originally described from the Lower Miocene of the Vienna Basin. The recent species, from southern waters, is of a more regular and evenly chambered form, and occurs in the Antarctic amongst other localities.

E 3915, r.; E 3921, v.r.

19 DENTALINA SOLUTA Reuss 1851

Reuss 1851, 60, pl. iii, fig. 4.
Nodosaria (D.) soluta Brady, 1884, 503, pl. lxii, fig. 13-16.

This remarkably persistent form in time ranges from the Cretaceous to the present. E 3915, v.r.

Genus NODOSARIA Lamarck 1812

20 NODOSARIA CATENULATA Brady 1884

Brady 1884, 515, pl. lxiii, fig. 32-34.

This species has an interesting distribution as regards the present soundings, for Brady records it from the Philippines at 95 fathoms and off Raine Island, Torres Strait, at 155 fathoms. E 3915, v.r.; E 3920, v.r.

21 NODOSARIA CALOMORPHA Reuss 1865

Reuss 1865, 129, pl. i, fig. 15-19; Brady, 1884, 497, pl. lxi, fig. 23-27; Chapman and Parr, 1937, 61.

The southern occurrences of this species, often at great depths, comprise the Falkland Islands, and Kerguelen Island (Brady) and also South Georgia (Earland), and in Bass Strait (Chapman and Parr). Brady also refers to it as from the Ki Islands and off the Philippines. Reuss' specimens were from the Oligocene of Pietzpuhl, North Germany. E 3922, v.r.

22 NODOSARIA PYRULA d'Orbigny 1826

d'Orbigny 1826, 253, No. 13. Brady, 1884, 491, pl. lxii, fig. 10-12.

This is a common species in the Philippines and it has also been obtained off the Ki Islands. It is a widely distributed species elsewhere. I have previously recorded it from "Endeavour" material from east of Tasmania, 777 fathoms.

E 3923, v.r.

23 NODOSARIA PYRULA var. SEMIRUGOSA d'Orbigny 1846

Nodosaria semirugosa d'Orb. 1846, 34, pl. i, fig. 29-23; Millett, 1902, 515, pl. xi, fig. 5.
Nodosaria costulata Brady 1884, 515, pl. lxiii, fig. 23-27.
Nodosaria pyrula var. *semirugosa* d'Orb., Cushman, 1913, 50, pl. xxvi, fig. 4-8.

This species is found from the Cretaceous to Recent. It has been dredged from the Philippines, the Malay Archipelago and off Japan, as well as at various Stations in the West Indies. E 3917, v.r.; E 3919, v.r.

24 NODOSARIA VERTEBRALIS (Batsch 1791)

Nautilus (Orthoceras) vertebralis Batsch 1791, 3, No. 6, pl. ii, fig. 6 *a*, *b*.
Nodosaria vertebralis (Batsch) Brady, 1884, 514, pl. lxiii, fig. 35; pl. lxiv, fig. 11-14.

Amongst other localities, this species occurs in the North Pacific, off the Hawaiian Islands, and from the east coast of New Zealand. E 3922, r.

Genus LAGENONODOSARIA Silvestri 1900

25 LAGENONODOSARIA SCALARIS (Batsch 1791)

Nautilus (*Orthoceras*) *scalaris* Batsch 1791, No. 4, pl. ii, fig. *a*, *c*.
Nodosaria scalaris (Batsch) Cushman, 1913, 58, pl. xxiv, fig. 7.

This species occurs as a common fossil in the Neogene of Europe. It is found living off the coast of Australia, on the east coast of New Zealand, the Philippines, Guam, Japan and the Hawaiian Islands. It is one of the most abundant forms in the present series; previously recorded from "Endeavour" material (1915), from 40 miles south of Cape Wiles, 100 fathoms.

E 3915, v.c.; E 3917, r.; E 3918, r.; E 3919, f.; E 3920, f.; E 3921, r.; E 3922, r.; E 3923, r.

26 LAGENONODOSARIA SCALARIS (Batsch) var. SEPARANS (Brady 1884)

Nodosaria scalaris var. *separans* Brady 1884, 510, pl. lxiv, fig. 16-19.

Hitherto from the west coast of New Zealand (*fide* Nuttall's Locality List of Brady's figured specimens of the "Challenger" Report in Annals and Mag. Nat. Hist., (9), **19**, 209-241, 1927—an invaluable adjunct to Brady's work).

E 3915, v.r.; E 3923, v.r.

27 **Lagenonodosaria scalaris** (Batsch) var. **seminuda** nov.

(Pl. ix, fig. 2)

Description—Test stoutly built, consisting of three sub-globular chambers, well inflated and even more so than in the type species; aperture round at the extremity of the extended tube, the surface of which is distinctly annulated. Shell surface polished, relieved by a few indistinct linear costae. Length, 0·59 mm.; greatest width of last chamber, 0·3 mm. E 3922, v.r.

Genus LAGENA Walker and Jacob 1798

28 LAGENA ANNECTENS Burrows and Holland 1895

Burrows and Holland (in Jones, Parker and Brady) 1895, 203, pl. vii, fig. 11 *a*, *b*.

This fossil *Lagena* from the English Crag (Pliocene) has more recently been recorded as an Antarctic (Kerguelen) and New Zealand species. It also occurs off the coast of New South Wales. As a fossil it has also been found in the Lower Miocene of Batesford, near Geelong, Victoria. E 3919, v.r.

29 LAGENA APICULATA (Reuss 1850)

Oolina apiculata Reuss 1850, 22, pl. i, fig. 1.

A cosmopolitan species both as to locality and depth. It is geologically an ancient type, dating from the Lias. E 3921, v.r.

30 LAGENA CLAVATA (d'Orbigny 1846)

Oolina clavata d'Orbigny 1846, 24, pl. i, fig. 2, 3.
Lagena clavata Brady, 1884, 456; Cushman, 1913, 9, pl. ii, fig. 3.

A bipolar form and otherwise extensively distributed. Cushman records it from the North Pacific, near Guam, at 234 fathoms, and from several Stations in the Philippines. E 3917, v.r.; E 3919, v.r.

31 LAGENA COSTATA (Williamson 1858)

Entosolenia costata Williamson 1858, 9, pl. i, fig. 18.
Lagena costata (Williamson) Sidebottom, 1912, 388, pl. xv, fig. 16-21.

This species has been recorded by Sidebottom from the South-west Pacific.
E 3919, v.r.

32 LAGENA CRENATA Parker and Jones 1865

Parker and Jones 1865², 420, xviii, fig. 4 *a, b;* Brady, 1884, 467, lvii, fig. 15, 21.

Besides occurring at several British localities, this comparatively rare form was noted by the "Challenger" from the Cape of Good Hope, 15-20 fathoms, from Australian shore-sands, off Moncoeur Island, Bass Strait, 38 fathoms, and at three localities in the South Pacific at 2,325-2,425 fathoms. Heron-Allen and Earland obtained it from the Antarctic (Terra Nova Expedition).
E 3919, v.r.; E 3920, v.r.

33 LAGENA DISTOMA Parker and Jones 1864

Parker and Jones (Ms. in Brady) 1864, 467, pl. xlviii, fig. 6.

Distributed in all seas and at varying depths. The figured specimens from the "Challenger" collection (pl. lviii, fig. 12-15) came from Kerguelen Island (*fide* Nuttall). E 3920, v.r.

34 LAGENA GLOBOSA (Montagu 1804)

Vermiculum globosum Montagu 1804 (in Brown, Ill. Rec. Conch.), 144, pl. lvi, fig. 37, 40.

Widely distributed in all seas. The figure 2 on pl. lvi of the "Challenger" Report came from Bass Strait (*fide* Nuttall). E 3919, v.r.

35 LAGENA HEXAGONA (Williamson 1848)

Entosolenia squamosa var. *hexagona* Williamson 1848, 20, pl. ii, fig. 23.
Lagena hexagona Brady 1884, 72, pl. lviii, fig. 32, 33.

Widely distributed in present seas. Common in various Tertiary deposits of Europe. Has been recorded generally from the Antarctic. E 3919, v.r.

36 LAGENA HISPIDA Reuss 1858

Reuss 1858, 434. *Idem*, 1862, 335, pl. iv, fig. 77-79.

Brady figures this species from Torres Strait and off Japan. It has an extensive geographical distribution and a wide geological range, from Lias to Recent.
E 3919, v.r.

37 LAGENA LACUNATA Burrows and Holland 1895

Lagena castrensis Brady (non Schwager) 1884, 485, pl. lx, fig. 1, 2.
Lagena lacunata Burrows and Holland 1895, 205, pl. vii, fig. 12 *a, b;* Chapman and Parr, 1926, 378, pl. xvii, fig. 18.

The "Challenger" records (under *L. castrensis*) are: Moncoeur Island, Bass Strait, 38 fathoms; Raine Island, Torres Strait, 155 fathoms; Amboyna, 15-20 fathoms; south of Japan, 345 fathoms. Heron-Allen and Earland noted it from North Cape, New Zealand (Terra Nova Expedition). Chapman and Parr found fossil specimens of Lower Miocene age in the Altona Bay Coal shaft, Port Phillip. The original type was recorded as fossil in the English Crag (Pliocene).

Lagena lacunata was previously recorded by me from "Endeavour" material east of Tasmania at 777 fathoms. E 3919, v.r.

38 LAGENA LAGENOIDES (Williamson 1858)

Entosolenia marginata var. *lagenoides* Williamson 1858, 11, pl. i, fig. 25, 26.
Lagena lagenoides (Will.), Brady, 1884, 479, pl. lx, fig. 6, 7, 9, 12-14.

Previously recorded by me from "Endeavour" material east of Tasmania, 1,122 fathoms. E 3920, v.r.

39 LAGENA MARGINATA (Walker and Boys 1784)

Serpula (Lagena) marginata Walker and Boys 1784, 2, pl. i, fig. 7.
Lagena marginata, Brady 1884, 476, pl. lix, fig. 21-23.

This species has a widely extended range, "almost to the Antarctic Ice-Barrier" (Brady). E 3917, v.r.; E 3919, v.r.

40 LAGENA MELO (d'Orbigny 1839)

Oolina melo d'Orbigny 1839[3], 20, pl, v, fig. 9.
Lagena melo, Jones, Parker and Brady, 1866, 38, pl. i, fig. 35.

Heron-Allen and Earland record this species from east of North Cape, New Zealand. E 3917, v.r.; E 3919, r.; E 3920, f.; E 3922, v.r.

41 LAGENA ORBIGNYANA (Seguenza 1862)

Fissurina orbignyana Seguenza 1862, 66, pl. ii, fig. 25, 26.
Lagena orbignyana , Brady, 1884, 484, pl. lix, fig. 1, 18, 24-26.

Distribution world-wide and geologically co-extensive with the Tertiaries. Earland records this species from South Georgia, and Cushman from New Zealand. Previously recorded from "Endeavour" material, 40 miles south of Cape Wiles, 100 fathoms. E 3919, r.; E 3920, v.r.

42 LAGENA STRIATA (d'Orbigny 1839)

Oolina striata d'Orbigny 1839, 21, pl. v, fig. 12.
Lagena striata, Brady 1884, 460, pl. lvii, fig. 22, 24, 28. 29.

Species of wide distribution. Previous records from "Endeavour" material (1915) are: east of Tasmania at 777 fathoms, and 40 miles south of Cape Wiles, 100 fathoms. E 3917, r.; E 3919, r.; E 3920, v.r.; E 3921, v.r.

43 LAGENA SULCATA (Walker and Jacob 1798)

Serpula (Lagena) sulcata W. and J. 1798, 634, pl. xiv, fig. 5.
Lagena sulcata, Brady 1884, 462, pl. lvii, fig. 23, 26, 33, 34.

Several examples figured in the "Challenger" Report came from Southern Seas, as, for instance, from Kerguelen Island (pl. lvii, fig. 23, 25, 34). A previous record from "Endeavour" material is 40 miles south of Cape Wiles, 100 fathoms. E 3919, v.r.; E 3920, v.r.

44 LAGENA VARIATA Brady 1884

Brady 1884, 461, pl. lxi, fig. 1; Chapman, 1907, 128, pl. ix, fig. 8.

A rare form, according to Brady. The only localities appear to be Bass Strait, 38 fathoms, Beaumaris (Chapman) and the Malay Archipelago.

E 3916, v.r.

Genus PSEUDOGLANDULINA Cushman 1929

45 PSEUDOGLANDULINA ROTUNDATA (Reuss 1850)

Glandulina rotundata Reuss 1850, 366, pl. xlvi, fig. 2
Nodosaria (Glandulina) rotundata Brady 1884, 491, pl. lxi, fig. 17-19; Chapman, 1916[1], 32, pl. iii, fig. 20 *a, b*.

Recorded from upthrust muds, slopes of Mount Erebus (Chapman) and from Mawson's Antarctic material (Chapman and Parr, 1911-14). Previously recorded by me from "Endeavour" soundings, 40 miles south of Cape Wiles, 100 fathoms. E 3915, r.

Fam. POLYMORPHINIDAE

Genus GUTTULINA d'Orbigny 1826

46 GUTTULINA COMMUNIS d'Orbigny 1826

Polymorphina (*Guttulina*) *communis* d'Orbigny 1826, 266, pl. xii, fig. 1-4.
Polymorphina communis, Brady 1884, 568, pl. lxxii, fig. 19.

A well-grown example of this species was found close to the Antarctic Ice Barrier, in 1,810 fathoms (Chapman and Parr, 1937). Also found generally in moderately shallow water off the coast of New Zealand ("Terra Nova"). Previous records from "Endeavour" material as *"Polymorphina communis,"* from 40 miles south of Cape Wiles, 100 fathoms. E 3915, v.r.

47 GUTTULINA LACTEA (Walker and Jacob 1798)

Serpula lactea Walker and Jacob 1798, 634, pl. xiv, fig. 4.
Polymorphina lactea, Williamson 1858, 70, pl. vi, fig. 145-152.
Guttulina lactea, Cushman and Ozawa 1936, 43, pl. x, fig. 1-4.

A common species round the British Isles; also found in shallow to moderately deep water in the West Indies, the Tortugas (Florida), the coast of Japan and the Philippines. It has also been recorded in shore sands of the Victorian coast. E 3919, r.

48 GUTTULINA PROBLEMA d'Orbigny 1826

Guttulina problema d'Orbigny 1826, 266, No. 14.
Polymorphina problema, Brady 1884, 568, pl. lxxii, fig. 20; pl. lxxiii, fig. 1.

Both of Brady's figured specimens came from Bass Strait (*fide* Nuttall). Recorded by Parr and Collins from San Remo, Victoria, and from Oyster Bay, and east of Cape Pillar, Tasmania, at 100 fathoms.
E 3915, r.; E 3917, r.; E 3918, r.

49 GUTTULINA REGINA (Brady, Parker and Jones 1870)

Polymorphina regina B., P. and J. 1870, 241, pl. xli, fig. 32 *a, b;* Chapman, 1907, 132, pl. x, fig. 4.
Guttulina regina, Cushman and Ozawa 1936, 34, pl. vi, fig. 1, 2; Parr and Collins 1937, 193. pl. xii, fig. 5; text fig. 1-7.

Localities in Victoria are Port Lonsdale and Barwon Heads; in New South Wales, Port Jackson; also from Queensland, Tasmania and West Australia, Great Australian Bight (Parr and Collins). "Challenger" examples were obtained from Raine Island, Torres Strait, 155 fathoms. E 3915, v.r.; E 3917, v.r.; E 3918, v.r.

50 GUTTULINA YABEI Cushman and Ozawa 1930

Polymorphina oblonga Brady (non d'Orb.) 1884, pl. lxxiii, fig. 6, 7.
P. thouini Chapman (non d'Orb.) 1907, pl. x, fig. 2.
Guttulina yabei Cushman and Ozawa 1930, 30, pl. iv, fig. 6, 7; Parr and Collins, 1937, 192, pl. xii, fig. 3, 4 *a-c;* pl. xiii, fig. 4 *a-c.*

This species is usually found at moderate depths (6-114 fathoms). It has been recorded (as *P. oblonga*) by the "Challenger" from Bass Strait (38-40 fathoms) and Port Jackson (6 fathoms); other localities are off Japan and New Zealand (off the Snares). E 3915, r.

Genus GLOBULINA d'Orbigny 1826

51 GLOBULINA GIBBA d'Orbigny var. GLOBOSA (Münster 1838)

Polymorphina globosa Münster 1838 (in Roemer), 386, pl. iii, fig. 33.

Globulina gibba var. *globosa,* Cushman and Ozawa 1930, 60, pl. xvi, fig. 1-4; Parr and Collins, 1937, 199, pl. xii, fig. 13.

Common in shore sand off the coast of Victoria. Also from Burnie, Tasmania, and Glenelg, South Australia (Parr and Collins). E 3923, v.r.

Genus GLANDULINA d'Orbigny 1826

52 GLANDULINA LAEVIGATA (d'Orbigny 1826)

Nodosaria (*Glandulina*) *laevigata* d'Orbigny 1826, 252, No. 1, pl. x, fig. 1-3; Brady, 1884, 490, pl. lxi, fig. 20-22.

Glandulina laevigata, Cushman and Ozawa 1930, 143, pl. xl, fig. 1 *a, b*; Parr and Collins, 1937, 208, pl. xiii, fig. 6 *a-c.*

Brady's figured specimen came from the West Indies (*fide* Nuttall). Parr and Collins record it from Oyster Bay, Tasmania. My previous note of its occurrence in "Endeavour" material is from Station 36, east of Tasmania, 777 fathoms. *G. laevigata* is found fossil in the Lower Miocene and Pliocene of Victoria and in the Lower Miocene of Table Cape, Tasmania. E 3919, r.

Fam. BULIMINIDAE

Genus BULIMINELLA Cushman 1911

53 BULIMINELLA sp.

Bulimina elegantissima v. *seminuda* Brady 1884 (non Terquem).

This species is now under description, in the Results of the Mawson Expedition to Antarctic, 1929-31. E 3915, v.r.

Genus BULIMINA d'Orbigny 1826

54 BULIMINA ACULEATA d'Orbigny 1826

d'Orb. 1826, 269, No. 7; Brady, 1884, 406, pl. li, fig. 7-9.

A species universally distributed, and usually found in deep water. It often accompanies *B. marginata* according to Dr. H. B. Brady. It is found as far south as the Antarctic Ice Barrier. Records in the Australian region are: 27½ miles east of Port Jackson Head, New South Wales (Goddard and Jensen) and Western Australia (Egger). Previous records from "Endeavour" material are: Station 36, east of Tasmania, 777 fathoms and east of Tasmania, 1,122 fathoms. E 3922, v.r.

55 BULIMINA ELEGANS d'Orbigny 1826

d'Orbigny 1826, 270, No. 10; Modèle, No. 9; Brady, 1884, 398, pl. l, fig. 1-4; Chapman and Parr, 1937, 86.

Recorded from the Islands of the South Pacific and from the coast of New Zealand. Chapman and Parr have recorded it from stations close to the Antarctic Ice Barrier.

NOTE ON THE "ENDEAVOUR" EXAMPLES—Typical forms of regularly ovate-elongate contour tend to have the initial series of chambers spinose or marginate, and thus pass into *B. marginata.* Dr. C. Fornasini found the same variation in his specimens of *B. elegans* from the Adriatic (Accad. Sci. Ist. Bologna, 1901, 375). These variations are shown on pl. o, fig. 7, 14, 33, 39, of his paper.

E 3920, c.; E 3921, f.; E 3922, f.

56 BULIMINA sp. aff. MARGINATA d'Orbigny 1826
(Pl. viii, fig. 6)

The figured specimens of the "Challenger" Report (Brady, 1884), were drawn from examples obtained off the west coast of Ireland. The forms met with in southern waters are of more tumid build and have the free edge of the segments more coarsely crenulated than those from the northern hemisphere.

E 3915, r.; E 3916, v.r.; E 3917, v.r.; E 3919, v.r.; E 3920, r.; E 3922, f.

57 **Bulimina notovata** sp. nov.

Bulimina ovata Brady (non d'Orbigny, 1846) 1884, pl. 1, fig. 13 *a, b*.

Brady's figured specimens of *B. "ovata"* were obtained east of New Zealand (*fide* Nuttall). d'Orbigny obtained his fossil type from the Miocene of the Vienna Basin; when the latter is compared with the living form, so familiar in southern waters, the differences are easily seen. *B. ovata,* according to the figured type, is a long ovate form, with the segments slightly inflated and prominent and therefore specifically different from the "Challenger" specimen. Goës (1894, 45) has placed Brady's *ovata* in the synonymy of *Bulimina ellipsoides* Costa, but that form, according to Goës' figures (1894, pl. viii, fig. 31-36), is also distinct from this southern living species. E 3918, r.

Genus VIRGULINA d'Orbigny 1826

58 VIRGULINA SUBSQUAMOSA Egger 1857

Egger 1857, 295, pl. xii, fig. 19-21; Brady, 1884, 415, pl. lii, fig. 7-11; Chapman and Parr, 1937, 89.

The "Challenger" figures of the above came from Tahiti (Nuttall). Heron-Allen and Earland obtained it around the Falkland Islands and Egger in the South Pacific. The "Aurora" soundings (Mawson, 1911-14) showed that this species commonly occurred to the east and south of Tasmania, and more rarely near the Antarctic Ice Barrier. E 3919, f.; E 3923, r.

Genus BOLIVINA d'Orbigny 1839

59 BOLIVINA ALATA (Seguenza 1862)

Vulvulina alata Seguenza 1862, 115, pl. ii, fig. 5, 5 *a*.
Bolivina beyrichi Reuss var. *alata* Brady (pars) 1884, pl. liii, fig. 2-4.

This form appears to be common in the Late Tertiary and Recent of Italy and the Mediterranean. One of the figured specimens of the "Challenger" came from the Philippines. It was of frequent occurrence in the "Aurora" soundings east of Tasmania.

E 3916, f.; E 3917, v.r.; E 3919, r.; E 3920, f.; E 3922, r.

60 BOLIVINA sp. aff. HENTYANA Chapman 1916

Bolivina hentyana Chapman 1916[1], 145, fig.

This species is common in one of the "Endeavour" soundings of the present series. It is a recent modification of the Lower Miocene fossil, *B. hentyana* Chapman. E 3915, v.c.; E 3917, v.r.; E 3918, r.

61 BOLIVINA BEYRICHI Reuss 1851

Reuss 1951[2], 83, pl. vi, fig. 51; Brady, 1884, 422, pl. liii, fig. 1; Chapman and Parr, 1937, 90.

This species occurred off Sydney at 110 fathoms ("Challenger"). Dr. Egger records it off the coast of Western Australia. It was found in material gathered by the "Aurora," 1911-14, and in former "Endeavour" soundings, in abundance at Station 36, east of Tasmania, 777 fathoms, and rarely at 1,122 fathoms in the same locality. E 3915, c.; E 3916, r.; E 3917, v.r.; E 3918, f.; E 3919, v.r.; E 3920, f.; E 3921, f.; E 3922,v.c.

62 BOLIVINA LIMBATA Brady 1884

Brady 1884, 419, pl. liii, fig. 26-28; Chapman, 1907, 32, pl. iv, fig. 83.

A well-distributed form in the Tasman Sea and the Indo-Pacific area. It has previously occurred in "Endeavour" material, east of Tasmania, at 1,122 fathoms, and 40 miles south of Cape Wiles at 100 fathoms. It is also a Lower Miocene fossil in Victoria. E 3921, v.r.; E 3923, r.

63 BOLIVINA PUNCTATA d'Orbigny 1839

d'Orbigny 1839[3], 63, pl. viii, fig. 10-12; Chapman, 1907, 32, pl. iv, 80; Chapman and Parr, 1937, 92, pl. viii, fig. 16.

Widely distributed in Australian waters. Previously recorded from "Endeavour" material, Station 36, east of Tasmania, 777 fathoms. Also in shore sands at Beaumaris, Port Phillip (Chapman). E 3919, v.r.

64 BOLIVINA ROBUSTA Brady 1884

Brady 1884, 421, pl. liii, fig. 7-9; Cushman, 1937, 131, pl. xvii, fig. 1-4.

Widely spread through Atlantic, Pacific, and Indian Oceans and Antarctic Seas. The "Challenger" figures are from the Ki Islands and Fiji. It has been recorded from former "Endeavour" material, east of Tasmania, 777 fathoms, and 40 miles south of Cape Wiles, 100 fathoms. E 3920, c.; E 3921, v.r.; E 3922, f.

Genus RECTOBOLIVINA Cushman 1927

65 RECTOBOLIVINA BIFRONS (Brady 1884)

Sagrina bifrons Brady 1884, 582, pl. lv, fig. 18-20.
Rectobolivina bifrons, Cushman, 1937, 204, pl. xxiii, fig. 13, 14.

Noted in dredgings made by the "Aurora," 1911-14, Antarctic Expedition, off the east coast of Tasmania. The "Challenger" record is off south-east of Japan. It is known also from the Philippines and from Funafuti, this latter a record of great depth (2,400 fathoms), by Chapman. Egger obtained it from "Gazelle" dredgings off Western Australia. E 3917, v.r.; E 3923, v.r.

Genus LOXOSTOMUM Ehrenberg 1854

66 LOXOSTOMUM KARRERIANUM (Brady 1884)

Bolivina karreriana Brady 1884, 424, pl. liii, fig. 19-21.
Loxostomum karrerianum (Brady), Cushman 1937, 184, pl. xxi, fig. 17.

This species is well distributed in the Southern Hemisphere, from Mauritius, the Philippines and the Fijis down to the east coast of Australia and New Zealand. E 3915, v.r.; E 3917, f.

Genus BIFARINA Parker and Jones 1872

67 BIFARINA FIMBRIATA (Millett 1900)
(Pl. ix, fig. 4)

Bigenerina fimbriata Millett 1900, 6, pl. i, fig. 2-4.
Bifarina fimbriata (Millett), Cushman 1937, 200, pl. xxiii, fig. 3-5; pl. iii, fig. 4.

The only record for this species was the Malay Archipelago. It is now noted for the first time from the Australian region, *viz.,* 33 miles east from Green Cape, 470 fathoms. E 3922, v.r.

Genus UVIGERINA d'Orbigny 1826

68 UVIGERINA sp. aff. PIGMEA d'Orb. 1826

Uvigerina pigmea d'Orbigny 1826, 269.

One of the most ubiquitous species in the Bass Strait dredgings. Both A and B stages (megalo- and microspheric) are represented. This type corresponds to Brady's fig. 13, 14, of pl. lxxiv, "Challenger" Report, which came from Station 232, south of Japan (*fide* Nuttall).

E 3915, v.c.; E 3916, c.; E 3917, v.r.; E 3918, c.; E 3919, c.; E 3920, r.; E 3921, v.r.; E 3922, c.; E 3923, f.

Genus TRIFARINA Cushman 1923

69 TRIFARINA BRADYI Cushman 1923

Rhabdogonium tricarinatum Brady (non *Vaginulina tricarinata* d'Orb.) 1884, 525, pl. lxvii, fig. 1-3.

Trifarina bradyi Cushman 1923, 99, pl. xxii, fig. 3-9; Chapman and Parr 1937, 98.

The "Aurora" dredgings off the coast of Tasmania, at 1,320 fathoms, included the above species. Heron-Allen and Earland noted this form from the "Terra Nova" dredgings off New Zealand.

The present record is from 33 miles east by south from Green Cape, 470 fathoms. As a fossil it occurs in the Lower Miocene of Victoria.

E 3920, v.r.

Genus CASSIDULINA d'Orbigny 1826

70 CASSIDULINA CRASSA d'Orbigny 1839

d'Orbigny 1839[3], 56, pl. vii, fig. 18-20; Cushman 1911, 97, text-fig. 151 *a-c;* Chapman and Parr 1937, 81.

This species becomes increasingly abundant towards the south. Falkland Islands and Cape Horn (d'Orbigny). The results of the Mawson Expedition showed its distribution to extend to the east of Tasmania and the Ice Barrier.

E 3917, r.

71 CASSIDULINA LAEVIGATA d'Orbigny 1826

d'Orbigny 1826, 282, No. 1, pl. xv, fig. 4, 5; Brady 1884, 428, pl. liv, fig. 1-3.

The "Aurora" results, 1911-14, proved the occurrence of this species to the east of Tasmania at 1,320 fathoms. The present investigation shows it to be abundant in fairly deep water, 33 miles east by south from Green Cape, north of the Victorian border. It is of minute size and only occurs in the finest siftings. *C. laevigata* is also fossil in the Lower Miocene of Victoria.

E 3919, v.r.; E 3920, v.c.; E 3921, v.r.; E 3922, v.c.

72 CASSIDULINA SUBGLOBOSA Brady 1884

Brady 1884, 430, pl. liv, fig. 17 *a-c*.

The "Challenger" figured specimens came from Pernambuco, Brazil. It is a well-distributed species in the Southern Ocean. Common as a Miocene fossil in Victoria.

E 3920, r.; E 3922, v.r.; E 3923, f.

73 CASSIDULINA SUBGLOBOSA var. PRODUCTA Chapman and Parr 1937

Cassidulina murrhyna Chapman (non Schwager) 1915, 20.

Cassidulina subglobosa Brady, var. *producta* Chapman and Parr 1937, 82, pl. viii, fig. 12.

The *"C. murrhyna"* of Schwager of my previous report on "Endeavour" material from east of Tasmania, 1,122 fathoms, has since proved to belong to a variety of Brady's species, *C. subglobosa.* Also as a fossil in the Lower Miocene of Victoria. E 3920, v.r.; E 3923, v.r.

Fam. PLEUROSTOMELLIDAE

Genus Ellipsolagena A. Silvestri 1928

74 Ellipsolagena schlichti (Silvestri 1902)

Fissurina schlichti A. Silvestri 1902, 143, text-fig. 9-11.
Ellipsolagena schlichti, Chapman and Parr 1937, 99.

Previous records for this species are:—the Subantarctic Islands of New Zealand, 50-85 fathoms; soundings from 121-171 fathoms in the Ross Sea, Antarctic, and from the "Terra Nova" Stations off New Zealand. From "Endeavour" material (Chapman 1915) it was obtained east of Tasmania, 777 fathoms. E 3919, v.r.; E 3920, r.

Fam. HETEROHELICIDAE

Genus Bolivinita Cushman 1927

75 Bolivinita quadrilatera (Schwager 1866)

Textularia quadrilatera Schwager 1866, 253, pl. vii, fig. 103.
Bolivina obsoleta, Chapman (non Eley) 1915, 20.
Bolivinita quadrilatera, Chapman and Parr 1937, 101.

The dredgings from the "Aurora" containing this species came from the east of New Zealand. As *Bolivina obsoleta* this species was recorded in 1915 from "Endeavour" material, east of Tasmania, 777 and 1,122 fathoms.

E 3918, c.; E 3919, v.r.; E 3920, r.; E 3921, v.r.; E 3922, v.c.; E 3923, v.r.

Bolivinita quadrilatera (Schwager) var. **tortilis** nov.

(Pl. iii, fig. 3)

Description—Differs from the specific form in having deeply concave faces, a twisted and incurved test and the opposite sides or square edges out of parallel, so that when mounted on edge one of the keels appears to be interfacial. The transverse section, therefore, resembles that of *Bolivina rhomboidalis* Millett, to which it was referred at first sight. It may yet prove that Millett's species is another modification of *Bolivinita* and not a true *Bolivina.* Length, 0·75 mm.; greatest breadth, 0·24 mm.

Note—Heron-Allen and Earland draw attention to the fact that their "*Bolivina obsoleta*" (now *Bolivinita quadrilatera*), from "Terra Nova," Station 6, east of North Cape, New Zealand, has a spiral twist. In all probability the present variety is identical with theirs. E 3920, f.; E 3921, v.r.; E 3922, f.

Genus Bolivinella Cushman 1927

77 Bolivinella folium (Parker and Jones 1865)

Textularia folium Parker and Jones 1865, 370 and 420, pl. xviii, fig. 19; Brady 1884 (pars), 357, pl. xlii, fig. 1, 2; Chapman 1907, 127, pl. ix, fig. 4.

Bolivinella folium Cushman 1927, 79; 1928, pl. xxxiii, fig. 15, 16; Parr 1931, 223, pl. xxi, fig. 23.

Parr has pointed out (op. cit., 1931) that Brady had confused two distinct species under Parker and Jones' name, and that subsequently Cushman gave an unnecessary varietal name, *ornata,* to the Australian species. This Australian form is typical of *B. folium* (P. and J.), and the tropical species erroneously linked with Parker and Jones' Australian form is distinct; for this Parr suggests *Bolivinella elegans.*

Although Parr refers to this second species figured by Brady (op. cit., pl. xlii, fig. 3-5) as tropical, Nuttall has given all but fig. 3, which came from Fiji, as from Bass Strait.

I have already recorded this species under the name of *Textularia folium*, from McHaffie's Reef, Phillip Island, as well as from previous "Endeavour" material from 40 miles south of Cape Wiles, 100 fathoms. The localities given by Parr are Hardwicke Bay, South Australia, and a bore at Boneo, near Rosebud, at 177-187 feet (Pleistocene).

Bolivinella folium occurs in one of the present samples, 33 miles east by south from Green Cape, north of the Victorian border, at 470 fathoms.

E 3918, r.

*Genus Parafrondicularia Asano 1938

78 **Parafrondicularia helenae** sp. nov.

(Pl. ix, fig. 5, 5 *a*)

Frondicularia interrupta Brady (non Karrer) 1884, 523, pl. lxvi, fig. 6, 7.

Description—Test narrowly hastate, margin finely, narrowly keeled; surface complanate, with a longitudinal shallow sulcus, and with closely set vertical raised striae numbering about 18-20. Chambers V-shaped for the last three-fourths of the test, the initial fourth being taken up by the biserial growth. The later frondicularian chambers consisting of eight enchevroned segments. Aperture terminal, central and elliptical, with a denticulate margin. Length, 0·946 mm.; greatest breadth, 0·243 mm.

Observations—Brady's figured specimen agrees with the present type in length, measuring about 1 mm. Its habitat was off the Ki Islands, south-west of New Guinea. He identified his "Challenger" specimen with Karrer's *Frondicularia interrupta*, from the Lower Miocene of Baden, Vienna (Karrer, F., 1877, 380, pl. xvi *b*, fig. 27). The Bass Strait and the New Guinea examples both belong to the genus *Parafrondicularia*. On reference to Karrer's original figure we find the arrangement of chambers is specifically frondicularian, and this is supported by his own description. It is also clear that the interrupted character of the striations is a feature in Karrer's species, hence the name, whereas the Australian form has continuous striae throughout the length of the test.

Note—I dedicate this beautiful species to the memory of my wife, who for nearly fifty years has been my constant and devoted helper in studies on the Foraminifera. Only within a short time of her passing, Mrs. Helen Mary Chapman assisted me in selecting the material included in the present investigation. From the time of describing the Foraminifera of the Gault of Folkestone, the genus *Frondicularia* and its allies were to her particularly attractive. E 3922 f.

Genus Nodogenerina Cushman 1927

79 Nodogenerina bradyi Cushman 1927

Sagrina virgula, Brady (pars), 1884, 583, pl. lxxvi, fig. 8.
Nodogenerina bradyi Cushman 1927, 79.

Brady found that the above form was confined to the South Pacific. The figured specimen was dredged by the "Challenger" from Pernambuco (Nuttall).

E 3922, v.r.

80 Nodogenerina insolita (Schwager 1866)

Nodosaria insolita Schwager 1866, 230, pl. vi, fig. 63; Cushman 1921, 191.

This species was originally described as a fossil (Pliocene), from Kar Nikobar. Cushman has recorded the species from the "Albatross" dredgings from Verde Island Passage at 260 fathoms, and from the east coast of

* See first footnote on page 154.

Mundanao, 490 fathoms, both in the Philippines. Unknown hitherto to the Australian coast. E 3917, v.r.

Fam. ROTALIIDAE

Genus Patellina Williamson 1858

81 Patellina corrugata Williamson 1858

Williamson 1858, 46, pl. iii, fig. 86-89; Brady 1884, 634, pl. lxxxvi, fig. 1-7; Heron-Allen and Earland 1922, 198; Parr and Collins 1930, 90, pl. iv, fig. 1-5; Chapman and Parr 1937, 102.

This species was found in "Aurora" dredgings close to the Antarctic Ice Barrier and near Macquarie Island. Parr and Collins recorded it from Geraldton Harbour, West Australia, and east of Cape Saunders, Otago, New Zealand. Earlier records of mine are from the Subantarctic Islands of New Zealand (off the Snares, 60 fathoms and 10 miles north of Enderby Island, 85 fathoms), and east of Tasmania, 777 and 1,122 fathoms ("Endeavour"). E 3923, v.r.

Genus Patellinella Cushman 1928

82 Patellinella inconspicua (Brady 1884)

Textularia inconspicua Brady 1884, 357, pl. xlii, fig. *a-c;* Millett 1899, 557, pl. vii, fig. 1.

Patellinella inconspicua, Cushman 1928, 5, pl. i, fig. 8 *a-c;* Parr and Collins 1930, 92, pl. v, fig. 7.

This species ranges from the south of Japan, through Admiralty Islands, Malay Archipelago to Bass Strait and New Zealand. It also occurs in the Indian Ocean, at Kerimba. Parr and Collins give additional localities around Victoria—shore sand Port Lonsdale, Torquay and Port Fairy. As a Pleistocene fossil it was found in a boring at Boneo, near Rosebud, at 177-187 feet (W. J. Parr). One of the "Challenger" Stations for this species was Moncoeur Island Bass Strait. E 3919, r.

Genus Discorbis Lamarck 1804

83 Discorbis australis Parr 1931

Discorbina valvulata Brady (non *Rosalina valvulata* d'Orb.) 1884, 644, pl. lxxxvii, fig. 57.

Discorbis australis Parr 1931, 227, pl. xxii, fig. 31 *a-c.*

This species occurred at Moncoeur Island, Bass Strait and near Fiji (Brady). It is found in shallow water on the coast of Victoria and fossil in the Lower Miocene of Muddy Creek (Parr). E 3915, v.r.

84 Discorbis bertheloti (d'Orb. 1839)

Rosalina bertheloti d'Orbigny 1839[1], 135, pl. i, fig. 28-30.

Discorbina bertheloti, Brady 1884, 650, pl. lxxxix, fig. 10-12.

Discorbis bertheloti, Chapman, Parr and Collins 1934, 561, pl. ix, fig. 13 *a-c;* Chapman and Parr 1937, 102.

Recorded by Brady from the Philippines, and down to the south-east corner of the Australian coast. Found in Bass Strait and along the Victorian coast. From the "Aurora" dredgings, east of Tasmania, at 1,320 and 1,300 fathoms. It is a common Tertiary fossil in Victoria, as old as the Lower Miocene.

E 3916, r.; E 3917, r.; E 3918, r.; E 3920, r.

85 DISCORBIS DIMIDIATUS (Jones and Parker 1862)

Discorbina dimidiata Jones and Parker (in Carpenter) 1862, 201, fig. xxxii B (in text); Chapman 1907, p. 136, pl. x, fig. 8 *a, b*.
Discorbis vesicularis (Lam.), var. *dimidiata*, Parr 1932, 227, pl. xxi, fig. 27 *a-c*., 28 *a-c*, 29 *a-c*.
Discorbis dimidiatus, Chapman and Parr 1937, 103.

Recorded from shore gatherings round Victoria, from Altona Bay, Beaumaris, McHaffie's Reef, Phillip Island, Port Nepean, Shoreham and Torquay. Common on the Australian coast below Sydney. On beaches near Auckland, New Zealand (Parr).

This species has also been noted from "Aurora" dredgings near the Antarctic Ice Barrier and east of Tasmania. E 3919, r.; E 3923, r.

86 DISCORBIS DISPARILIS (Heron-Allen and Earland 1922)

Discorbina disparilis Heron-Allen and Earland 1922, 205, pl. vii, fig. 20-22.
Discorbis disparilis, Parr 1932, pl. xliv, fig. 2.

Originally recorded off New Zealand, 100 fathoms. Parr has since noted it in Victorian shore sands. E 3917, v.r.

87 DISCORBIS OPERCULARIS (d'Orbigny 1826)

Rosalina opercularis d'Orb. 1826, 7, 271, No. 7; 1839[2], 101, pl. iii, fig. 24, 25, pl. iv, fig. 1.
Discorbina opercularis, Brady 1884, 650, pl. lxxxix, fig. 8, 9.

Brady records this species from Moncoeur Island, Bass Strait (at 38 fathoms) and Port Jackson, 2-10 fathoms. Also from Torres Strait and Queensland. E 3916, r.; E 3923, r.

88 DISCORBIS ORBICULARIS (Terquem 1876)

Rosalina orbicularis Terquem 1876, 75, pl. ix, fig. 4 *a-b*.
Discorbina orbicularis, Brady 1884, 647, pl. lxxxviii, fig. 4-8.

This species is known from both the Atlantic and Pacific Oceans and is found as far south as the southern coast of Australia (Brady). My previous record in "Endeavour" material was 40 miles south of Cape Wiles, 100 fathoms. E3918, v.r.; E 3923, r.

89 DISCORBIS RARESCENS (Brady 1884)

Discorbina rarescens Brady 1884, 651, pl. xc, fig. 2, 3.
Discorbis rarescens, Chapman and Parr 1937, 105.

The "Challenger" examples came from Raine Island, Torres Strait and from the Philippines. Heron-Allen and Earland obtained this species in "Terra Nova" dredgings off the coast of New Zealand. From the "Aurora" samples it occurred east of Tasmania, in 1,320 fathoms. E 3918, v.r.; E 3923, r.

90 DISCORBIS ROSACEA (d'Orbigny 1826)

Rotalia rosacea d'Orbigny 1826, 7, 273, No. 15—Modèle No. 39.
Discorbina rosacea, Brady 1884, 644, pl. lxxxvii, fig. 1, 4; Chapman 1915, 29.

The "Challenger" specimens were figured from Admiralty Islands, north of New Guinea and Bass Strait (Nuttall). Found in former "Endeavour" material, 40 miles south of Cape Wiles, 100 fathoms. E 3918, v.r.; E 3919, v.r.

91 DISCORBIS RUGOSA (d'Orbigny 1839)

Rosalina rugosa d'Orbigny 1839[3], 42, pl. ii, fig. 12-14.
Discorbina rugosa, Brady 1884, 652, pl. lxxxvii, fig. 3 *a-c,* pl. xcvi, fig. 4 *a-c;* Chapman 1915, 29.

The "Challenger" figured specimens were obtained from the Ki Islands and Torres Strait. It has already occurred in "Endeavour" material, east of Tasmania, 777 fathoms. **E 3923, v.r.**

92 DISCORBIS GLOBULARIS (d'Orbigny 1826)

Rosalina globularis d'Orb. 1826, Modèles No. 69, 271, pl. xiii, fig. 1-4.
Discorbina globularis, Brady 1884, pl. lxxxvi, fig. 8 and 13.

This widely spread species occurs in Sample E 3918. Heron-Allen recorded it from the coasts of New Zealand ("Terra Nova" Report).

E 3918, v.c.

Genus EPONIDES Montfort 1808

93 EPONIDES KARSTENI (Reuss 1855)

Rotalia karsteni Reuss 1855, 275, pl. ix, fig. 6.
Pulvinulina karsteni, Brady 1884, 698, pl. cv, fig. 8, 9.

The "Challenger" recorded this species from the Magellan Strait at 55 fathoms, from which locality it was figured; also from the Falkland Islands, 4 fathoms, and the Rio Plata, 13 fathoms. E 3922, v.r.; E 3923, r.

94 EPONIDES REPANDUS (Fichtel and Moll 1798)

Nautilus repandus Fichtel and Moll 1798, 35, pl. iii, fig. *a-d.*
Pulvinulina repanda, Brady 1884, 684, pl. civ, fig. 18 *a-c*; Cushman 1921, 326.

Found in every sea, excepting the Arctic (Brady). Cushman records this species at many Stations in the Philippines. In previous "Endeavour" dredgings, 40 miles south of Cape Wiles, 100 fathoms. Common in Tertiary strata from borings in Victoria. E 3915, r.

Genus STREBLUS Fischer 1817

95 STREBLUS BECCARII (Linn. 1767)

Nautilus beccarii L. 1767, Syst. Nat., 12th ed. 1,162.
Streblus beccarii, Fischer 1819, 75.
Rotalia beccarii, Brady 1884, 704, pl. cvii, fig. 2, 3.

This species ranges from the Shetlands to the Cape of Good Hope (Brady). It is well established in the Philippines at the average depth of 318 fathoms. It is common as a fossil in borings in the Tertiaries of Victoria and South Australia, especially the Pleistocene.

E 3915, c.; E 3917, r.; E 3918, r.; E 3920, v.r.; E 3922, v.r.

Genus NOTOROTALIA Finlay 1939

96 NOTOROTALIA CLATHRATA (Brady 1884)

Rotalia clathrata Brady 1884, 709; pl. cvii, fig. 8, 9; Chapman 1915, 32, 33; Chapman and Parr 1937, 108.

Common around the New Zealand coast. Brady's Report shows its restriction to the South Pacific, between Moncoeur Island, Bass Strait and Cook Strait, New Zealand. It has also been found at two Stations on the west coast of Patagonia, and also occurred in shore sands at Torquay, Victoria. Previous records from "Endeavour" material are: Station 36, east of Tasmania, 777 fathoms, and 40 miles south of Cape Wiles, 100 fathoms. Fossil in the Tertiary bores in Victoria. E 3920, v.r.; E 3922, v.r.

97 **Notorotalia decurrens** sp. nov.

(Pl. viii, fig. 7 *a, b*)

Description—Test rotaline, plano-convex, depressed. Superior face almost flat, with thickened sutural shell development, breaking up into papillae near the initial stage of the shell. Inferior face strongly convex, with thickened, curved sutural lines of a more regular character than those on the upper surface, with faint striae at right angles between them. Diameter of test, 0·386 mm.

Distinct from Brady's *Rotalia clathrata* in the suppression of strong lattice ornament, surface sutural thickening and more depressed superior face.

E 3915, r.; E 3917, v.r.; E 3918, f.

Genus Epistomina Terquem 1883

98 Epistomina elegans (d'Orbigny 1826)

Rotalia (Turbinulina) elegans d'Orbigny 1826, 7, 276, No. 54.

Pulvinulina elegans, Parker, Jones and Brady 1871, 174, pl. xii, fig. 142; Brady 1884, 699, pl. cv, fig .4-6.

Brady's figured specimens came from Tristan d'Acunha and Fiji. This species was common in "Aurora" material, between Tasmania and the Antarctic Ice Barrier. Previous records of "Endeavour" material, 40 miles south of Cape Wiles, 100 fathoms. E 3915, c.; E 3917, r.; E 3918, r.; E 3919, v.r.; E 3922, f.

Genus Mississippina Howe 1930

99 Mississippina concentrica (Parker and Jones 1864)

Pulvinulina concentrica Parker and Jones (in Brady) 1864, 470, pl. xlviii, fig. 14; Brady 1884, 686, pl. cv, 1 *a-c.*

Eponides concentricus, Chapman, Parr and Collins, 1934, 565, pl. ix, 17 *a-c.*

Common and typical in the Philippines (Cushman). Previous record from "Endeavour" material, 40 miles south of Cape Wiles, 100 fathoms. Common and of variable size. Found in the Lower Miocene of Port Phillip. E 3919, r.

Genus Cancris Montfort 1808

100 Cancris auricula (Fichtel and Moll 1798)

Nautilus auricula Fichtel and Moll 1798, 108, pl. xx *a-c;* pl. xx *d-f.*

Pulvinulina auricula, Brady 1884, 688, pl. cvi, fig. 5 *a-c;* Chapman 1915, 31; Cushman 1915, 53, pl. xxii, fig. 1.

Cancris auricula, Cushman 1931, 72, pl. xv, fig. 1 *a-c;* Chapman and Parr 1937, 109.

A well distributed species in southern waters. Records from the "Aurora" give one typical example east of Tasmania, 1,320 fathoms. From the "Terra Nova" was noted at 7 miles east of North Cape, New Zealand. Also occurred in dredgings by the trawler "Bonthorpe" in the Great Australian Bight. Cushman states in his Philippine memoir, 1921, that it is one of the characteristic species in the dredgings off the Philippines below 100 fathoms. Previously recorded in "Endeavour" material, 40 miles south of Cape Wiles, 100 fathoms. Common as a fossil in the Lower Miocene of Victoria. E 3916, v.r.

Genus ANOMALINA d'Orbigny 1826

101 ANOMALINA COLLIGERA Chapman and Parr 1937

Anomalina ammonoides, Brady (non *Rosalina ammonoides* Reuss) 1884, 672, pl. xciv, fig. 2, 3.
Anomalina colligera Chapman and Parr 1937, 117, pl. ix, fig. 26.

Brady's "Challenger" specimens came from Fiji and Papua. The "Aurora" examples were found in dredgings east of Tasmania and between Tasmania and the Antarctic. It was recently recorded from the Great Australian Bight ("Bonthorpe"). Previous records from the "Endeavour" (Chapman 1915, as *A. ammonoides*) were—east of Tasmania, 777 fathoms, and 40 miles south of Cape Wiles, 100 fathoms. E 3915, v.r.; E 3922, v.r.

102 ANOMALINA GLABRATA Cushman 1924

Cushman 1924[1], 39, pl. xii, fig. 5-7; Chapman, Parr and Collins 1934, 570, pl. xi, fig. 39 *a-c;* Chapman and Parr 1937, 117.

Type locality, off Samoa, in shallow water. From "Aurora" dredgings this species was obtained off the Shackleton Shelf, Antarctic, and south and north-east of Tasmania. It also occurs as a fossil in the Miocene of Victoria (Parr) and in beds of the same age in California.

E 3915, c.; E 3917, r.; E 3918, v.r.; E 3920, r.; E 3922, v.r.

103 ANOMALINA GLOBULOSA Chapman and Parr 1937

Anomalina grosserugosa, Brady (non *Truncatulina grosserugosa* Gümbel) 1884, 673, pl. xciv, fig. 4, 5.
Anomalina globulosa Chapman and Parr 1937, 117, pl. ix, fig. 27.

Brady's "Challenger" Stations for this form are situated in the North and South Atlantic and the North Pacific; two are in the South Pacific. *A. globulosa* occurred in the "Aurora" soundings off St. Frances Island and to the east of Tasmania. It has also been found on the coasts of Victoria and New South Wales. Under the name of *A. grosserugosa* it was recorded earlier from an "Endeavour" sample, east of Tasmania, 777 fathoms. E 3920, v.r.; E 3922, v.r.

104 ANOMALINA POLYMORPHA Costa 1856

Costa 1856, 252, pl. xxi, fig. 7-9; Brady 1884, 676, pl. xcvii, fig. 3-7; Chapman 1907, 138.

Recorded by the "Challenger" off Sydney, 410 fathoms, west of New Zealand, 275 fathoms and Fiji, 210 fathoms. Previous "Endeavour" material proved this species to be common at 40 miles south of Cape Wiles, 100 fathoms. It was also found in shore sand at Beaumaris, Port Phillip.

E 3917, v.r.; E 3918, v.r.; E 3923, v.r.;

105 ANOMALINA sp. aff. ROTULA d'Orbigny 1846

Anomalina rotula d'Orbigny 1846, 172, pl. x, fig. 10-12; Macfadyen 1930, 99, pl. iv, fig. 10 *a-c;* Chapman, Parr and Collins 1934, 570, pl. xi, fig. 38 *a-c.*

Hitherto a fossil (Miocene) species, from the Vienna Basin, Egypt and Victoria. The recent specimens are not quite typical when compared with the Lower Miocene fossils from Victoria. E 3915, f.

106 ANOMALINA VERMICULATA (d'Orbigny 1839)

Truncatulina vermiculata d'Orbigny 1839[3], 39, pl. vi, fig. 1-3.
Anomalina polymorpha Costa?, Brady, 1884, 676 pl. xcvii, fig. 7.
Anomalina vermiculata, Heron-Allen and Earland 1932, 423, pl. xv, fig. 1-15.

Common in the Falkland area (H.-A. and E.). E 3915, f.; E 3920, v.r.

Genus Planulina d'Orbigny 1826

† 107 Planulina biconcava (Parker and Jones 1862)

Discorbina biconcava Parker and Jones (in Carpenter) 1862, 201, text-fig. xxxii; Brady 1884, 653, pl. xci, fig. 2 *a-c* (non fig. 3).

The "Aurora" soundings from east of Tasmania contained examples of this species. Also found off New Zealand ("Terra Nova"). Notably an Australian species, it has been found in Bass Strait, Port Jackson, Torres Strait and Gulf of Carpentaria. As *Discorbina biconcava* it also came from a former "Endeavour" dredging, 40 miles south of Cape Wiles, 100 fathoms. E 3918, v.r.

108 Planulina biconcava (Parker and Jones), var. unguiculata (Sidebottom 1918)

Discorbina lingulata, Burrows and Holland, var. *unguiculata* Sidebottom 1918, 255, pl. vi, fig. 12-14.

This variety appears to belong to the *Planulina* type of test rather than to *Heronallenia*, in which genus *lingulata* is now placed. It was originally obtained from Pteropod ooze, dredged by H.M.S. "Dart," Station 19, at 465 fathoms. The locality is north of Shoal Bay, New South Wales. E 3922, v.r.

109 Planulina haliotis (Heron-Allen and Earland 1924)

Discorbina haliotis Heron-Allen and Earland 1924, 173, pl. xiii, fig. 99-101.

Originally described from the Lower Miocene of Batesford, Victoria, it is of much interest to find this species still existing in Bass Strait. The locality is 33 miles east from Green Cape, 470 fathoms. E 3922, v.r.

Genus Cibicides Montfort 1808

110 Cibicides aknerianus (d'Orbigny 1846)

Rosalina akneriana d'Orb. 1846, 156, pl. viii, fig. 13-15.
Truncatulina akneriana, Heron-Allen and Earland 1932, 421.

Recorded in "Discovery" Reports as very common in the Falkland Island area. E 3920, v.r.

111 Cibicides lobatulus (Walker and Jacob 1798)

Nautilus lobatulus Walker and Jacob 1798, 642, pl. xiv, fig. 36
Cibicides lobatulus, Chapman and Parr 1937, 119.

Very common at a large number of Stations, from the Antarctic to Tasmania and New Zealand ("Aurora" Expedition).

E 3916, r.; E 3917, r.; E 3918, r.; E 3919, r.; E 3921, v.r.; E 3922, f.

112 Cibicides sp. aff. victoriensis Chapman, Parr and Collins 1934

Cibicides victoriensis Chapman, Parr and Collins 1934, **38**, 571, pl. ix, fig. 16 *a-c*.

A recent development of the Victorian Miocene *C. victoriensis*.

E 3915, v.c.; E 3917, v.r.; E 3918, r.; E 3919, f.; E 3920, v.r.

113 Cibicides pseudoungerianus (Cushman 1922)

Truncatulina pseudoungeriana Cushman 1922, 97, pl. xx, fig. 9.
Cibicides pseudoungerianus Cushman 1930, 123, pl. xxii, fig. 3-7.

Universally distributed in Southern Seas.

E 3915, f.; E 3918, c.; E 3919, v.r.; E 3922, f.; E 3923, f.

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† See second footnote, p. 154.

114 CIBICIDES REFULGENS Montfort 1808

Montfort 1808, I, 122, 31me gènre.
Truncatulina refulgens, Brady 1884, 659, pl. xcii, fig. 7-9.

Of world-wide distribution, this species occurs generally in the Southern Hemisphere, and has been recorded from the Cape of Good Hope, Patagonia, Falkland Islands, the Antarctic Ice Barrier and up to the shores of the Australian continent. E 3915, r.; E 3918, v.r.; E 3922, r.

115 CIBICIDES WUELLERSTORFI (Schwager 1866)

Anomalina wuellerstorfi Schwager 1866, 258, pl. vii, fig. 105, 107.
Truncatulina wuellerstorfi, Brady 1884, 662, pl. xciii, fig. 8, 9.
Cibicides wuellerstorfi, Chapman and Parr 1937, 21.

Brady's figured specimens came from the west coast of New Zealand. This species was also found in the "Bonthorpe" dredgings off the Great Australian Bight. Earlier "Endeavour" material recorded it from east of Tasmania, 777 fathoms, and 40 miles south of Cape Wiles, 100 fathoms. Fossil examples are known from the Eocene and Miocene of New Zealand, and Schwager's specimens came from the Pliocene of Kar Nikobar.

E 3916, r.; E 3919, r.; E 3920, f.; E 3921, f.; E 3922, f.; E 3923, f.

Genus DYOCIBICIDES Cushman and Valentine 1930

116 DYOCIBICIDES BISERIALIS Cushman and Valentine 1930

Cushman and Valentine 1930, 31, pl. x, fig. 1, 2 *a-b.;* Cushman 1931, 126, pl. xxiv, fig. 2; Chapman, Parr and Collins 1934, 572, pl. xi, fig. 43 *a-c.*

Sparsely occuring off the coast of Australia and in the Southern Ocean. Also fossil in the Lower Miocene and upward in Victoria. E 3923, v.r.

Genus AMPHISTEGINA d'Orbigny 1826

117 AMPHISTEGINA LESSONII d'Orbigny 1826

d'Orbigny (pars) 1826, 304, No. 3, pl. xvii, fig. 1-4; Brady 1884, 740, pl. cxi, fig. 1-7.

The examples here recorded came from 505 fathoms, just north of Twofold Bay, New South Wales (37° 21′ S., 150° 24′ E.). It is probably a record for this high latitude, and it is interesting to note that the soundings from the "Bonthorpe" trawler, in the Great Bight, record another solitary instance of the species in high latitudes (from Sample 4, 33° 14′ S., 126° 16′ E.) at a depth of 100 fathoms, a little south of Dover Point. E 3919, v.r.

Fam. CHILOSTOMELLIDAE

Genus CHILOSTOMELLA Reuss 1850

118 **Chilostomella cushmani** sp. nov.

(Pl. viii, fig. 9; pl. ix, fig. 6)

Chilostomella ovoidea Cushman (non Reuss) 1919, 621.

Cushman remarks, under the above reference, which deals with the examples found off "Poor Knights Islands," as follows: "There are several specimens mounted on the slide which seem to show possibly both microspheric and megalospheric forms. There are two very distinct sizes: the larger specimen is evidently somewhat like *C. grandis* Cushman, described from the Philippines. It is, however, not as large as that species."

The definition of these New Zealand chilostomellids as given by Cushman so well fits the characters of the specimens before me, and not *C. grandis,* that I have no hesitation in referring them to the same form as those from the "Endeavour" soundings, including their reference (as Cushman supposes in his case) to the forms A and B, as here illustrated. I have much pleasure, therefore, in naming the species after my long-standing, eminent and indefatigable friend, as *Chilostomella cushmani.*

Description—Test large, ovoid, about twice as long as broad; sides evenly and fully curved; aperture sub-terminal, with an elevated rim (stand-up-collar shape) and a widely open mouth. No internal segmentation visible from outside. Surface of test smooth to polished, with numerous scattered puncta. Length, 1·08 mm.; breadth, 0·65 mm. This is probably Form A, pl. ii, fig. 9.

Test small, more narrowly ovoid and thinner than in Form A, more pointed at oral end, with sides slightly more convex in proportion to Form A. Aperture slit-like, closely adpressed to surface of test and without a rim-like margin as in Form A. Surface smooth, less punctate and with internal chambers alternating on a transverse axis, the edges of which are seen through the transparent test. Length, 0·57 mm.; breadth, 0·27 mm. This is probably Form B, pl. iii, fig. 6.

Under the name of *Chilostomella oölina* Schwager, Heron-Allen and Earland have figured ("Discovery" Reports Foram., Falkland Islands, 1932, 360, pl. ix, fig. 38, 39) what appears to me to belong to a form very like *C. cushmani* of the stage B. Their figures also agree in point of size, measuring 0·677 mm. in length.

E 3917, r.; E 3918, v.r.; E 3923, f.

Genus PULLENIA Parker and Jones 1862

119 PULLENIA SPHAEROIDES (d'Orbigny 1826)

Nonionina sphaeroides d'Orb. 1826, 293, No. 1—Modèle No. 43.

Pullenia sphaeroides, Brady 1884, 615, pl. lxxxiv, fig. 12, 13; Chapman and Parr 1937, 110.

Of world-wide distribution, from lat. 70° N., to lat. 54° S. (Brady). In the Southern Hemisphere it ranges down to the Antarctic Ice Barrier, and is also found around the coast of New Zealand. Previous "Endeavour" material recorded it east of Tasmania, at 1,122 fathoms. E 3915, v.r.; E 3916, v.r.; E 3920, r.

120 PULLENIA SUBCARINATA (d'Orbigny 1839)

Nonionina subcarinata d'Orbigny 1839[3], 28, pl. v, fig. 23, 24.

Pullenia subcarinata, Heron-Allen and Earland 1932, 403, pl. xiii, fig. 14-18.

Originally described from the Falkland Islands by d'Orbigny, it has been generally confused with *P. quinqueloba* (Reuss), as pointed out by Heron-Allen and Earland. It remains to be seen whether the northern form differs from this species and agrees with the fossil forms of *P. quinqueloba.*

E 3916, v.r.; E 3919, v.r.; E 3920, r.

Genus SPHAEROIDINA d'Orbigny

121 SPHAEROIDINA BULLOIDES d'Orbigny 1826

d'Orbigny 1826, 267, No. 1; Modèle No. 65; Brady 1884, 620, pl. lxxxiv, fig. 1-7.

The "Aurora" dredgings containing this species were found around Tasmania. It occurs in Sample 4 of the dredgings by the "Bonthorpe" in the Great Australian Bight (Chapman and Parr).

E 3915, v.r.; E 3917, r.; E 3919, r.; E 3920, v.r.; E 3922, v.r.

Fam. ORBULINIDAE

Genus Globigerina d'Orbigny 1826

122 Globigerina bulloides d'Orbigny 1826

d'Orbigny 1826, 277, No. 1, Modèles Nos. 17 and 76; Chapman and Parr 1937, 111.

A ubiquitous deep water and pelagic form.

E 3915, r.; E 3916, c.; E 3917, f.; E 3918, v.c.; E 3919, c.; E 3920, v.c.; E 3921, f.; E 3922, v.c.; E 3923, f.

123 Globigerina conglomerata Schwager 1866

Schwager 1866, 255, pl. vii, fig. 113.
G. dubia, Brady (non Egger) 1884, 595, pl. lxxix, fig. 17 *a-c*.
G. conglomerata, Cushman 1927[3], 172; Chapman and Parr 1937, 111.

An Eastern Pacific form agreeing with the Pliocene species of Kar Nikobar

E 3918, r.

124 Globigerina dutertrei d'Orbigny 1839

d'Orbigny 1839[2], 84, pl. iv, fig. 19-21.

This species was noted as common from the soundings by the "Aurora," extending from the Antarctic Barrier to New Zealand and Tasmania. From previous "Endeavour" material the species was found at Station 35, east of Tasmania, bottom sample, 377 fathoms; and 40 miles south of Cape Wiles, 100 fathoms.

E 3919, r.; E 3922, v.r.

125 Globigerina inflata d'Orbigny 1839

d'Orbigny 1839[1], 134, pl. ii, fig. 7-9.

The "Aurora" soundings contained numerous records of this species, from south of Tasmania and near Macquarie Island. It is one of the commonest of the genus in the present samples. Former "Endeavour" material contained the species as follows: Station 35, east of Tasmania, bottom sample, 377 fathoms. Station 36, ditto, 777 fathoms; east of Tasmania, 1,122 fathoms; 40 miles south of Cape Wiles, 100 fathoms.

E 3915, f.; E 3916, c.; E 3917, f.; E 3918, v.c.; E 3919, c.; E 3920, v.c.; E 3921, v.c.; E 3922, v.c.; E 3923, v.c.

126 Globigerina pachyderma (Ehrenberg 1873)

Aristerospira pachyderma Ehr. 1873, 386, pl. i, fig. 4.
Globigerina pachyderma, Brady 1884, 600, pl. cxiv, fig. 19, 20; Heron-Allen and Earland 1922, 190; Chapman and Parr 1937, 112.

From the east of Tasmania down to the Antarctic Ice Barrier.

E 3916, v.r.; E 3917, v.r.

127 Globigerina subcretacea Chapman 1902

Globigerina cretacea, Brady (non d'Orbigny) 1884, 596, pl. lxxxii, fig. 10.
G. subcretacea Chapman 1902, 410, pl. xxxvi, fig. 16 *a, b*; 1924, 17; Chapman and Parr 1937, 113.

G. subcretacea was originally described from Funafuti, and has since been found off the South African coast (Chapman). More lately it has been recorded from the "Aurora" soundings round Tasmania and off the Shackleton Shelf (Chapman and Parr).

E 3918, r.; E 3919, r.; E 3920, f.; E 3923, c.

Genus GLOBIGERINOIDES Cushman 1927

128 GLOBIGERINOIDES TRILOBUS (Reuss 1850)

Globigerina triloba Reuss 1850, 374, pl. xlvii, fig. 11.
G. bulloides var. *triloba,* Brady 1884, 595, pl. lxxix, fig. 1, 2; pl. lxxx, fig. 2, 3.

Present in "Aurora" samples, between Tasmania and New Zealand, south of Tasmania and in mid-ocean, north of the Antarctic Ice Barrier. Heron-Allen and Earland (1932) found this species more abundant than *G. bulloides,* in "Discovery" material from the Falkland Islands. Previously from "Endeavour" soundings (Chapman, 1915), east of Tasmania, 1,122 fathoms, and 40 miles south of Cape Wiles, 100 fathoms. E 3916, f.; E 3917, r.; E 3920, c.; E 3922, v.r.

Genus GLOBIGERINELLA Cushman 1927

129 GLOBIGERINELLA AEQUILATERALIS (Brady 1884)

Globigerina aequilateralis Brady 1884, 605, pl. lxxx, fig. 18-21.

Cushman recorded it from many Stations in the Philippines. Earlier "Endeavour" material secured this species from Station 36, east of Tasmania, 777 fathoms, and East Tasmania, 1,122 fathoms. E 3919, v.r.

Genus ORBULINA d'Orbigny 1839

130 ORBULINA UNIVERSA d'Orbigny 1839

d'Orbigny 1839[2], 3, pl. i, fig. 1; Brady 1884, 608, pl. lxxviii; pl. lxxxi, fig. 8-26; pl. lxxxii, fig. 1-3; Chapman and Parr 1937, 114.

Abundant in dredgings by the "Aurora," from Tasmania to the Antarctic Ice Barrier. Previous "Endeavour" records: Station 36, east of Tasmania, 777 fathoms, common; east of Tasmania, 1,122 fathoms, common; 40 miles south of Cape Wiles, 100 fathoms, common and small.
E 3915, f.; E 3917, r.; E 3918, v.c.; E 3919, v.c.
E 3920, v.c.; E 3921, v.c.; E 3922, c.; E 3923, f.

Genus PULLENIATINA Cushman 1927

131 PULLENIATINA OBLIQUILOCULATA (Parker and Jones 1865)

Pullenia obliquiloculata Parker and Jones 1865, 368, 421, pl. xix, fig. 4; Brady 1884, 618, pl. lxxxiv, fig. 16-20.
Pulleniatina obliquiloculata, Chapman and Parr 1937, 114.

This species occurred in only one sample from the "Aurora," south of Tasmania. The "Terra Nova" records were mainly round New Zealand (Heron-Allen and Earland). E 3918, c.; E 3919, v.r.; E 3921, v.r.; E 3922, r.

Genus SPHAEROIDINELLA Cushman 1927

132 SPHAEROIDINELLA DEHISCENS (Parker and Jones 1865)

Sphaeroidina dehiscens, Brady 1884, 621, pl. lxxxiv, fig. 11; Egger 1893, 376, pl. xiii, fig. 58, 59; Chapman 1910, 418.

This species is apparently absent or very rare in cold water areas. Only one immature specimen is recorded by the "Discovery" from the Falkland Islands. It did not occur in any of the "Aurora" soundings. Cushman notes it from numerous Stations in and around the Philippines. At Funafuti it occurred at 23 Stations, mostly in very deep water, from 590 to 1,489 fathoms. Brady records it from 23 Stations in the South Pacific. Egger records it, from amongst other Stations, from Mauritius, West Australia, Timor, New Guinea and Eastern Australia. It has been found only once in the fossil state, from the Pliocene of Kar Nikobar (as *Globigerina seminulina* Schwager). E 3919, v.r.; E 3920, r.

Genus Globorotalia Cushman 1927

133 Globorotalia hirsuta (d'Orbigny 1839)

Rotalia hirsuta d'Orbigny 1839[1], 131, pl. i, fig. 37-39.
Globorotalia hirsuta, Chapman and Parr 1937, 115, pl. ix, fig. 24.

The "Aurora" dredgings showed a restricted distribution for this species—south and east of Tasmania and in Bass Strait, east of Adelaide.

E 3915, v.r.; E 3917, r.; E 3918, c.; E 3919, c.; E 3920, v.c.; E 3922, f.; E 3923, f.

134 Globorotalia scitula (Brady 1882)

Pulvinulina scitula Brady 1882, 716.
Pulvinulina patagonica Brady (non d'Orbigny) 1884, 693, pl. ciii, fig. 7 *a-c*.
Pulvinulina patagonica (d'Orb.) var. *scitula,* Heron-Allen and Earland 1922, 215.
Globorotalia scitula, Chapman and Parr 1937, 116.

Common in the "Aurora" dredgings; its distribution comprises Bass Strait and south-west of Australia in the Southern Ocean, and the Antarctic Ice Barrier, off Queen Mary Land. From the previous "Endeavour" dredgings (under *Pulvinulina patagonica*), at Station 36, east of Tasmania, 777 fathoms, and east of Tasmania, 1,122 fathoms. E 3922, f.; E 3923, v.r.

135 Globorotalia truncatulinoides (d'Orbigny 1839)

Rotalina truncatulinoides d'Orb. 1839[1], 132, pl. ii, fig. 25-27.
Globorotalia truncatulinoides, Chapman and Parr 1937, 116.

From the "Aurora" it was obtained at Stations south-west of New Zealand and deeper parts of the Southern Ocean. Previous material from "Endeavour" soundings yielded it from Station 35, east of Tasmania, bottom sample, 377 fathoms; Station 36, east of Tasmania, 777 fathoms; east of Tasmania at 1,122 fathoms, and 40 miles south of Cape Wiles, 100 fathoms.

E 3916, f.; E 3917, r.; E 3918, v.c.; E 3919, v.r.; E 3921, v.r.; E 3922, f.; E 3923, f.

Fam. NUMMULITIDAE

Genus Nonion Montfort 1808

136 Nonion depressulus (Walker and Jacob 1798)

Nautilus depressulus Walker and Jacob 1798, 641, pl. xiv, 33.
Nonionina depressula, Brady 1884, 725, pl. cix, 6, 7; Chapman 1916[2], 70, pl. v, fig. 41.
Nonion depressulus, Chapman and Parr 1937, 99.

From the "Aurora" samples the above species was obtained in the D'Urville Sea, off the Ice Barrier; also south of Tasmania and in the deeper parts of the Southern Ocean. Heron-Allen and Earland found it in the "Discovery" samples round the Falkland Islands, where they were numerous but small.

E 3917, r.; E 3919, r.

137 Nonion grateloupi (d'Orbigny 1826)

Nonionina grateloupi d'Orbigny 1826, 294, No. 19; 1839[2], 46, pl. vi, fig. 6, 7.
Nonion grateloupi, Heron-Allen and Earland, 1932, 437, pl. xvi, fig. 9, 10.

This species occurs in the West Indies and also in the Falklands ("Discovery"). E 3920, f.

138 NONION SCAPHA (Fichtel and Moll 1798)

Nautilus scapha Fichtel and Moll 1798, 105, pl. xix, fig. *d-f*.
Nonionina scapha, Brady 1884, 780, pl. cix, fig. 14, 15.

The "Aurora" samples (Chapman and Parr 1937) contained the above species at two stations, east of Tasmania and off Queen Mary Land, Antarctica.

E 3916, v.r.; E 3918, r.

139 NONION UMBILICATULUS (Montagu 1803)

Nautilus umbilicatulus Montagu 1803, 191; Suppl., 78, pl. xviii, fig. 1.
Nonionina umbilicatula, Brady 1884, 726, pl. cix, fig. 8, 9.
Nonion umbilicatulus, Chapman and Parr 1937, 100.

The above species occurred at the following Stations: south-east of Tasmania; between Tasmania and New Zealand; off the Ice Barrier (Wilkes Land); north of Auckland Island, 85 fathoms. Previous "Endeavour" material, east of Tasmania, 1,122 fathoms. Fossil in the Lower Miocene of Victoria.

E 3915, r.; E 3922, v.r.

Genus ELPHIDIUM Montfort 1808

140 ELPHIDIUM ADVENUM Cushman 1922

Polystomella subnodosa, Brady (non Münster) 1884, 734, pl. cx, fig. *a, b*.
Polystomella advena, Cushman 1922, 56, pl. ix, fig. 11, 12.
Elphidium advenum Cushman 1930, 25, pl. x, fig. 1, 2.

This species, under the name of *Polystomella subnodosa,* was recorded by Brady from two "Challenger" Stations south-west of New Guinea, *viz.,* Station 187, off Booby Island, 6-8 fathoms, and Station 188, closely adjacent, at 28 fathoms. Cushman recorded it, under the same name as Brady, at 13 Stations in the Philippines. E 3915, c.; E 3916, v.r.; E 3917, v.r. E 3918, f.; E 3919, r.; E 3922, v.r.; E 3923, v.r.

141 ELPHIDIUM CRISPUM (Linné 1767)

Nautilus crispus Linné 1767, 1,162; 1788, 3,370.
Polystomella crispa, Brady 1884, 736, pl. cx, fig. 6, 7; Cushman 1921, 368.
Elphidium crispum, Chapman and Parr 1937, 100.

Recorded from the Subantarctic Islands, New Zealand, and off Kerguelen Island. Fairly common in the dredgings by the trawler "Bonthorpe," from West Australia. Previous "Endeavour" dredgings found it 40 miles south of Cape Wiles, 100 fathoms, where it was frequent. E 3923, v.r.

142 ELPHIDIUM IMPERATRIX (Brady 1884)

Polystomella imperatrix Brady 1884, 738, pl. cx, fig. 13-15.

Brady's figured types were, fig. 13, 14, from Storm Bay, Tasmania, and fig. 15, from Station 163B, Port Jackson, 2-10 fathoms (*fide* Nuttall).

E 3915, r.; E 3918, f.; E 3919, f.

143 ELPHIDIUM JENSENI (Cushman 1924)

Polystomella jenseni Cushman 1924, 49, pl. xv, ?4, 6.
Polystomella macella (F. and M.) var., Jensen 1905, 817, pl. xxiii, fig. 4.

Cushman's specimens were dredged at Samoa. Jensen's original examples came from 100 fathoms off Wollongong, New South Wales.

E 3920, v.r.

144 ELPHIDIUM LESSONII (d'Orbigny 1826)

Polystomella lessonii d'Orbigny 1826, 284, No. 6; 1839[3], 29, pl. iii, fig. 1, 2.
Elphidium lessonii, Cushman 1930, 22, pl. ix, fig. 1-4; Heron-Allen and Earland 1932, 44, pl. xvi, fig. 29, 30.

d'Orbigny's specimens came from Patagonia and the Falkland Islands.

E 3917, r.; E 3918, v.r.; E 3922, f.

145 ELPHIDIUM MACELLUM (Fichtel and Moll 1798)

Nautilus macellus F. and M. 1798, 66, pl. x, fig. *e-k*.
Polystomella macella, Brady 1884, 737, pl. cx, fig. 8, 9, 11.
Elphidium macellum, Chapman and Parr 1937, 101.

The "Aurora" samples came from east of Tasmania. Previous "Endeavour" material occurred at Station 36, east of Tasmania, 777 fathoms, and from 40 miles south of Cape Wiles, 100 fathoms.

E 3920, r.; E 3921, v.r.; E 3922, r.

146 ELPHIDIUM POEYANUM (d'Orbigny 1839)

Polystomella poeyana d'Orbigny, 1839[2], 55, pl. iv, fig. 25, 26; Cushman 1922, 55, pl. ix, fig. 9, 10.

This species has been described from Cuba and Jamaica; also from Florida.

E 3920, r.

147 ELPHIDIUM VERRICULATUM (Brady 1884)

Polystomella verriculata Brady 1884, 738, pl. cx, fig. 12 *a, b.;* Chapman 1907, 142, pl. x, fig. 10.
Elphidium verriculatum, Chapman and Parr 1937, 101.

Brady records this species from Moncoeur Island, Bass Strait, at 38 fathoms, and according to Nuttall this is the type locality. Brady also gives Curtis Strait, Queensland, which, however, does not appear in the list of Stations, but would inferentially be of not very deep water. Other localities for this species are the Malay Archipelago, Sagami Bay, Japan and from shore sand, Beaumaris, Port Phillip, Victoria. Jensen notes it from Lizard Island, Great Barrier Reef, Queensland; whilst Goddard and Jensen obtained it from Palm Island, Townsville, at 15 fathoms. The exceptional depths recorded for this species, of 1,320 and 1,300 fathoms, were from samples dredged by the "Aurora" to the east of Tasmania; it is usually considered a shallow water form.

E 3915, v.c.; E 3918, v.r.; E 3922, v.r.; E 3923, r.

Superfam. AMMODISCOIDEA

Fam. HYPERAMMINIDAE

Genus HYPERAMMINA Brady 1878

148 HYPERAMMINA NOVAEZEALANDIAE Heron-Allen and Earland 1922

Technitella mestayeri, Cushman 1919, 595, pl. lxxiv, fig. 4.
Hyperammina novaezealandiae Heron-Allen and Earland 1922, 89, pl. iii, fig. 1-5.

Heron-Allen and Earland obtained this species in "Terra Nova" dredgings, 7 miles east of North Cape, New Zealand.

E 3920, r.

Fam. SACCAMMINIDAE

Genus Saccammina M. Sars 1869

149 Saccammina sphaerica Sars 1872

G. O. Sars 1872, 250; Brady 1884, 253, pl. xviii, fig. 11-17; Chapman 1916[2], 61, pl. ii, fig. 12; Heron-Allen and Earland 1922, 85, pl. i, fig. 16; Chapman and Parr 1937, 161.

This bipolar species has been shown, by the investigations of the "Challenger" at the Antarctic Ice Barrier, to be almost as equally abundant in Antarctic Seas as in the North Atlantic. From the "Nimrod" gatherings (Shackleton Expedition) I obtained it from the Ross Sea; whilst from the soundings of the "Terra Nova" (Scott Expedition) Heron-Allen and Earland recorded it as occurring on the east coast of New Zealand and off the Ice Barrier. The "Aurora" records (Mawson 1911-14) were off Wilke's and Adelie Land. The present example is small, white, globular with a short neck and composed of minute, irregularly-sized quartz grains. E 3915, v.r.

Genus Pelosina Brady 1879

150 Pelosina cylindrica Brady 1884

Brady 1884, 236, pl. xxvi, fig. 1-6; Chapman and Parr 1937, 162.

It is interesting to find this species ranging into lower latitudes of the Southern Ocean, for it was formerly known as occurring off the Ice Barrier and off the east coast of New Zealand. The "Aurora" obtained it to the east of Tasmania. E 3915, f.

Genus Brachysiphon Chapman 1906

151 ? Brachysiphon corbuliformis Chapman 1906

Chapman 1906, 84, pl. iii, fig. 2 *a, b*, 3.

Two examples, referable to the above species, were found. These are subspherical, open at one end in the smaller and at both ends in the larger specimen. Test composed of small foraminiferal shells mingled with broken spicules of sponge. Diameter of larger specimen twice that of the type from New Zealand. Orifice in both nearly circular, with internal margin smooth. E 3915, r.

Genus Technitella Norman 1878

152 Technitella cf. legumen Norman 1878

Norman 1878, 279, pl. xlvi, fig. 3, 4.

This species has been recorded from, amongst other localities, Kerguelen Islands, 120 fathoms; off Sydney, 410 fathoms; the Society Islands and Fiji. Also from the North and South Atlantic. E 3915, v.r.

Fam. ASTRORHIZIDAE

Genus Rhabdammina M. Sars 1869

153 Rhabdammina discreta Brady 1884

Brady 1884, 268, pl. xxii, fig. 7-10.

Recorded off Kerguelen Island, 120 fathoms. Also in the North and South Atlantic and the Pacific Ocean. As the cooler waters of the north and south poles are approached, the habitat of the species decreases in depth.

E 3918, f.; E 3919, v.r.; E 3920, v.c.; E 3921, v.r.

154 RHABDAMMINA IRREGULARIS W. B. Carpenter 1869

Carpenter 1869, 60; Brady 1884, 268, pl. xxi, fig. 9; Cushman 1918, 17, pl. viii, fig. 1.

Norman obtained this form from the Bay of Biscay. It has also been found off the West Coast of Australia and in the Pacific. E 3920, v.r.

Fam. OPHTHALMIDIIDAE

Genus CORNUSPIRA Schultze 1854

155 CORNUSPIRA FOLIACEA (Philippi 1844)

Orbis foliacea Philippi 1844, 147, pl. xxiv, fig. 26.
Cornuspira foliacea, Brady 1884, 199, pl. xi, fig. 5-9; Cushman 1921, 387, pl. lxxvii, fig. 1.

This species is common to a fauna extending from Japan, the Philippines and the South Seas, the extremity of which area includes Tasmanian shores and Bass Strait. A large specimen, 6 mm. in diameter. E 3915, v.r.

156 CORNUSPIRA FOLIACEA (Philippi 1844) var. EXPANSA Chapman 1915

Cornuspira carinata (Costa) var. *expansa* Chapman 1915, 12, pl. i, fig. 3.
Cornuspira foliacea (Phil.) var. *expansa,* Cushman 1919, 633.
C. foliacea (Phil.) var. *expansa,* Cushman 1921, 388, pl. lxxvii, fig. 2.

In 1921 Cushman pointed out that my variety *expansa* belonged to *C. foliacea,* a typical *Cornuspira* of the Philippines. Although my specific determination of *C. carinata,* to which *expansa* was referred, was based on Brady's figure of Costa's species, in deference to Cushman's close acquaintance with the Philippine foraminiferal fauna I accept this view of the case. Cushman had already discovered my variety in the New Zealand fauna, from the east coast, at Poor Knights Islands. In previous "Endeavour" material, two examples from 40 miles south of Cape Wiles, 100 fathoms. E 3919, v.r.

157 CORNUSPIRA LACUNOSA Brady 1884

Brady 1884, 202, pl. cxiii, fig. 1.

Recorded from Torres Strait (type locality), and rarely in the Philippines and off Japan (Cushman). E 3915, v.r.

158 CORNUSPIRA STRIOLATA Brady 1884

Brady 1884, 202, pl. cxiii, fig. 18, 19; Chapman 1907, 23, pl. iii, fig. 47.

The type locality is Faröe Channel (cold area), 540 fathoms. Howchin, in 1889 (Trans. Roy. Soc. S. Aust., 12, 4), regarded this species as a variety of *C. foliacea,* with its structure presumably brought out by weathering. This was the first note on the occurrence of this interesting species, living elsewhere, as an Australian Lower Miocene fossil.

When describing the above as a fossil species in 1907, I remarked that "the doubts relating to their specific identification were removed," and further noted "its strictly northern distribution in the living condition." Since then it has been recorded also in the living condition in the Southern Hemisphere in two instances: (1) By Heron-Allen and Earland, in "Terra Nova" samples, off South Victoria Land (Station 339), where one specimen reached the dimensions of the enormous tests found in the cold area of the Faröe Channel, namely, 21 mm. x 19 mm.; (2) in the present series, east of Babel Island, Flinders Island, Bass Strait. E 3915, v.r.

Genus OPHTHALMIDIUM Zwingli and Kübler 1870

159 OPHTHALMIDIUM CIRCULARIS (Chapman 1915)

Spiroloculina dorsata Reuss var. *circularis* Chapman 1915, 7, pl. i, fig. 1.

Previously obtained from "Endeavour" dredgings, Station 36, east of Tasmania, 777 fathoms. E 3918, v.r.

Genus PLANISPIRINA Seguenza 1880

160 PLANISPIRINA BUCCULENTA (Brady 1884)

Miliolina bucculenta Brady 1884, 170 pl. cxiv, fig. 3 *a, b;* Heron-Allen and Earland 1922, 65.

Planispirina bucculenta, Schlumberger 1892, 194, pl. viii, fig. 6, 7; Chapman 1909. 324, 14, pl. xiv, fig. 2; Chapman 1916[1], 42, pl. v, fig. 4; Heron-Allen and Earland 1932, 322; Chapman and Parr 1937, 129.

This species is fairly abundant and often of large size in southern waters; notably near the Subantarctic Islands of New Zealand, near the Western Base, Shackleton Shelf ("Aurora"), Falkland Islands ("Discovery")—small specimens, and from the upthrust muds on Mount Erebus ("Nimrod").

E 3915, r.; E 3918, f.; E 3919, f.; E 3923, c.

161 PLANISPIRINA BUCCULENTA var. PLACENTIFORMIS (Brady 1884)

Miliolina bucculenta var. *placentiformis* Brady 1884, 71, pl. iv, fig. 1, 2.

Planispirina bucculenta var. *placentiformis*, Chapman 1916[1], 43, pl. v, fig. 5.

Found in upthrust muds on Mount Erebus. E 3918, r.; E 3923, c.

Fam. MILIOLIDAE

Genus QUINQUELOCULINA d'Orbigny 1826

162 QUINQUELOCULINA AUBERIANA d'Orbigny 1839

d'Orbigny 1839[2], 193, pl. xii, fig. 1-3.

A small and rather contorted form of *Q. lamarckiana* d'Orb. Also cf. *Q. contorta* d'Orb., which was recorded from previous "Endeavour" samples; Station 36, east of Tasmania, 777 fathoms. E 3919, r.; E 3922, v.r.; E 3923, r.

163 QUINQUELOCULINA AUSTRALIS Parr 1932

Parr 1932, 7, pl. 1, fig. 8 *a-c*.

Having a more compressed test and marginal keel, as compared with the northern *Q. subrotunda* (Montagu). Recorded as the latter from former "Endeavour" material, 40 miles south of Cape Wiles, 100 fathoms. E 3919, r.

164 QUINQUELOCULINA CRASSA d'Orbigny 1826

d'Orbigny 1826, 301, No. 14; Fornasini 1905, 65, pl. iii, fig. 5.

Test suborbicular, swollen and finely striated. Occurred in several samples of dredgings by the trawler "Bonthorpe" in the Great Australian Bight.

E 3915, v.r.

165 QUINQUELOCULINA CUVIERIANA d'Orbigny 1839

d'Orbigny 1839[2], 190, pl. xi, fig. 19-21.

Miliolina cuvieriana, Brady 1884, 162, pl. v, fig. 12 *a-c*.

Periphery sharply keeled. In shore sand, Victoria, Papua and the Philippines. From previous "Endeavour" material, 40 miles south of Cape Wiles, 100 fathoms. Common as a Lower Miocene fossil in Victoria.

E 3915, r.; E 3917, v.r.; E 3918, v.r.

166 QUINQUELOCULINA LAMARCKIANA d'Orbigny 1839

d'Orbigny 1839[2], 164, pl. ix, fig. 14, 15.

A common species in shore sands in Victoria. Distinguished by its sharp periphery.

E 3915, f.; E 3917, v.r.; E 3920, r.; E 3921, v.r.; E 3922, v.r.; E 3923, f.

167 QUINQUELOCULINA SEMINULUM (Linn. 1767)

Serpula seminulum Linn. 1767, ed. xii, 1,264, No. 791.
Miliolina seminulum, Brady 1884, 157, pl. v, fig. 6.

One of the commonest miliolines, in shore sands on the coast of Victoria.

E 3917, v.r.; E 3923, f.

168 QUINQUELOCULINA VULGARIS d'Orbigny 1826

d'Orbigny 1826, 302, No. 33; Schlumberger 1893, 65, (207), pl. ii, fig. 65, 66, woodcuts 13, 14.

Recorded from previous "Endeavour" material, 40 miles south of Cape Wiles, 100 fathoms. Abundant and rather small. Abundant as a Lower Miocene fossil in Victoria.

E 3915, c.; E 3916, v.r.; E 3918, c.; E 3919, c.; E 3920, r.; E 3922, v.r.; E 3923, r.

Genus SPIROLOCULINA d'Orbigny 1826

169 SPIROLOCULINA CANALICULATA d'Orbigny 1846

d'Orbigny 1846, 269, pl. xvi, fig. 10-12; Cushman 1921, 395, pl. lxxx, fig. 3, *a*, *b*; Chapman 1915, 6.
Spiroloculina impressa, Brady 1884 (non Terquem), 151, pl. x, fig. 3, 4.

Common in the Philippines, usually at less depth than 100 fathoms. From previous "Endeavour" material 40 miles south of Cape Wiles, 100 fathoms, abundant.

E 3915, c.; E 3918, r.; E 3919, r.; E 3923, f.

Genus SIGMOÏLINA Schlumberger 1887

170 **Sigmoilina latissima** sp. nov.
(Pl. viii, fig. 8)

Description—Test broadly ovate, complanate, with surface encrusted by cement and fine sand. Exterior showing slight undulations indicating the sigmoiline arrangement of the interior. Contour not so tumid as in *S. schlumbergeri* Silvestri, nor so spiroloculine as in ? *Spiroloculina arenaria* Brady. Aperture small, at the end of a short tube, but as long as in the latter form, with which, however, it may be related. Length, 1·83 mm.; breadth, 1·6 mm.; thickness, 0·44 mm.

E 3918, r.; E 3919, f.

171 SIGMOÏLINA SCHLUMBERGERI Silvestri 1904

Planispirina celata, Brady (non Costa) 1884, 197 pl. viii, fig. 1-4.
Sigmoïlina schlumbergeri Silvestri 1904, 267; Chapman 1915, 317; Cushman 1921, 449.

Previous "Endeavour" material contained this species at Station 36, east of Tasmania, 777 fathoms, frequent; and east of Tasmania, 1,122 fathoms.

E 3922, v.r.; E 3923, v.r.

Genus PTYCHOMILIOLA Eimer and Fickert 1899

172 PTYCHOMILIOLA SEPARANS (Brady 1881)

Miliolina separans Brady 1881, 45; 1884, 175, pl. vii, fig. 1-4.

This species has previously been recorded from Raines Island, Torres Strait, Booby Island, New Guinea, and Storm Bay, Tasmania. E 3915, r.

Genus TRILOCULINA d'Orbigny 1826

173 TRILOCULINA CHRYSOSTOMA (Chapman 1909)

Miliolina chrysostoma Chapman 1909, 322, pl. xiii, fig. 8-10; pl. xiv, fig. 1-4.

These show an extremely variable series, ranging from ovate to bi- and triloculine modifications. The oral septum is plate-like or feebly T-shaped. Found off the Snares at 60 fathoms; 20 miles north; and 10 miles north of Enderby Island, 85 fathoms. E 3919, v.r.

174 TRILOCULINA CIRCULARIS Bornemann 1855

Bornemann 1855, 349, pl. xix, fig. 4; Cushman 1921, 462, pl. xcii, fig. 1, 2.
Miliolina circularis, Brady 1884, 169, pl. iv, fig. 3 *a-c*; pl. v, fig. 13.

A common species in the Indo-Pacific, and in the dredgings by the "Bonthorpe" off the Great Australian Bight. Previous "Endeavour" soundings recorded this species 40 miles south of Cape Wiles, 100 fathoms; small but very abundant. E 3923, f.

175 TRILOCULINA QUADRILATERALIS d'Orbigny 1839

d'Orbigny 1839[2], 173, pl. ix, fig. 14-16 (*quadrilatera* on pl.).

This form resembles *Q. auberiana* but is triloculine and with straight sides. The type locality is the West Indies. E 3920, v.r.; E 3921, v.r.; E 3922, v.r.

176 TRILOCULINA TRICARINATA d'Orbigny 1826

d'Orbigny 1826, 7, 299, No. 7, Modèle, 94.
Miliolina tricarinata, Brady 1884, 165, pl. iii, fig. 17 *a, b*.

Its distribution extends from Franz Josef Land in the north to the Antarctic Ice Barrier in the south. Found in shallow water on the Victorian coast. As a fossil it ranges through the Tertiary and is frequent in the bores in Victoria. Previous "Endeavour" material yielded this species as follows: 40 miles south of Cape Wiles, 100 fathoms, and east of Tasmania, 1,122 fathoms.

E 3915, f.; E 3919, v.r.; E 3920, r.

177 TRILOCULINA TRIGONULA (Lamarck 1804)

Miliolites trigonula Lamarck 1804, 351, No. 3; 1822, 612, No. 3.
Triloculina trigonula, d'Orbigny 1826, 299, No. 1, pl. xvi, fig. 5-9.
Miliolina trigonula, Brady 1884, 164, pl. iii, fig. 14-16.

A widely distributed species, extending even to the Antarctic, but there very small. The largest forms occur in tropical waters. Also as a fossil from earliest Tertiary time. Previous "Endeavour" material yielded one rather large specimen from 40 miles south of Cape Wiles, 100 fathoms. E 3915, r.; E 3917, v.r.

Genus MILIOLINELLA Wiesner 1931

178 MILIOLINELLA OBLONGA (Montagu 1803)

Vermiculum oblongum Montagu 1803, 522, pl. xiv, fig. 9.
Triloculina oblonga, d'Orb. 1839[2], 175, pl. x, fig. 3-5; Chapman and Parr 1937, 134
Miliolina oblonga, Brady 1884, 160, pl. v, fig. 4 *a, b*.

A widely distributed species from the North Sea to the Antarctic. A bipolar form. E 3915, v.r.; E 3916, v.r.; E 3918, v.r.; E 3922, v.r.

Genus Pyrgo Defrance 1824

179 Pyrgo comata (Brady 1881)

Biloculina comata Brady 1881, 45; 1884, 144, pl. iii, fig. 9 *a, b*; Schlumberger 1891; 565, text-fig. 26-28, pl. x, fig. 72, 73; Cushman 1921, 477, pl. xcvi, fig. 3 *a,b*.

Amongst Brady's localities for this rare species are: off Sydney, 410 fathoms; north of New Guinea, 1,070 fathoms; and off Pernambuco, 350 fathoms. Cushman records *B. comata* from several Stations in the Philippines, and also from the east coast of New Zealand. Schlumberger's specimens came from the Gulf of Gascony and the Skagerak. E 3919, v.r.

180 Pyrgo elongata (d'Orbigny 1826)

Biloculina elongata d'Orbigny 1826, 298, No. 4; Brady 1884, 144, pl. ii, fig. 9 *a, b;* Schlumberger 1891, 571, text-fig. 35, 36; pl. xi and xii, fig. 87-89; Chapman 1907, 15, pl. i, fig. 14; Cushman 1921, 473, pl. xcv, fig. 4 *a, b*.

Abundant in the North and South Pacific (Brady). Schlumberger's specimens came from the Mediterranean. Previous "Endeavour" material contained this species from Station 36, east of Tasmania, 777 fathoms. This species occurs as a fossil in the Lower Miocene and Pliocene of Victoria.

E 3919, r.; E 3920, v.r.; E 3921, v.r.; E 3923, v.r.

181 Pyrgo fornasinii Chapman and Parr 1935

Biloculina ringens, Brady (non *Miliolites ringens* Lamarck) 1884, 142, pl. ii, fig. 7.
Biloculina bradyi, Schlumberger (non Fornasini) 1891, 170, text-fig. 15-19, pl. x, fig. 63-71.
Pyrgo fornasinii Chapman and Parr 1935, 5.

The trivial name for this species, having been pre-occupied by Fornasini, necesitated the above change of name. The original specimen figured by Brady came from the West Indies (*fide* Nuttall). Those figured by Schlumberger were dredged in the Gulf of Gascony, Coast of Marocco. The Australian examples were dredged by the trawler "Bonthorpe" in the Great Australian Bight. The species was also met with in "Endeavour" dredgings (1915), when I described it under the name of *Biloculina bradyi* Schl., from 40 miles south of Cape Wiles at 100 fathoms. It has also been dredged from the area around the Subantarctic Islands of New Zealand. As a fossil it is found in the Lower Miocene Tertiaries of Port Phillip (Chapman). E 3915, f.; E 3918, v.r.

182 Pyrgo sarsi (Schlumberger 1891)

Biloculina ringens, Brady pars (non Lamarck) 1884, 139.
Biloculina sarsi Schlumberger 1891, 551, text-fig. 10-12, pl. ix, fig. 55-59; Chapman 1907, 14, pl. i, fig. 1, 2.

The type locality for the above, as given by Schlumberger, is the North Sea, between Norway and Greenland. Brady does not specifically figure it, but it comes from the same "Biloculina Clay" discovered by G. O. Sars of Christian and described by him in his official report on the Norwegian Sea-fisheries for the year 1876. It has been recorded by me from the Subantarctic Islands of New Zealand, and from previous "Endeavour" dredgings, 40 miles south of Cape Wiles. The species has also been found in the Lower Miocene of Victoria.

E 3918, v.r.; E 3922, v.r.; E 3923, r.

183 PYRGO VESPERTILIO (Schlumberger 1891)

Biloculina vespertilio Schlumberger 1891, 561, pl. x, 74-76, text-fig. 20-22.
Biloculina ringens, Brady (non *Miliolites ringens* Lamarck) 1884, 142, pl. ii, fig. 8; Chapman 1909[2], 315, pl. xiii, fig. 4 *a, b;* Cushman 1917, 77, pl. xxx, fig. 1.
Pyrgo vespertilio, Chapman and Parr 1937, 142, pl. ii, fig. 8.

Schlumberger's specimens came from the Gulf of Gascony. Cushman has noted it off the coast of Japan at 258 fathoms, and it has occurred around the Sub-antarctic Islands of New Zealand (Chapman) and in "Aurora" dredgings south-west of Tasmania (Chapman and Parr) E 3919, v.r.

Genus PYRGOELLA Cushman and White 1936

184 PYRGOELLA SPHAERA (d'Orbigny 1839)

Biloculina sphaera d'Orbigny 1839[3], 66, pl. viii, fig. 13-16; Brady 1884, 141, pl. ii, fig. 4 *a, b.*
Planispirina sphaera, Schlumberger 1891, 377, text-fig. 45, 46; Chapman 1906, 82, pl. iii, fig. 1 *a, b;* Heron-Allen and Earland 1932, 322, pl. vi, fig. 41, 42.
Pyrgoella sphaera, Cushman and White 1936, 90.

The South American type of d'Orbigny's *Biloculina sphaera* shows a similar labyrinthic aperture to one found off Great Barrier Island, New Zealand (Chapman 1906). Schlumberger's specimens came from the Gulf of Gascony. Heron-Allen and Earland's Antarctic examples came from the Falkland Islands and South Georgia. E 3915, f.; E 3918, f.; E 3920, v.r.; E 3923, v.r.

Genus BILOCULINELLA Wiesner 1931

185 BILOCULINELLA GLOBULUS (Bornemann 1855)

Biloculina globulus Bornemann 1855, 349, pl. xix, fig. 3; Schlumberger 1891, 575, text-fig. 42-44, pl. xii, fig. 97-100; Chapman 1907, 15, pl. i, fig. 17, 18.
Pyrgo globulus, Chapman and Parr 1937, 137.

This species was found in the Antarctic ("Aurora" dredgings), near the Western Base, off Queen Mary Land, specimens frequent. Cushman records it from the Philippines, at eleven different Stations. It was found as a fossil in the Lower Miocene of Port Phillip, Victoria. E 3915, f.; E 3916, v.r.; E 3919, v.r.

Fam. LITUOLIDAE

Genus HAPLOPHRAGMOIDES Cushman 1910

186 HAPLOPHRAGMOIDES EMACIATUS (Brady 1884)

Haplophragmium emaciatum Brady 1884, 305, pl. xxxiii, fig. 26-28; Heron-Allen and Earland 1922, 98.

Haplophragmoides emaciatum, Cushman 1910, 102, text-fig. 150-152; 1920, 40, pl. viii, fig. 4, text-fig. 1-3.

Haplophragmoides emaciatus, Chapman and Parr 1937, 139.

Brady recorded this species from the West Indies. It has recently been found in the Antarctic, off Adele Land, Queen Mary Land, east of Tasmania and to the south of New Zealand, in dredgings from the "Aurora." E 3918, v.r.

187 HAPLOPHRAGMOIDES GRANDIFORMIS Cushman

Cushman 1910, 440, text-fig. 11; 1921, 82, pl. xi, fig. 2.

Cushman described this species from the China and Molucca Seas. It has been lately recorded in "Bonthorpe" material from the Great Australian Bight. E 3915, c.; E 3918, v.r.

Genus Recurvoides Earland 1934

188 Recurvoides contortus Earland 1934

Earland 1934, 91, pl. x, fig. 7-19; Chapman and Parr 1937, 138, pl. ix, fig. 34 *a, b*.

First described from the Falklands Sector of the Antarctic ("Discovery"). Chapman and Parr did not find it north of latitude 60° ("Aurora"); it was commonest at 150-300 fathoms. Its greatest depth was 1,550 fathoms. The present occurrence, 33 miles east from Green Cape, is a great distance from its hitherto known habitat. E 3922, r.

Genus Ammobaculites Cushman 1910

189 Ammobaculites agglutinans (d'Orbigny 1846)

Spirolina agglutinans d'Orbigny 1846, 137, pl. vii, fig. 10-12.

Haplophragmium agglutinans, Brady 1884, 301, pl. xxxii, fig. 19, 20, 24-26; Heron-Allen and Earland 1922, 97.

Ammobaculites agglutinans, Cushman 1920, 60, pl. xii, fig. 3; Chapman and Parr 1937, 142, pl. x, fig. 37.

A well-distributed species. It occurs sparingly off the Antarctic Ice Barrier ("Aurora"). It was originally described from the Tertiary of the Vienna Basin. E 3919, v.r.

Fam. REOPHACIDAE

Genus Reophax Montfort 1808

190 Reophax dentaliniformis Brady 1884

Brady 1884, 293, pl. xxx, fig. 21, 22; Chapman and Parr 1937, 147.

This species has been recorded from the Ross Sea ("Nimrod") and from the Antarctic by the "Terra Nova." The "Aurora" dredged it from the Antarctic and from east of Tasmania. E 3919, r.

191 Reophax distans var. pseudodistans Cushman 1919

Reophax spiculifera Brady var. *pseudodistans* Cushman 1919, 598, pl. lxxv, fig. 1.

Reophax distans var. *pseudodistans,* Heron-Allen and Earland 1932, 338, pl. vii, 17-20.

From the "Discovery" soundings around the Falkland Islands. The present, Green Cape, locality is remote from the earlier one. E 3920, v.r.

192 Reophax scorpiurus Montfort 1808

Montfort 1808, 330, 83 gènre; Brady 1884, 291, pl. xxx, fig. 12-17; Chapman and Parr 1937, 149.

Found off the Ice Barrier and commonly around the Australian coast. The species was dredged by the trawler "Bonthorpe" off the Great Australian Bight.

The previous "Endeavour" record for this species is 40 miles south of Cape Wiles, 100 fathoms. E 3928, r.

Fam. TEXTULARIIDAE

Genus Textularia Defrance, 1824

193 Textularia conica (d'Orbigny 1839)

d'Orbigny 1839[2], 135, pl. i, fig. 19, 20; Brady 1884, 365, pl. xliii, fig. 13, 14; pl. cxiii, fig. 1 *a, b*.

Heron-Allen and Earland recorded this species from east of North Cape, New Zealand ("Terra Nova"). It has also occurred off the Great Australian Bight ("Bonthorpe"). E 3915, c.

194 TEXTULARIA CORRUGATA Heron-Allen and Earland 1915

Textularia conica d'Orbigny, var. *corrugata* Heron-Allen and Earland 1915, 629, pl. xlvii, fig. 24-27

Textularia corrugata, Cushman 1932, 12, pl. iii, fig. 2, 4.

This form was first described from the Kerimba Archipelago. Cushman also records it from the Fijis at 40-50 fathoms; off Rougelap Atoll, Marshall Islands; and from Guam Anchorage, Ladrone Islands at 21 fathoms. E 3915, f.

195 TEXTULARIA PSEUDOGRAMEN Chapman and Parr 1937

Textularia gramen, Brady (non d'Orbigny) 1884, 365, pl. xliii, fig. 10.

Textularia pseudogramen Chapman and Parr 1937, 153.

Common on the Australian coast. It is recorded in the list of the "Bonthorpe" Foraminifera, 1935. This species was identified in the previous "Endeavour" material (1915) as *Spiroplecta gramen* (d'Orb.) at Station 36, east of Tasmania, 777 fathoms; and also from 40 miles south of Cape Wiles, 100 fathoms. E 3915, c.; E 3919, v.r.; E 3923, v.r.

196 TEXTULARIA SAGITTULA Defrance 1824

Defrance 1824, 177. Atlas Conch., pl. xiii, fig. 5; Chapman and Parr 1937, 154

This species is common on the Australian coast. The "Terra Nova" dredged it from the New Zealand area. In the previous material from the "Endeavour" it was recorded, as *Spiroplecta sagittula,* from 40 miles south of Cape Wiles, 100 fathoms. E 3915, r.; E 3917, v.r.; E 3918, r.; E 3919, r.; E 3923, f.

Fam. TROCHAMMINIDAE

Genus TROCHAMMINA Parker and Jones 1859

197 TROCHAMMINA PLANOCONVEXA Chapman and Parr 1937

Chapman and Parr 1937, 158, pl. x, fig. 45.

In the above original reference the distribution of the species is given as confined to the Shackleton Shelf, from 250-358 fathoms. E 3922, v.r.

Fam. VALVULINIDAE

Genus CLAVULINA d'Orbigny 1826

198 CLAVULINA SERVENTYI Chapman and Parr 1935

Chapman and Parr 1935, 5, pl. i, fig. 7 *a, b.*

The original specimens were dredged by the trawler "Bonthorpe," from the Great Australian Bight (Sample 6, 170 fathoms). Recorded from previous "Endeavour" dredgings as *Clavulina parisiensis* d'Orb. from 40 miles south of Cape Wiles, 100 fathoms, common. E 3915, r.; E 3917, r.

Genus DOROTHIA Plummer 1931

199 DOROTHIA ARENATA Cushman 1936

Cushman 1936, 32, pl. v, fig. 11 *a-c.*

This species was described from the "Albatross" dredgings off Mindanao, Philippines, in 490 fathoms. To find this species so far south is of great interest. E 3915, c.; E 3919, v.r.

200 Dorothia scabra (Brady 1884)

Brady 1884, 381, pl. xlvi, fig. 7; Cushman 1921, 146, pl. xxviii, fig. 5.

Localities for this species are Luzon, Borneo, north of Celebes, and Macassar Strait. E 3915, r.

Genus Listerella Cushman 1933

201 Listerella sp.

This species will be shortly described from the Mawson Antarctic dredgings, 1929-31. E 3915, v.r.

Fam. VERNEUILINIDAE

Genus Gaudryina d'Orbigny 1839

202 Gaudryina robusta Cushman 1913

Cushman 1913, 636, pl. lxxviii, fig. 2; 1937, 67, pl. ix, fig. 15.

This species was described from the "Albatross" dredgings, Gulf of Tomini, Celebes, at 750 fathoms. E 3915, v.r.; E 3922, v.r.

203 Gaudryina triangularis Cushman 1911

Cushman 1911, 65, text-fig. 104; 1937, 66, pl. ix, fig. 16.

Recorded from the Poor Knights Islands, east coast of New Zealand; also east of Mesbate Island, Philippines, 108 fathoms. As *Gaudryina rugosa* d'Orb. it was recorded from previous "Endeavour" material (1915, 16), from 40 miles south of Cape Wiles, 100 fathoms. E 3915, f.

Subphyl. **CRUSTACEA**

Class **OSTRACODA**

Fam. CYPRIDAE

Genus Pontocypris G. O. Sars 1865

1 Pontocypris bradyi nom. mut.

(Pl. viii, fig. 1)

Pontocypris faba G. S. Brady (non Reuss 1855) 1878, 382, pl. lxiii, fig. 6 *a-c*; G. S. Brady 1880, 37, pl. i, fig. *a-d*; Chapman 1916, 71, pl. iv, fig. 45 *a, b*.

In 1855 Reuss figured an ostracod from the Chalk of England as *Bairdia faba* (Zeitschr. d. Geol. Gesellsch., 278, pl. x, fig. 2), which I consider he correctly placed in that genus. Reuss states that the material from which he obtained this form came from Charing, in Kent, England. The only one likely to supply Reuss with that local material would have been my old friend and fellow worker, Professor T. Rupert Jones. From the same source I have also a fairly large quantity of Charing washings, and so was able to search for a topotype. Upon examining this material, which I fortunately brought with me to Australia, I found definite examples of a form agreeing with Reuss' original figures. Brady himself made only a provisional comparison with Reuss' species and usually queried it. A careful comparison of the topotypes with Brady's Crag specimens shows that the anterior of the latter is broader than that of the Chalk fossils (*Bairdia faba*).

Specimens similar to *Pontocypris bradyi* have been obtained by the "Challenger" off East Moncoeur Island, Bass Strait, 38-40 fathoms, and off reefs, Honolulu, 40 fathoms. E 3916, v.r.; E 3917, v.r.; E 3918, r.; E 3920, v.r.

2 Pontocypris attenuata G. S. Brady 1868

(Pl. ix, fig. 8)

Brady 1868, 179, pl. iv, fig. 11-14, Idem, 1880, 38, pl. xv, fig. 2 *a-d.*, Idem, 1890, 491, pl. i, fig. 3, 4; Chapman 1919, 17.

Brady points out, in his South Sea Ostracod Memoir that the original figures were based on young examples; those of the full-grown specimens, from the South Seas (and incidentally our present ones), being armed at the posterior ventral angle with a single short and stout spine. The original types came from Mauritius, whilst it was later noted from New Caledonia and the Fiji Islands. It also occurred at Funafuti, in the deeper dredgings by H.M.S. "Penguin," at 1,215 fathoms. E 3919, r.

3 Pontocypris simplex G. S. Brady 1880

G. S. Brady 1880, 37, pl. i, fig. 5 *a-d*; Egger 1901, 421, pl. i, fig. 1-3; Chapman 1919, 18, pl. xi, fig. 2, 2 *a*.

This species was previously recorded from Ascension Island, at 7 fathoms. It also occurred in "Aurora" dredgings, west of Tasmania, at 1,300 fathoms. Egger found it at Station 9 ("Gazelle"), off North-West Australia, 357 metres.

E 3918, r.; E 3919, v.r.; E 3923, v.r.

4 Pontocypris subreniformis G. S. Brady 1880

Brady 1880, 38, pl. xv, fig. 2 *a-d*; Egger 1901, 421, pl. vii, fig. 50-52; Chapman 1915, 35.

Previously recorded (Brady) from Simon's Bay, South Africa, 15-20 fathoms and from Port Jackson, 2-10 fathoms. The "Gazelle" obtained it from Mauritius, Station 66 (Egger), at 411 metres. This species previously occurred in "Endeavour" material from Station 36, east of Tasmania, 777 fathoms.

E 3915, v.r.; E 3916, v.r.; E 3918, v.r.

Genus Argilloecia G. O. Sars 1865

5 Argilloecia badia G. S. Brady 1880

Brady 1880, 40, pl. vi, fig. 3 *a-d*; Egger 1901, 422, pl. iv, fig. 6, 7; Chapman 1919, 19.

Recorded from Port Jackson ("Challenger"), 210 fathoms. Egger ("Gazelle") recorded it from Station 90, off North-West Australia at 357 metres, and from Station 116 (off North-East Australia) at 951 metres. Chapman ("Aurora") noted it from south of Tasmania at 200 fathoms. E 3923, v.r.

Genus Macrocypris G. S. Brady 1868

6 Macrocypris decora (G. S. Brady 1866)

Cytherideis decora Brady 1866, 366, pl. lvii, fig. 13 *a-c*.
Macrocypris decora, Brady, 1880, 44, pl. i, fig. 3 *a-d*, pl. vi, fig. 8 *a, b.*; Chapman 1915, 37; 1919, 20.

Widely distributed in the Southern Hemisphere. Locations given by Brady ("Challenger") are: Culebra Island, 390 fathoms; North Brazil, 350 fathoms; Kerguelen Island, 120 fathoms; Admiralty Islands, 16 fathoms. The types of this species were from Australia, 17 fathoms (Brady 1866). The previous "Endeavour" record is, Station 36, east of Tasmania, 777 fathoms, frequent.

E 3915, f.; E 3916, v.r.; E 3917, v.r.; E 3918, r.; E 3919, v.r.; E 3923, v.r.

7 Macrocypris setigera G. S. Brady 1880
(Pl. vii, fig. 5)

Brady 1880, 43, pl. i, fig. 1 *a-d.;* Egger 1901, 423, pl. i, fig. 21, 22.

This species was originally recorded from Port Jackson, at 2-10 fathoms. It is distinguished from *M. maculata* by the broader valve and evidence of bristle pits on the extremities. It may only be a variety of *M. maculata,* as Brady's earlier figures seem to show. Egger found this species at Station 90, North-West Australia at 357 metres, and near Mauritius at 411 metres ("Gazelle").

E 3915, f.; E 3917, v.r.; E 3923, v.r.

Genus Bythocypris G. S. Brady 1880

8 Bythocypris reniformis G. S. Brady 1880

Brady 1880, 46, pl. v, fig. 1 *a, b;* Egger, 425, pl. i, fig. 40, 41.

The "Challenger" records are: Culebra Island, North Brazil, Prince Edward Island, and off East Moncoeur Island, Bass Strait, 38-40 fathoms. Egger reports this species from Kerguelen Island, 104 metres ("Gazelle").

E 3918, v.r.; E 3919, v.r.; E 3920, v.r.

Genus Bairdia McCoy 1844

9 Bairdia acanthigera G. S. Brady 1868
(Pl. viii, fig. 4)

Brady 1868, 390, pl. xxvii, fig. 18-21, Idem 1880, 61, pl. ix, fig. 4 *a-c;* Egger 1901, 425, pl. ii, fig. 16-19; Chapman 1919, 22.

The type specimens came from the English Channel. Recorded by G. S. Brady off St. Vincent. Egger had it from Kerguelen, Fiji and West Africa. The present examples are fairly typical. From the "Aurora" soundings, 1,300 and 1,320 fathoms (Chapman). E 3917, r.; E 3918, r.

10 Bairdia amygdaloides G. S. Brady 1866

Brady 1866, 364, pl. lvii, fig. 6 *a-c,* Idem, 1880, 54, pl. ix, fig. 5 *a-f,* pl. x, fig. 2 *a-c.*

Bairdia subdeltoidea, Egger (non Münster) 1901, 428, pl. ii, fig. 20, 21; Chapman 1915, 38.

Egger's record (as *B. subdeltoidea*) is Station 55, Kerguelen Island, 104 metres. Previous "Endeavour" records are: Station 36, east of Tasmania, 777 fathoms, frequent; 40 miles south of Cape Wiles, 100 fathoms.

E 3915, c.; E 3916, v.r.; E 3917, f.; E 3918, r.;
E 3919, v.r.; E 3921, v.r.; E 3922, v.r. E 3923, v.c.

11 Bairdia australis Chapman 1914

Bairdia ovata, Brady (non Bosquet sp.) 1866, 354, pl. lvii, fig. 7 *a-c.*
Bairdia ?ovata, Brady 1880, 53, pl. vii, fig. 3 *a-d.*
Bairdia australis Chapman 1914, 31, 32, pl. vi, fig. 7.

(For relationship and fossil distribution see the last reference, *supra cit.*).

The "Challenger" specimens were found at Station 140, Simon's Bay, South Africa, 15-20 fathoms, and east of New Zealand, 150 fathoms.

E 3917, v.r.; E 3918, v.r.; E 3919, v.r.; E 3920, v.r.; E 3923, f.

12 Bairdia cf. expansa G. S. Brady 1880

Brady 1880, 58, pl. ix, fig. 2 *a-e,* Idem, 1890, 495; Chapman 1910, 430.

Recorded from Honolulu, 40 fathoms ("Challenger"); also South Sea Islands and Noumea in shallow water. Around Funafuti, in deep water, 1,050 and 1,215 fathoms. E 3920, v.r.

13 Bairdia foveolata G. S. Brady 1867

Brady 1867, 56, pl. vii, fig. 4-6, Idem, 1880, 55, pl. viii, fig. 1 *a-f*, 2 *a-f*, Idem, 1890, 493; Egger 1901, 426, pl. ii, fig. 2-4; Chapman 1902, 423, Idem, 1910, 429.

Egger records it from Amboyna, 54 metres; Monrovia, West Africa, 68 metres; near Mauritius 411 metres. Around Funafuti in both shallow and deep water (7½ to 1,485 fathoms), Chapman. E 3915, v.r.

14 Bairdia fusca G. S. Brady 1866

Brady 1866 364, pl. lvii, fig. 9 *a-d*, Idem, 1880, 49, pl. vii, fig. 2 *a-d*; Egger 1901, 427, pl. vii, 46-49.

This species was dredged by the "Challenger" from Port Jackson, 2-10 fathoms. Egger records it from West Africa at 677 metres. Previous "'Endeavour" material gave Station 36, east of Tasmania, 777 fathoms. E 3917, r.

15 Bairdia minima G. S. Brady 1880

Brady 1880, 53, pl. vii, fig. 6 *a-g*; Egger 1901, 427, pl. ii, fig. 14, 15.

Egger's record for the "Gazelle" is Station 90, North-West Australia, 357 metres. E 3917, v.r.; E 3919, f.

Fam. CYTHERIDAE

Genus Cythere Müller 1785

16 **Cythere acerosella** sp. nov.

(Pl. viii, fig. 5)

Description—Valve seen from the side, subreniform, slightly higher in front than behind; anterior roundly curved, posterior broadly so; dorsal margin slightly curved and tapering posteriorly; ventral slightly sinuate in the middle. Seen from above, oblong, ovate, thickest in the middle, tapering to the anterior extremity and broadly to the posterior, both being sharply acuminate. End view, broadly ovate. Surface of valve sparsely covered with minute papillae, which are distinctly setose. Length, 0·88 mm.; greatest height, at anterior, 0·54 mm.

Observations—This species, in outline and form, belongs to the *Cythere kerguelenensis* group of the genus, but has no surface pittings, these being otherwise represented by papillae. E 3917, v.r.; E 3920, v.r.; E 3923, v.r.

17 Cythere canaliculata (Reuss 1850)

Cypridina canaliculata Reuss 1850, 76, pl. ix, fig. 12.

Cythere canaliculata (Reuss), Egger 1858, 33, pl. v, fig. 10, 11; Brady 1866, 373, pl. lix, fig. 4 *a-f*, Idem 1880, 73, pl. xiv, fig. 7 *a-d*; Egger 1901, 432, pl. iv, fig. 15, 16; Chapman 1914, 32, pl. vi, fig. 8, Idem 1919, 23.

The first recent occurrence of this species in Australia was recorded by Brady from Hobson's Bay in 1866. It was later obtained in "Challenger" dredgings from E. Moncoeur Island, Bass Strait and at Port Jackson. Egger's recent forms were found in "Gazelle" dredgings, at Station 90, North-West Australia. The "Aurora" Antarctic Expedition (Mawson 1911-14) obtained this species south-west of Tasmania. Previous "Endeavour" material yielded this species from Station 36, east of Tasmania, 777 fathoms. It was found, in association with many other still living ostracods, in the Mallee Bores of Tertiary age in Victoria, and recorded in 1914. It ranges as far back as the Lower Miocene.

E 3921, v.r.; E 3922, v.r.

18 CYTHERE CRISPATA G. S. Brady 1868

Brady 1868, 221, pl. xiv, fig. 14, 15, Idem 1880, 72, pl. xiv, fig. 8 *a-d*; Chapman 1914, 33, pl. vi, fig. 9, Idem 1919, 23.

In lower latitudes this species seems to inhabit shallow water, as at Port Jackson, 2-10 fathoms; Booby Island, New Guinea, 6-8 fathoms; and Hong Kong, 7 fathoms. In the "Aurora" sample, however, it occurred to the south-west of Tasmania at 1,300 fathoms. Fossil in Lower Miocene strata in the Mallee Bores. E 3920, v.r.; E 3923, v.r.

19 CYTHERE CRISTATELLA G. S. Brady 1880

G. S. Brady 1880, 90, pl. xix, fig. 6 *a-d*.

Dredged by the "Challenger" at Booby Island, at 6-8 fathoms. E 3915, r.

20 CYTHERE CYTHEROPTEROIDES G. S. Brady 1880

Brady 1880, 78, pl. iv, fig. 16-18; pl. xx, fig. 1 *a-f*.

The "Challenger" obtained specimens of this species from the Cape of Good Hope at 150 fathoms. From previous "Endeavour" material this species was obtained at Station 36, east of Tasmania, at 777 fathoms. E 3915, r.

21 CYTHERE DASYDERMA G. S. Brady 1880

Brady 1880, 105, pl. xvii, fig. 4 *a-f*, pl. xviii, fig. 4 *a-f*; Chapman 1910, 432, Idem 1914, 34, pl. vi, fig. 10.

This is a distinctly deep water form. Brady gives 13 "Challenger" Stations of over 1,000 fathoms from which it was obtained. The greatest depth was at Funafuti at 1,485 fathoms (Chapman). Many localities in the Indian Ocean and South Pacific are given for this species. It was found as a fossil in the Lower Miocene of the Mallee Bores, Victoria. E 3918, v.r.

22 CYTHERE DEMISSA G. S. Brady 1868

Brady 1868, 180, pl. xii, fig. 1, 2, Idem 1880, 66, pl. xii, fig. 1 *a-j*, Idem 1890, 497; Chapman 1914, 34, pl. vi, fig. 11.

This species was described from Port Jackson, 2-10 fathoms. It is a shallow water form. As a fossil it occurs in the Lower Pliocene of the Mallee Bores.

E 3918, v.r.; E 3922, v.r.

23 CYTHERE DICTYON G. S. Brady 1880

Brady 1880, 99, pl. xxiv, fig. 1 *a-y*; Egger 1901, 442 pl. vi, fig. 41-43; Chapman 1910, 433, Idem 1914, 34, pl. vii, fig. 12, 13, Idem 1915, 41.

This is another deep water form; fifteen of the "Challenger" Stations contained this species, which reached a depth of over one thousand fathoms. Egger records it from "Gazelle" dredgings from Kerguelen Island and Table Bay, South Africa. Previous "Endeavour" material contained this species, as follows: Station 36, east of Tasmania, 777 fathoms; and 40 miles south of Cape Wiles, 100 fathoms. It is fairly common in the Lower Miocene strata of the Mallee Bores. E 3915, v.r.; E 3918, r.; E 3922, v.r.

24 CYTHERE EXILIS G. S. Brady 1880

Brady 1880, 69, pl. xvi, fig. 5 *a-h*; Egger 1901, 439, pl. vii, fig. 29-31.

The "Challenger" specimens came from Simon's Bay, South Africa, at 15-20 fathoms. The "Gazelle" dredged it from Kerguelen Island at 104 metres.

E 3922, v.r.

25 Cythere falklandi G. S. Brady 1880

Brady 1880, 65, pl. xii, fig. 6 *a-f*.

The original locality for the species is Stanley Harbour, Falkland Island, 6 fathoms. E 3919, r.

26 Cythere foveolata G. S. Brady 1880

Brady 1880, 75, pl. xiii, fig. 5 *a-h*; Chapman 1915, 41, Idem 1916, 38, 49, pl. iv, fig. 2.

The "Challenger" specimens came from Christmas Harbour, Kerguelen Island, at 120 fathoms, and from Heard Island, at 75 fathoms. Typical specimens were found in the upthrust muds on the slopes of Mount Erebus on the "Nimrod" expedition (Chapman). Previous "Endeavour" material from Station 36, east of Tasmania, afforded this species, at 777 fathoms. E 3917, r.; E 3919, v.r.

27 Cythere goujoni G. S. Brady 1867

Brady 1867, 78, pl. x, fig. 9, 10, Idem 1880, 96, pl. xxv, fig. 7 *a-g*; Egger 1901, 431, pl. vi, fig. 29-31.

The "Challenger" found this species at Port Jackson, 2-10 fathoms; at Booby Island, 6-8 fathoms, and at Hong Kong Harbour, 7 fathoms. From the "Gazelle," Station 90, off North-West Australia, it was found at 357 metres.

E 3919, v.r.; E 3922, v.r.

28 Cythere inconspicua G. S. Brady 1880

Brady 1880, 70, pl. xiii, fig. 1 *a-d*.

The "Challenger" obtained this species at one Station only, at Raines Island, Torres Strait, 155 fathoms. E 3918, r.

29 Cythere irrorata G. S. Brady 1880

Brady 1880, 108, pl. xviii, fig. 2 *a-d*.

Recorded from one "Challenger" Station, near the Admiralty Islands, at 16-25 fathoms. E 3919, v.r.

30 Cythere militaris (G. S. Brady 1866)

Cythereis subcoronata G. S. Brady (non Speyer) 1866, 384, pl. lx, fig. 9 *a-e*.

Cythereis militaris G. S. Brady 1866, 385, pl. lxi, fig. 9 *a-d*.

Cythere clavigera G. S. Brady 1880, 109, pl. xxiii, fig. 7 *a-d*; Chapman 1914, 37, pl. vii, fig. 18.

In commenting on *Cythere clavigera* of the "Challenger" collection, Brady (1880, 110) says: "And it is just possible that the Australian species described in the same memoir (*Cythereis militaris*) may represent a very young specimen of *C. clavigera*." *C. militaris* (1866 Memoir) was from Hobson's Bay, Melbourne. The "Challenger" specimens were dredged from Port Jackson, at 2-10 fathoms. In the descriptions of Ostracoda from borings in the Victorian Mallee, the writer has shown that typical as well as varietal forms of the above species are very common in both Kalimnan (Lower Pliocene) and Lower Miocene strata in those borings. At the depth of 256-263 feet (Lower Pliocene) this species, in association with *Cythere dictyon*, another living species, was so abundant that it formed about 15 per cent. of the washings of a glauconitic clay in which they were embedded. E 3916, v.r.

31 Cythere normani G. S. Brady 1880

Brady 1880, 101, pl. xvii, fig. 3 *a-d*, and (?) pl. xxvi, fig. 4 *a, b*; Chapman 1914, 37, pl. vii, fig. 19, Idem, 50, 73, pl. vi, fig. 2.

The "Challenger" specimens were dredged off Heard Island, Station 150, on coarse gravelly bottom at 150 fathoms. The examples described by the writer in 1916 were from dredgings in the Ross Sea and from upthrust muds on Mount Erebus ("Nimrod"). This species dates, as a fossil, from the Lower Miocene of the Mallee Bores, and has been identified in late Tertiary deposits from a well-sinking in the Murray Flats, South Australia, by Brady. E 3915, v.r.

32 **Cythere obtusalata** G. S. Brady **tenuis** var. nov.

(Pl. ix, fig. 9)

Ref. to specific form—*Cythere obtusalata* G. S. Brady 1880, 91, pl. xii, fig. 1 *a-c*; Egger 1901, 443, pl. viii, fig. 12-15; Chapman 1914, 38, pl. vii, fig. 20.

Resembling Brady's type figure, excepting for the very delicate areolation or polygonal pitting and the thinner build of the shell. The outline of the carapace agrees with the specific form.

Brady's species was found in "Challenger" dredgings off E. Moncoeur Island, Bass Strait, 38-40 fathoms, and off Admiralty Islands, 16-25 fathoms. Egger records the species from Kerguelen; Monrovia, West Africa; and Mauritius ("Gazelle"). The writer found the species, *C. obtusalata,* in the Lower Miocene and the Lower Pliocene of the Mallee, Victoria.

E 3919, r.; E 3921, r.; E 3923, r.

33 Cythere ovalis G. S. Brady 1880

Brady 1880, 66, pl. xiv, fig. 4 *a-d;* Chapman 1914, 38, pl. vii, fig. 21.

Brady's type specimens were dredged off Booby Island, 6 to 8 fathoms. The fossil specimens, from the Victorian Mallee, were found in Lower Miocene strata.

E 3918, v.r.

Cythere postcaudispinosa sp. nov.

(Pl. viii, fig. 3)

Description—Valve seen from the side, subrectangular, anterior extremity wider than posterior, roundly arched and bordered by a raised flange beset with a few denticles; narrower to posterior extremity which is terminated by a few stout teeth. Dorsal margin sinuate below the anterior third, thence sloping to posterior elevation. Ventral margin gently curved to meet the toothed extremity. Surface of valves anteriorly swollen and punctate, with prominent anterior median tubercle; posterior area slightly concave, without pittings. In profile the carapace is much more inflated than in the related Kalimnan to Lower Miocene fossil (*C. caudispinosa*) of the Sorrento Bore. It also lacks the long spine of the posterior extremity and the thickly punctate ornament of the Sorrento fossil (*Cythere caudispinosa* Chapman and Crespin. In Chapman, "The Sorrento Bore, Mornington Peninsula."—Records Geol. Surv. Vict., **5**, pt. i, 1928, 125, pl. ix, fig. 64 *a*, *b*). Length, 0·8 mm.; greatest height, at anterior, 0·43 mm.; thickness of carapace, 0·03 mm. E 3917, v.r.

35 Cythere rastromarginata G. S. Brady 1880

Brady 1880, 83, pl. xvi, fig. 1 *a-d*; Egger 1901, 442, pl. vi, fig. 5-9; Chapman 1914, 40, pl. vii, fig. 24.

The "Challenger" dredgings of *C. rastromarginata* were: off Reefs, Honolulu, 40 fathoms; off Moncoeur Island, Bass Strait, 38-40 fathoms; and Station 167, blue mud, between Sydney and New Zealand, 145-150 fathoms. The "Gazelle" soundings, recorded by Egger, containing this species, were from Fiji, Samoa and Western Australia. Fossil specimens of this species, fairly typical, came from the Tertiary of the Victorian Mallee.

E 3917, v.r.; E 3920, v.r.; E 3922, r.

36 CYTHERE SCUTIGERA G. S. Brady 1868

Brady 1868, 70, pl. viii, fig. 15, 16, Idem 1880, 109, pl. xxii, fig. 5 *a-f*; Chapman 1914, 41, pl. viii, fig. 27.

Brady's "Challenger" specimens came from Java, Amboyna and Papua. The fossil specimens from the Mallee Lower Miocene were typical though not so clearly sculptured. E 3923, r.

37 CYTHERE SUBRUFA G. S. Brady 1880

Brady 1880, 81, pl. xx, fig. 3 *a-f*.

From amongst the "Challenger" samples Brady recognised this species from Balfour Bay, Kerguelen, 20-50 fathoms, and Prince Edward's Island, 50-150 fathoms. E 3923, v.r.

38 CYTHERE TETRICA G. S. Brady

Brady 1880, 104, pl. xxiii, fig. 5 *a-d*.

"Challenger" specimens dredged off Booby Island, 6-8 fathoms (Station 87). E 3920, v.r.

Genus EUCYTHERE G. S. Brady 1868

39 EUCYTHERE DECLIVIS (Norman 1865)

(Pl. viii, fig. 10)

Cythere declivis Norman 1865, 16, pl. v, fig. 9-12.

Eucythere declivis G. S. Brady 1868, 430, pl. xxvii, fig. 22-26; Egger 1901, 449. pl. iv, fig. 65-67.

The species was previously recorded by the present writer from "Endeavour" soundings off Cape Wiles, 25 years ago. A more typical example of this rare form is here figured. Its wide distribution is remarkable. Earlier records are from the coasts of Great Britain and Ireland (G. S. Brady), and off North-Western Australia at 357 metres (Egger, "Gazelle," Station 90). It was also found in the Pleistocene glacial clays of Scotland. E 3918, v.r.; E 3919, v.r.

Genus KRITHE Brady, Crosskey and Robertson 1874

40 KRITHE PRODUCTA G. S. Brady 1880

Brady 1880, 114, pl. xxvii, fig. 1 *a-j*; Egger, 1901, 451, pl. iv, fig. 17, 18; Chapman, 1902, 427, Idem 1910, 434.

The "Challenger" dredgings from which this species was recorded came from Pernambuco, North Brazil, Prince Edward's Island, and off Sydney at 410 fathoms. Egger's specimens from the "Gazelle" soundings came from Kerguelen Island and the north-west coast of Australia. In 1910 the writer recorded this species from around Funafuti (H.M.S. "Penguin") at the great depths of 1,489-2,715 fathoms. Previous "Endeavour" material (1915) showed it to occur at Station 36, east of Tasmania, 777 fathoms, common; and south of Tasmania at 1,122 fathoms. E 3915, f.; E 3918, v.r.

Genus LOXOCONCHA G. O. Sars 1865

41 LOXOCONCHA AUSTRALIS G. S. Brady 1880

Brady 1880, 119, pl. xxviii, fig. 5 *a-f*, pl. xxix, 3 *a-d*; Chapman 1914, 42. pl. viii, fig. 30, Idem 1915, 44.

In the latter reference, on pl. ii, fig. 6, a thin-shelled and nearly smooth form is figured as var. *tasmanica*. This has not been met with in the present samples, with the exception of a possibly solitary specimen. The "Challenger" met with this well-distributed Australian form at Port Jackson, 2-10 fathoms; Booby Island, 6-8 fathoms. E 3918, r.; E 3919, v.r.; E 3920, v.r.; E 3921, v.r.; E 3922, f.; E 3923, v.r.

42 LOXOCONCHA AVELLANA G. S. Brady 1880

Brady 1880, 117, pl. xxviii, fig. 1 *a-f*.

The "Challenger" examples were dredged at Port Jackson, 2-10 fathoms; and at Tongatabu, 18 fathoms. E 3918, r.; E 3922, r.

Genus XESTOLEBERIS G. O. Sars 1865

43 XESTOLEBERIS CURTA (G. S. Brady 1866)

? *Cytheridea curta* G. S. Brady 1866, 370, pl. lviii, fig. 7 *a, b*.

Xestoleberis curta G. S. Brady 1868, 79, pl. x, fig. 16-18; Idem 1880, 126, pl. xxxi, fig. 6 *a-d*.

The "Challenger" dredgings containing this species are: Kerguelen Island, Port Jackson, Booby Island, Fiji, New Caledonia. The writer found this species at Funafuti to inhabit shallow to deeper water to 200 fathoms. It occurred as a Pliocene fossil in the Mallee Bores. E 3915, r.; E 3920, v.r.

44 XESTOLEBERIS DAVIDIANA Chapman 1915

(Pl. viii, fig. 2)

Chapman 1915, 45; Idem 1916, 51, pl. vi, fig. 5, 6 (typical); Idem 1919, 32, pl. xxii, fig. 2, 2 *a* (not typical).

The earlier references to the above species relate to the material collected as upthrust muds on the slopes of Mount Erebus, and also muds dredged in the Ross Sea by the "Nimrod," of the Shackleton Expedition of 1907-9. The "Aurora" specimens were obtained from several dredgings along the Ice Barrier, and also from South-East Tasmania towards Macquarie Island. Previous records of "Endeavour" material include south of Tasmania, 1,122 fathoms.

E 3916, v.r.; E 3917, r.

45 XESTOLEBERIS MARGARITEA (G. S. Brady 1866)

Cytheridea margaritea G. S. Brady 1866, 370, pl. lviii, fig. 6 *a-d*.

Xestoleberis margaritea (Brady) 1880, 127, pl. xxx, fig. 2 *a-g;* Egger 1901, 456, pl. iii, fig. 27-30; Chapman 1902, 429, Idem 1914, 43, pl. viii, fig. 32.

Records by Brady are Sponge sand, Mediterranean, and from the "Challenger," off Booby Island. Egger's "Gazelle" Stations are: Kerguelen and off the coast of West Australia. It was also found by the writer in shallow water round Funafuti, and as a Lower Miocene fossil in the Mallee Bores, Victoria.

E 3923, v.r.

46 XESTOLEBERIS NANA G. S. Brady 1880

Brady 1880, 127, pl. xxxi, fig. 5 *a-c;* Egger 1901, 456, pl. iii, fig. 31, 33; Chapman 1902, 430, Idem 1915, 46, Idem 1919, 32.

Recorded by Brady ("Challenger") off Tongatabu, 18 fathoms in coral bottom. Egger found it in "Gazelle" dredgings from Fiji, Samoa, and North-West Australia. The writer has noted its occurrence at Funafuti (South Pacific) at 18-200 fathoms, and also in "Aurora" soundings, west of Tasmania. Previous records in "Endeavour" material are: east of Tasmania, 1,122 fathoms, and 40 miles south of Cape Wiles, 100 fathoms. E 3923, r.

47 XESTOLEBERIS POLITA G. S. Brady 1876

Brady 1876, 202, pl. xxvii, fig. 15, 16, Idem 1880, 127, pl. xxxi, fig. 7 *a-c;* Chapman 1919, 33.

The type specimens were obtained from the Straits of Magellan, and the "Challenger" examples came from Stanley Harbour, Falkland Islands, in 6 fathoms. The writer recorded the species from Mawson's "Aurora" dredgings from the west of Tasmania at 1,300 fathoms. E 3923, v.r.

48 XESTOLEBERIS SETIGERA G. S. Brady 1880

Brady 1880, 125, pl. xxxi, fig. 2 *a-d*, 3 *a-c*; Egger 1901, 456, pl. iii, fig. 37-39; Chapman 1902, 428.

The "Challenger" specimens came from Kerguelen, Heard and Prince Edward's Islands. The "Gazelle" dredged it off Monrovia, West Africa. From Funafuti the writer obtained it from beach sand of Avalau, sand from the lagoon beach at Funafala, the lagoon dredgings Rocky Islet, lagoon dredgings 8½ miles from the Mission Church at 12 fathoms, and off Tutanga at 50-60 fathoms.

E 3918, v.r.

49 XESTOLEBERIS VARIEGATA G. S. Brady 1880

Brady 1880, 129, pl. xxxi, fig. 8 *a-g*, Idem 1890, 508; Chapman 1902, 429, Idem 1914, 43, pl. viii, fig. 33, Idem 1915, 46, Idem 1919, 33.

The "Challenger" records for this species are: off St. Vincent, Cape Verde, at 1,070-1,150 fathoms; and off Tongatabu in 18 fathoms. Brady also found the species at Noumea in 2-6 fathoms, and in shallow water from seven localities in the South Sea Islands, in shore sands and reef pools. At Funafuti, *X. variegata* was found in lagoon dredgings in shallow water, and off Funamanu at 50 fathoms. Only one occurrence was noted from the "Aurora" dredgings, at Station 59, in 1,320 fathoms, near Western Tasmania. As a fossil this species was found in the Lower Miocene of the Victorian Mallee Bores (Chapman). But for the more swollen dorsal convexity, this fossil form was typical of the living form, even to the variegated surface markings. Previous "Endeavour" samples showed this species to occur at the Station 40 miles south of Cape Wiles, 100 fathoms.

E 3923, v.r.

Genus CYTHERURA G. O. Sars 1865

50 CYTHERURA COSTELLATA G. S. Brady 1880

Brady 1880, 134, pl. xxxii, fig. 7 *a-d*; Chapman 1916, 51, pl. vi, fig. 7, Idem 1919, 34.

The "Challenger" examples came from Balfour Bay, Kerguelen Island, 20-50 fathoms. From soundings in the Ross Sea and from upthrust muds on the slope of Mount Erebus, Shackleton Expedition, the writer obtained typical examples of this striking species. It also occurred in the "Aurora" dredgings opposite Kaiser Wilhelm II Land off the Ice Barrier, and off West Tasmania.

E 3918, v.r.; E 3922, v.r.

51 CYTHERURA CRYPTIFERA G. S. Brady 1880

Brady 1880, 134, pl. xxxii, fig. 4 *a-c*; Chapman 1919, 34.

When first described, this species was monotypic and represented by a single valve, which was found east of Moncoeur Island, Bass Strait, 37-40 fathoms. It was noted from previous "Endeavour" material (Chapman 1915, 46), when two valves were found in dredgings, east of Tasmania, in 777 fathoms. Since then the species has been found in dredgings by the "Aurora" (Mawson 1911-14) Expedition from the west of Tasmania at 1,300 and 1,320 fathoms. E 3918, v.r.

Genus CYTHEROPTERON G. O. Sars 1865

52 CYTHEROPTERON ASSIMILE G. S. Brady 1880

Brady 1880, 138, pl. xxxiv, fig. 3 *a-d*; Chapman 1902, 431

The "Challenger" examples were dredged off Christmas Harbour, Kerguelen Island, 120 fathoms, and off Heard Island in 75 fathoms. *C. assimile* was also found at Funafuti, in the beach sand, Avalau Islet, and in Sollas's second boring at 40 feet down. E 3919, v.r.; E 3920, v.r.

53 Cytheropteron dannevigi Chapman 1915

Chapman 1915, 47, pl. iii, fig. 2 *a-c*.

The nearest relation to this form is *Cytheropteron wellingtoniense* G. S. B. The original type was obtained from Station 36, east of Tasmania, 777 fathoms.

E 3917, v.r.

54 **Cytheropteron hedleyi** sp. nov.

(Pl. vii, fig. 6, 7)

Description—Right valve subrhomboidal, anterior narrowly rounded; ventral border nearly straight, ending posteriorly in blunt wing. Dorsal margin steeply arched, posterior extremity sharply pointed. Height of carapace slightly more than half the length. Edge view of carapace broadly ovate, dorsal edge with a distinct flange. Ornament sparsely punctate; a deep fossa near the border of the alate margin. Length of carapace, ·07 mm.; thickness of carapace, 0·76 mm.

Observations—Both *Cytheropteron wilesi* Chapman and *C. hedleyi* are related to *C. abyssorum* Brady, but probably not conspecific as all three differ strongly in ornament though not in shape. E 3915, v.r.

Genus Bythocythere G. O. Sars 1865

55 Bythocythere arenacea G. S. Brady 1880

Brady 1880, 142, pl. xxxiii, fig. 3 *a-g* (*B. arenosa* on pl. xxxiii); Chapman 1902, 432; Chapman and Crespin 1928, 171.

This species was described from a "Challenger" specimen from Torres Strait, 155 fathoms. It was obtained from Funafuti, South Pacific, at Tutanga, 200 fathoms (Chapman). As a fossil it was found in the Kalimnan (Lower Pliocene) of the Sorrento Bore, at 605 feet (Chapman and Crespin).

E 3918, v.r.; E 3921, v.r.

Genus Pseudocythere G. O. Sars 1865

56 Pseudocythere caudata G. O. Sars 1865

Sars 1865, 88; G. S. Brady 1868[2], 543, pl. xxxiv, fig. 49-52, pl. xli, fig. 6; Brady, Crosskey and Robertson 1874, 210, pl. ii, fig. 9; Brady 1880, 144, pl. i, fig. 6 *a-d;* Brady and Norman 1889, 225.

Brady recorded this species from Kerguelen Island and from Prince Edward's Island. It is also a northern species, found round the coasts of Britain; also fossil, from the Pleistocene of Scotland and Ireland. E 3917, v.r.; E 3922, v.r.

57 Pseudocythere fuegiensis G. S. Brady 1880

Brady 1880, 145, pl. i, fig. 7 *a-d*; Egger 1901, 464, pl. viii, fig. 39, 40.

Brady's species was monotypic when described, from Tierro del Fuego. Much interest attaches to this discovery in the Tasman Sea, for, in 1901 Egger found another single valve, at Station 90, off North-West Australia ("Gazelle"). This third specimen comes from 33 miles east by south from Green Cape; it is a right valve, agreeing exactly in form and lineate ornament with Brady's type.

E 3918, v.r.

Fam. CYTHERELLIDAE

Genus Cytherella Rupert Jones 1849

58 Cytherella lata G. S. Brady 1880

Brady 1880, 173, pl. xliv, fig. 5 *a-e*; Chapman 1914, 50, pl. ix, fig. 44 *a, b*; Chapman and Crespin 1928, 171.

A widely distributed species. Recorded from the "Challenger" dredging at Culebra Island, off the Azores, Pernambuco, Torres Strait and the Ki Islands. As a fossil it has been recorded from the Lower Miocene of the Sorrento Bore, and as a Miocene and Pliocene form from the Mallee Bores. E 3922, v.r.

59 CYTHERELLA POLITA G. S. Brady 1880

Brady 1880, p. 172, pl. xliii, fig. 5 *a-c*, pl. xliv, fig. 1 *a-g;* Chapman 1914, 50, pl. ix, fig. 45 *a-b;* Chapman and Crespin 1918, 171.

This species was found in "Challenger" dredgings at Wellington Harbour, New Zealand, in tow-net at trawl; and at the mouth of the Rio de la Plata, 13 fathoms. As a fossil it was found in the Lower Miocene to Pliocene of the Sorrento Bore, Mornington Peninsula and in the Lower Miocene and Lower Pliocene in the Victorian Mallee Bores. E 3917, r.; E 3922, v.r.

60 CYTHERELLA PULCHRA G. S. Brady 1866

Brady 1866, 361, pl. lvii, fig. 1 *a-d*, Idem 1880, 174, pl. xliv, fig. 3 *a, b*; Chapman 1914, 50, pl. ix, fig. 46 *a, b*; Chapman and Crespin 1928, 171.

This minute form is here represented by a valve having a length of 0·55 mm., against Brady's figured specimen with a length of 0·77 mm. Amongst other localities Brady has recorded it from Port Jackson. It was apparently well established in Lower Miocene times, for it occurs abundantly in strata of that age both in the Mallee Bores and that of Sorrento. E 3976, v.r.; E 3917, r.; E 3918, v.r.

61 CYTHERELLA PUNCTATA G. S. Brady 1866

(Pl. ix, fig. 11)

Brady 1866, 362, pl. lvii, fig. 2 *a, b*, Idem 1880, 174, pl. xxxvi, fig. 6 *a, b*, pl. xliv, fig. 4 *a-g*; Egger 1901, 469, pl. iv, fig. 34, 35; Chapman 1914, 51, pl. ix, fig. 47, Idem 1919, 42; Chapman and Crespin 1928, 171.

The localities given by the "Challenger" are Tristan d'Acunha, Port Jackson, Ki Islands, between Sydney and New Zealand, and the Straits of Magellan. Brady has figured a medio-sulcate form as *C. punctata;* as this seems to pass into *C. irregularis* Brady, these may have to be separated from *C. punctata*, sensu stricto. This species, *C. punctata* was also found in "Gazelle" dredgings, Station 90, off the North-West Australian coast.

The "Aurora" deep water dredgings which contained this species were taken off the east coast of Tasmania, in 1,180 and 1,300 fathoms. The fossil examples are quite typical and denote a Lower Miocene to Pliocene age from both the Mallee and the Sorrento Bores.

E 3915, v.r.; E 3916, v.r.; E 3918, r.; E 3920, v.r.; E 3922, v.r.; E 3923, v.c.

62 CYTHERELLA SEMITALIS G. S. Brady 1867

Brady 1867, 72, pl. viii, fig. 23, 24, Idem 1880, 175, pl. xliv, fig. 2 *a-c*.

This species was first described from north of Java. The "Challenger" samples containing this species were from Booby Island, 6-8 fathoms; Humboldt Bay, Papua, 37 fathoms; Nares Harbour, Admiralty Islands, 16 fathoms.

E 3918, v.r.

Genus CYTHERELLOIDEA Alexander 1929

63 **Cytherelloidea auris** sp. nov.

(Pl. ix, fig. 10)

Description—Valve (right) somewhat depressed, subrectangular, with broadly rounded extremities. Dorsal margin gently sinuous. Ventral edge slightly concave, with rounded margin. Anterior border with an inner, sulcated rim. Central area largely occupied by a thickened oval ring, having a central fossa nearly divided transversely. This central, raised, ridge-like feature is not so definitely cochleate as in the Tertiary *Cytherelloidea auricula* (Chapman), of the Mallee Bore and the Sorrento Bore. Length, 0·58 mm.; height, 0·34 mm.

Observations—The nearly related *Cytherelloidea auricula* (Chapman) (Proc. Roy. Soc. Vict., **27**, pt. i, 49, pl. ix, fig. 42 *a*, *b*, 43) of the Tertiary of the Mallee and Sorrento Bores is similarly of a long rectangular shape, but the central ridge-like ring is more sinuous, narrow, and more nearly resembling the inner fold of the ear.

E 3922, v.r.

SUMMARY OF RESULTS

(a) On Hedley's Regional Areas of the Australian Coastline

The majority of these samples are beyond the mud-line. The present evidence, however, strongly supports the use of the terms first suggested by Charles Hedley for those regional areas that are primarily marked out by their shallower, molluscan fauna.

The *Solanderian* region takes in the coastline from Torres Strait to Moreton Bay, Queensland; the *Adelaidean* includes the south and south-west coasts of Australia, from Wilson's Promontory in Victoria to Shark Bay, and the north and west coasts of Tasmania; the *Peronian*, the remainder of the east coast of Australia and Tasmania and the south coast of Victoria; and the *Dampierian* from Torres Strait, North-East Australia, to Houtman's Abrolhos, below Shark Bay, West Australia.

In general support of these four divisions of the coastal regions, Iredale[5] has drawn attention to the fact that, in regard to the *littoral* molluscan faunas, these are distinct if we take a central point in those regional areas; Sydney showing a pure Peronian assemblage, whilst Adelaide gives a typical Adelaidean fauna. At the same time, as one would expect, there is an overlapping of regional faunas near their respective boundaries.

This regional distribution also applies to that of the microzoa (the Foraminifera and Ostracoda), especially in the littoral zone (between tide-marks) and, to some extent, in the shallow water deposits between low-water mark and the 100 fathoms line. Two of the present samples, E 3915 and E 3923, come within that category.

Beyond the mud-line, however, including E 3916 to E 3922, a remarkable number of species, of both Foraminifera and Ostracoda, are included in the present lists, many of which are recorded for the first time as Northern or Southern types, respectively. This particular assemblage has a distinct bearing on the Antarctic or the Torresian origin of many of the species now found in the Australian deep water microzoic fauna. This points either to a vestigial southern or northern remanié fauna, as the case may be, or, possibly, and what is perhaps more likely, the direct influence of two opposite sets of currents. The actual existence of one, the northern, has been demonstrated by Charles Hedley, who consequently named these southward-flowing currents, the Notonectian.

For the occurrence and effect of the latter, Hedley cites several instances

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(5) Results from Roy Bell's Molluscan Collections, Proc. Linn Soc. N.S.W., 49, (3), 180.

where tropical and northern organisms have been found as far south as Flinders Island.[6]

It should, however, be borne in mind that even in the shallower soundings there are occasional stray species which show a similar origin; but they only prove the general rule, that by far the larger number of these apparently introduced forms are to be found where the deeper currents prevail.

In the paper above quoted, Iredale rightly points out, in discussing the distribution of his groups of mollusca, that he is there dealing only with the littoral faunas. As we have seen elsewhere, Hedley has occasionally found types of mollusca of a different or specialised character inhabiting the greater deeps of the ocean below the mud-line around the east and south-east coasts of Australia.

In regard to the deeper dredgings of the "Endeavour" at 470 and 505 fathoms, 33 miles east by south of Green Cape, the "strangers" brought from vast distances, most likely through the agency of persistent currents, are often very much in evidence.

Within the mud-line, however, as at Babel Island, at 65 fathoms, the following is perhaps a typical selection of species that are well established on the benthic feeding ground of the mud-line itself, perhaps in association with a few adventurous Notonectian forms.

Forms Typical of a 65 Fathom Level, North-east of Tasmania

FORAMINIFERA—

Lenticulina cultrata
,, sp. aff. orbicularis
Bolivina sp. aff. hentyana
,, beyrichi
Streblus beccarii
Epistomina elegans
Anomalina glabrata
,, aff. rotula
,, vermiculata
Cibicides sp. aff. victoriensis
,, pseudoungerianus
Elphidium advenum
,, verriculatum
Pelosina cylindrica
Quinqueloculina lamarckiana
,, vulgaris
Spiroloculina canaliculata
Triloculina tricarinata
Pyrgo fornasinii
Pyrgoella sphaera
Biloculinella globulus
Haplophragmoides grandiformis
Textularia conica
,, corrugata
,, pseudogramen
Clavulina serventyi
Dorothia arenata
Gaudryina aff. rugosa

OSTRACODA—

Macrocypris decora
,, maculata
Bairdia amygdaloides
Krithe producta

(b) Specific Elements of a Microzoic Fauna which may have been introduced by Deeper Currents beyond the Continental Shelf.

Taking the samples E 3920, E 3921 and E 3922 at 470 to 505 fathoms as being typical of the blue, grey and green muds below the 100 fathom line, it is very enlightening to make a comparison of certain species contained therein which have a naturally northern or southern habitat. The following, therefore, are especially regarded as having been distributed by Notonectian or Antarctic currents, respectively:

(6) Chas. Hedley, Presidential Address, Linn. Soc. N.S.W., 1910, 30 (1), 10-12. For the Discussion of Regions, see Hedley—The Effect of the Bassian Isthmus upon the Existing Marine Fauna: a Study in Ancient Geography, *ibid.*, 1903, (4).

NOTONECTIAN

(Philippines, Andaman Islands, Ki Islands, Torres Strait)

FORAMINIFERA—

Vaginulina legumen
Nodosaria fistuca
,, catenulata
,, pyrula semirugosa
Lagenonodosaria scalaris
Lagena clavata
Rectobolivina bifrons
Bifarina fimbriata
Uvigerina sp. aff. pigmea
Parafrondicularia helenae
Sphaeroidinella dehiscens
Elphidium advenum
Cornuspira foliacea
,, ,, expansa
,, lacunosa
Quinqueloculina cuvieriana
Spiroloculina canaliculata
Ptychomiliola separans
Pyrgo comata
,, fornasinii
Haplophragmoides grandiformis
Textularia corrugata
Dorothia arenata
Gaudryina scabra
,, robusta
,, triangularis

OSTRACODA—

Cythere crispata
,, goujoni
,, inconspicua
,, irrorata
,, scutigera
Loxoconcha australis
Xestoleberis curta
Bythocythere arenacea
Cytherella lata
,, punctata
,, semitalis

ANTARCTIC

(Great Ice Barrier, Kerguelen Islands, Heard Island, Falklands, New Zealand)

FORAMINIFERA—

Lagena annectens
,, crenata
,, distoma
,, marginata
,, melo
,, orbignyana
,, sulcata
Bulimina elegans
Bolivina alata
,, robusta
Cassidulina crassa
Ellipsolagena schlichti
Bolivinita quadrilatera v. tortilis
Patellina corrugata
Cibicides refulgens
Anomalina wuellerstorfi
Chilostomella cushmani
Pullenia sphaeroides
,, subcarinata
Globigerina dutertrei
,, inflata
,, pachyderma
,, subcretacea
,, triloba
Orbulina universa
Pulleniatina obliquiloculata
Globorotalia scitula
,, truncatulinoides
Nonion depressulus
,, grateloupi
,, scapha
,, umbilicatulus
Elphidium lessoni
Hyperammina novaezealandiae
Saccammina sphaerica
Rhabdammina discreta
Planispirina bucculenta
Triloculina chrysostoma
,, tricarinata
Miliolinella oblonga
Pyrgoella sphaera
Haplophragmoides emaciatus
Recurvoides contortus
Reophax dentaliniformis
,, distans v. pseudodistans
,, scorpiurus
Textularia conica
Trochammina planoconvexa

Ostracoda—

Bairdia australis
Cythere dictyon
,, exilis
,, falklandi
,, foveolata
,, normani
,, subrufa
Xestoleberis davidiana
,, setigera
Cytherura costellata
Cytheropteron assimile
Pseudocythere caudata
,, fuegiensis

(c) Evidence of Rapid Temperature Changes during the Deposition of Sample E 3917.

The main facts leading to this conclusion are given on pp. 149, 150. These go to prove that the deposition of calcitic rhombs in such sediments must be due to fairly rapid changes in temperature which are taking place in the waters of Bass Strait.

(d) General Nature of the Sediments of the present Samples.

The majority are richly organic and largely calcareous. In four out of the nine samples there were small quantities of quartz sand present, as follows:

E 3917 A minute quantity of angular quartz grains. Could not have travelled far from source, by weathering of continental rocks.

E 3918 Occasional polished quartz grains. Probably wind-blown, and carried out to sea from desert regions.

E 3919 A small proportion of fine angular quartz sand and other terrigenous material. Deposited not far from source of origin (continental).

E 3922 Concretionary mud, stained with iron oxide. When dissolved in HCl, leaves a small residue of quartz sand (derived from continental rocks). The microzoa released by crushing are found to be marvellously perfect.

Deposition of Types and Duplicate Specimens described in this Monograph

The Director of the National Museum, Melbourne, Mr. D. J. Mahony, M.Sc., has kindly consented to undertake the care of the present collection. Former collections of the Microzoa described by me from the "Endeavour" soundings are also to be found in the collection of the National Museum, Melbourne.

Acknowledgment

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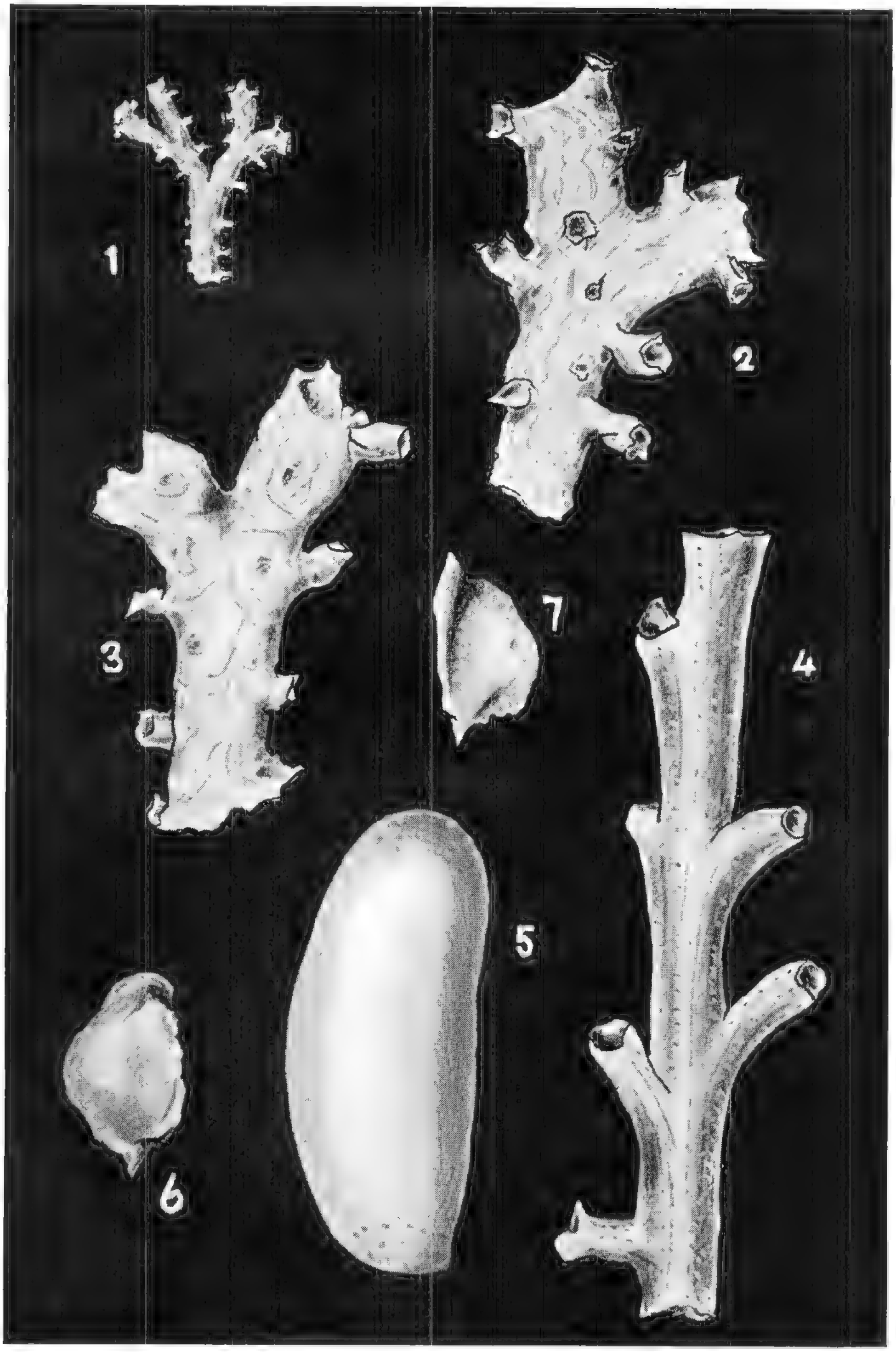
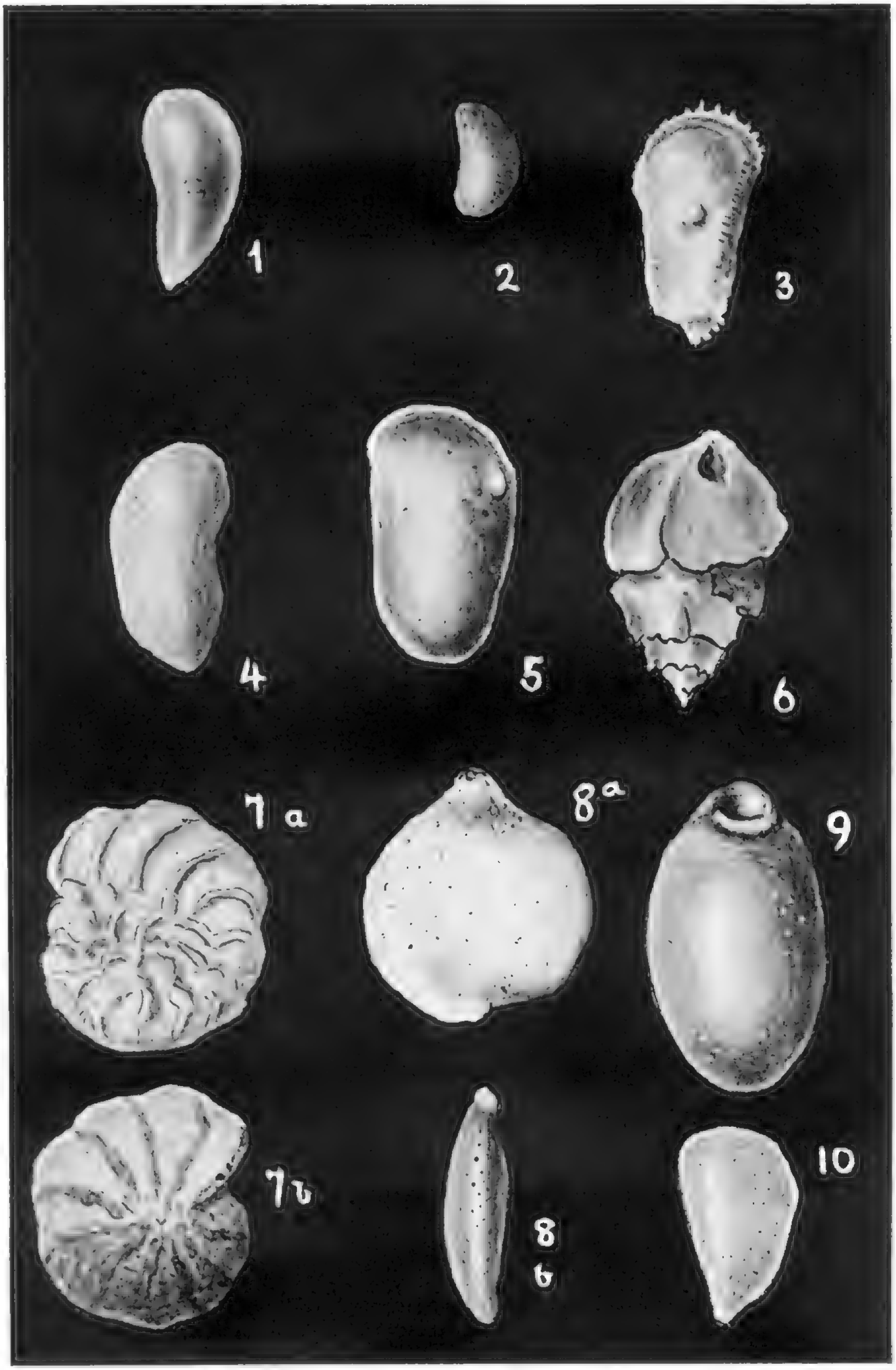


Polyzoa and Ostracoda, F.I.S. "Endeavour," E 3915

F. Chapman, del. ad nat.



Ostracoda and Foraminifera, F.I.S. "Endeavour," E 3916-8

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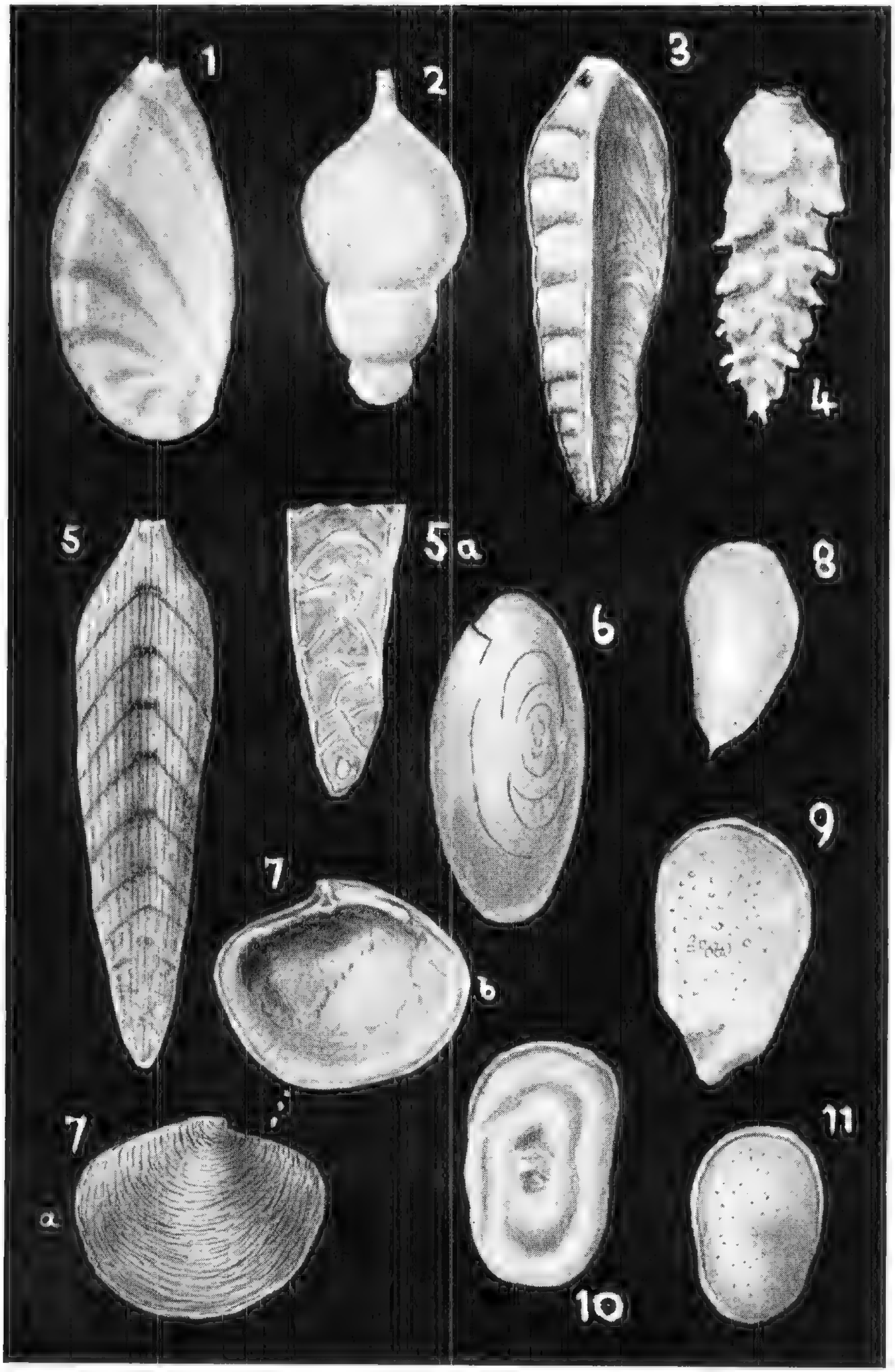

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EXPLANATION OF PLATES

PLATE VII

All specimens from Sample E 3915. East of Babel Island, 65 fathoms.

Fig. 1 *Retepora babelensis* sp. nov. Portion of zoarium under low power. Holotype. X 5.
Fig. 2 „ „ „ Zoecial surface. X 18.
Fig. 3 „ „ „ Dorsal surface. X 18.
Fig. 4 *Mecynoecia dannevigi* sp. nov. Holotype. X 18.
Fig. 5 *Macrocypris setigera* G. S. Brady. X 37.
Fig. 6 *Cytheropteron hedleyi* sp. nov. Holotype. Valve seen from the side. X 37.
Fig. 7 „ „ „ Dorsal aspect. X 37.

PLATE VIII

Fig. 1 *Pontocypris bradyi* (nom. mut.). Plesiotype. Left valve. E 3916. X 37.
Fig. 2 *Xestoleberis davidiana* Chapman. Plesiotype. Left Valve. E 3917. X 37.
Fig. 3 *Cythere postcaudispinosa* sp. nov. Holotype. Right valve. E 3917. X 37.
Fig. 4 *Bairdia acanthigera* G. S. Brady. Right valve. E 3917. X 37.
Fig. 5 *Cythere acerosella* sp. nov. Holotype. Left valve. E 3917. X 37.
Fig. 6 *Bulimina* aff. *marginata* d'Orb. E 3917. X 88.
Fig. 7 *Notorotalia decurrens* sp. nov.: *a*, superior face; *b*, inferior face. Holotype. E 3918. X 18.
Fig. 8 *Sigmoïlina latissima* sp. nov.: *a*, lateral aspect; *b*, edge view. Holotype. E 3918. X 18.
Fig. 9 *Chilostomella cushmani* sp. nov. Syntype. Form A. E 3918. X 37.
Fig. 10 *Eucythere declivis* (Norman). Left valve. E 3918. X 88.

PLATE IX

Fig. 1 *Planularia australis* sp. nov. E 3919. X 74.
Fig. 2 *Lagenonodosaria scalaris* (Batsch), var. *seminuda* var. nov. E 3922. Type of var. X 74.
Fig. 3 *Bolivinita quadrilatera* (Schwager), var. *tortilis* nov.
Fig. 4 *Bifarina fimbriata* (Millett). E 3922. X 74.
Fig. 5 *Parafrondicularia helenae* sp. nov. E 3922. Holotype. X 74 5 *a*, Another example, longitudinal section at a bored end. E 3922. X 112.
Fig. 6 *Chilostomella cushmani* sp. nov. Form B. E 3923. Syntype of stage B. X 74.
Fig. 7 *a*, *b* *Myrtaea gabrieli* sp. nov. Holotype. E 3920. Nat. size.
Fig. 8 *Pontocypris attenuata* G. S. Brady (showing spine). E 3919. X 74.
Fig. 9 *Cythere obtusalata* G. S. Brady var. *tenuis* var. nov. E 3921 Holotype of var. X 74.
Fig. 10 *Cytherelloidea auris* sp. nov. E 3922. X 55.
Fig. 11 *Cytherella punctata* G. S. Brady. E 3923. X 55.

THE BROMINE CONTENT OF SOME SALINE WATERS IN SOUTH AUSTRALIA

By W. TERNENT COOKE

Summary

There are a few references (2, 5, 6) to be found dealing with the bromine content of the many saline waters which exist in this State. Goyder (6) examined many bore and spring waters, and mentions the absence or presence of traces of bromine in some of them, but gives no actual figures for bromine.

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The growing importance of bromine is shown by the increase in output in the U.S.A., where between 1928 and 1938 the production rose from slightly more than 2 to 38 million pounds per annum. So far, apparently, Australia has not manufactured bromine commercially, and in 1938-9 nearly 100,000 pounds, valued at nearly £9,000, were imported. This is all the more regrettable since liquors from salt works, etc., are virtually relatively concentrated bromide solutions, often as rich in bromine as those from which it was in general obtained before the present increased demand for this element arose.

Method of Analysis

The procedure given by Doering (4) was used. The chemical basis of the method consists in oxidising the bromide present to bromate, allowing this to liberate iodine from potassium iodide, and titrating the liberated iodine with standardised sodium thiosulphate solution. Standardisation can be made directly against pure potassium bromate, or indirectly against potassium bromide by putting it through the routine process of the analysis. The method was found to be simple, cheap, quick, and quite sufficiently accurate for the present purpose; it can be carried out on 10 ml. of solution by using a 0·005 normal thiosulphate solution. Usually two portions of sample were taken, 10 ml., and 25 ml., and titrated against 0·005 N, and/or 0·05 N thiosulphate, respectively, giving values such as, e.g., 544, 541, 535, 549 grammes per million ml. of sample. Experiments were made with some of the samples in order to compare the volumetric method here used with the "aspiration" method of Baughman and Skinner (1). It was found that satisfactory agreement could be obtained if the time of the aspiration was increased at least three times; this increase is necessary apparently on account of the very small amounts of bromine under estimation. Also, where as in the present case, the ratio of chlorine to bromine is high, the finding of Baughman and Skinner concerning the necessity for two aspirations and absorptions was confirmed. The bromine, carrying with it some chlorine, must first be absorbed in carbonate-sulphite solution, and the bromine then aspirated from this into a solution of potassium iodide.

Results

The results of the analyses are set out in tabular form in Table I, the bromine contents being expressed in grammes of bromine per million millilitres of the sample, or roughly pounds per 100,000 gallons. The water of the open sea, from which large amounts of bromine are today being obtained, contains from 60 to 70 parts per million. The figures for bromine actually include any iodine which may be present, but the amounts of the latter are very minute; in sea water the ratio of bromine to iodine is about 3,000 to one (3).

The results in Table I show the bromine content of the samples as received, since the main objective of the work was to ascertain what available raw materials might be considered as possible sources of commercial supplies of bromine. For the sake of being able to make a further comparison between some of the samples, certain additional data are given in Table II, which data show the actual saline content of some of the samples, and the bromine content of the salts present in the solution, the bromine content of the solution being known from the results of Table I. The saline contents were determined by evaporation and drying of the saline residue at about 230° C. Admittedly the method does not give strictly accurate values of the saline contents of the liquors, since some chlorine (and bromine) is lost by hydrolysis of the halogen salts present, particularly magnesium chloride, but the method is sufficiently accurate to serve as a basis of comparison. The loss of halogens by hydrolysis can be seen by comparing column 4 of Table II, which gives the bromine content of the salts after drying (and hydrolysis), with the bromine content of the same salts as existing in the original liquors (column 3, Table II). The figures in column 4 give the proportion of bromine in the dried salts, on the basis of 100 in the dissolved salts. Column 5 gives figures for chlorine calculated on the same basis. The losses in bromine in the different samples are seen to be considerable and variable, while those for chlorine, as might be predicted, are distinctly less.

TABLE I

No.	Sample	Locality	Grammes of Bromine per Million Millilitre
A 1	Seawater	Brighton	70
2	,,	Port Augusta	96
3	,,	,, ,,	103
4	,,	,, ,,	131
5	Creek	Witchellina	53
6	Pool of Siloam	Beachport	158
7	Bore	Dry Creek	8
8	Well ?	Reedy Creek	14
B 1	Lake Butler	Near Robe	5
2	Dogleg Lake	,, ,,	9
3	Fellmongery Lake	,, ,,	21
4	Lakeside	,, ,,	43
5	Battye's Lake	,, ,,	46
6	Lake Robe	,, ,,	84
7	,, Eliza	,, ,,	201
8	,, Amy	,, ,,	231
9	,, St. Clair	,, ,,	272
C 1	Brine	Gypsum Works	353
2	,,	,, ,,	370
3	,,	Salt ,,	382
4	,,	Gypsum ,,	406
5	,,	Salt ,,	411
6	,,	,, ,,	437
7	,,	,, ,,	472
8	,,	,, ,,	542
9	,,	,, ,,	611
10	,,	,, ,,	725
11	,,	,, ,,	850
12	,,	,, ,,	927
13	,,	,, ,,	1015
14	,,	,, ,,	1249
15	,,	,, ,,	1448
16	,,	,, ,,	1569
17	,,	,, ,,	1640
18	,,	,, ,,	1647
19	,,	,, ,,	1789
20	,,	,, ,,	1932
21	,,	,, ,,	5636

TABLE II

1 Sample	2 Grms. Salt per 100 ml. Solution	3 Per cent. of Bromine in Salts, in Solution	4 Per cent. of original Bromine left in Dry Salts	5 Per cent. of Chlorine left in Dry Salts
C 6	2·76	0·159	88·5	—
C 4	2·26	0·184	82·7	—
B 7	11·11	0·217	69·1	—
B 8	6·37	0·363	81·7	97·4
B 4	1·55	0·277	—	98·2

Grateful acknowledgment is hereby made of the valuable help I have received in prosecuting this investigation. Several firms have kindly collected and forwarded samples; the Education Department and some of its country officers have also been very helpful in collecting samples for analysis.

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ON CENTRAL AUSTRALIAN MAMMALS
PART II THE MURIDAE
(Continued from 64, (I), 136, 1940)

By H. H. FINLAYSON

Summary

RATTUS spp.

No species of *Rattus* was taken in the area worked over, nor reliable reports of them obtained. However, the specimens of *R. villosissimus* described by Waite (15, 125) evidently came from a locality west of the Lake Eyre Basin.[1] and two slight anomalies in the skull measurements as compared with skulls from the latter district have already been pointed out.

ON CENTRAL AUSTRALIAN MAMMALS
PART II THE MURIDAE

(Continued from **64**, (1), 136, 1940)

By H. H. Finlayson

[Read 10 July 1941]

Plates X, XI, XII, XIII

Rattus spp.

No species of *Rattus* was taken in the area worked over, nor reliable reports of them obtained. However, the specimens of *R. villosissimus* described by Waite (**15**, 125) evidently came from a locality west of the Lake Eyre Basin,[1] and two slight anomalies in the skull measurements as compared with skulls from the latter district have already been pointed out.

The skulls have since been re-examined and the anomalies confirmed (in a reduced form). Both skulls have slightly longer molar rows, 7·5 and 7·4 as against a maximum of 7·3 in the Lake Eyre Basin, and the male skull has an interorbital breadth of 5·6 as against a maximum of 5·3. The latter skull is damaged and evidently old, and its temporal ridges are more like those of *norvegicus* than any other I have examined. In other dimensions and in non-metrical characters both are in good agreement with the eastern series.

Pseudomys (Pseudomys) minnie Troughton

This species, originally described from the Lake Eyre Basin, where it is periodically extremely abundant, was not taken in the Amadeus Basin, nor in any of the highlands adjacent to it, in the work of 1931-35; nor does it occur in any other collection from this region which I have examined. A small series, however, from the Arckaringa tablelands in the winter of 1933, about 60 miles south-west of Oodnadatta, has already been briefly noticed (3, 99).

The pelage in four is of the rich brown type common at Cordillo in 1930-31; the other two a paler grizzled buff phase approaching that of Mulka and Appamunna. Flesh dimensions of the four adults are slightly lower than the average for the Lake Eyre Basin series, but well within the extremes. The skulls are of the light and comparatively fragile type common in Appamunna collections, with both zygomatic breadth and width of brain case lower than in the larger series; they agree with these, however, in the three critical characters of molar length, anterior palatal foramina and palate length which separate *minnie* from *rawlinnae*.

The slight differences noted can have little significance as geographical variations, since specimens taken at Ooldea, 250 miles further to the south-west, are still closer to the Lake Eyre Basin average.

Pseudomys (Leggadina) hermannsburgensis Waite

Menki, of the Pitchenturra. Described (**14**, 405) in 1896 from material taken in and about the Macdonnell Ranges, subsequent work has proved its

[1] This term is used throughout these papers in the restricted sense defined by me in an earlier paper in Trans. Roy. Soc. S. Aust., **57**, 195, 1933, and excludes the greater part of the western drainage towards the lake from the Finke, Stevenson, Hamilton, Alberga, and Arckaringa Creeks. In their upper course these streams traverse areas in which the mammals are scarcely differentiated from those of the Amadeus lands, while the eastern part of the Lake Eyre Basin is a well marked natural region, distinguished both by the absence of western forms and the presence of indigenous ones.

range to extend north to Alexandria (**9**, 536) in approximately 19° south and 136° 50′ east; south to Ooldea (**6**, 318) in latitude 30° 27′ south and longitude 131° 25′ east; south-west to Rawlinna (**13**, 292), 400 miles west of Ooldea, and south-east (1, 10) to the junction of the Murray and Darling Rivers in north-west Victoria. It is absent from the Lake Eyre Basin, which is probably its eastern limit in the central areas, while to the west, in these latitudes, although no specimen has been examined from beyond Ayers Rock, it almost certainly extends to the Rawlinson Range on the Western Australian border and probably far beyond. It was not taken, however, by the Canning Stock Route expedition of 1930 through the Western Sandridge Desert.

Throughout the area between the Macdonnells and Everards, personally worked over during 1931-1935, it was widely spread but nowhere very plentiful, and on the loamy grass and mulga flats where most of the collections were made, it was out-numbered by *Notomys alexis*. It proved difficult to trap in the open country, with ordinary baits, largely because of the ants which swarm upon the traps in such areas. A few were got with bread baits in store tents at camps near the Basedow Range, where it had adopted the raiding habits of *Mus musculus*, which latter was often trapped alongside it.

The majority of the specimens were dug by the blacks from simple burrows two to three feet long and nine to twelve inches deep. Five was the greatest number taken from a tunnel, and on two occasions the gecko, *Nephurus laevis*, was found in occupation at the same time; the association is evidently well known to the blacks, as I had independent accounts of it from several localities. The natural diet seems to be entirely seeds, grass roots and small tubers; the chief constituent of the stomach contents in summer collections, particularly from the Basedow Range area, was a small dark-cased seed from the local succulent called Wokiti—a *Portulaca* species extremely abundant on flooded ground after summer rains. Sand was always present in variable, but sometimes very large amount.

The following examination is based upon 73 specimens, of which 22 are skins and skulls and the rest alcohol preserved. The series is made up of eight collections, taken at the following times and places.[2]

(1) At two camps between Wollara and the Basedow Ranges, February and March, 1932. (2) Ayers Rock, February, 1932. (3) Wollara, in winter of 1932. (4) Alpera, at the north-west extremity of the Musgrave Range, December, 1932. (5) Erliwunyawunya, Owellinna and Ernabella on the southern side of the Musgrave Range, January, 1933. (6) Chundrinna, on the northern front of the Everard Range, February, 1933. (7) Karmeena, on the southern side of the Everard Range, winter of 1915. (8) Miscellaneous specimens from Charlotte Waters, Hermannsburg, Macdonnell Ranges, Tennant's Creek, and three un-localized.

The conclusions as to reproductive activity which can be deduced from these records are similar to those relating to *Notomys alexis; i.e.*, seasonal independence of such activity and its occurrence in marked form after heavy rains. At Wollara, in February, 1932, six weeks after a heavy rain, reproduction was particularly active the collection comprising numerous growth stages from aged examples to nestlings. In this batch nearly all females are pregnant, and the frequency of litters is shown by the occurrence of heavily pregnant females still suckling nestlings. In adult males the testes are generally well developed and scrotal, or have undergone very recent retraction, leaving a prominent scrotal skin flap. Uterine embryos are either three or four, asymetrically arranged with the larger number in the right horn. In the entire series sexed females predominate in the ratio 24 ♂ : 42 ♀.

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[2] The bearings of these localities have been given in connection with *Notomys alexis* collections in Trans. Roy. Soc. S. Aust., **64**, (1), 1940, 127.

A *Laelaps* occurs, but very sparsely; and in this respect the species is in strong contrast to *Notomys alexis*, which (at the same times and places) was heavily infested.

The great bulk of the material is clearly referable to the typical race, of which topotypes have been available, but in collections from the Musgraves, anomalous examples occur which fore-shadow racial differentiation; in the sequel the data relating to these has been disassociated from that of the main series, and will be considered under Section B.

A The Typical Race

External Characters—Size, build and general appearance much as in *Mus musculus*, but the head larger and broader between the orbits when seen from above. Mysticial vibrissae to 32 mm.; moderately stout at base but the larger members terminating in an extremely attenuated almost invisible tip. Ear short and conspicuously broad; maximum length, 14·5.

The *manus* varies in size and proportions from individual to individual, and is sometimes widely different on the two sides of the same individual. Length from base of carpal pads to apex of third digit, to 6 mm. Breadth across the base of digits 2-5, 3 mm.; third digit to 3 mm. Undersurface of digits lightly haired; claws moderate and lightly fringed. Palmar pads generally well developed and high, their proportions moderately constant. Carpals, generally large and squat; outer much larger in area than inner, but not markedly elongate. Occasionally, especially in subadults, the carpals may be subequal and are then smaller than usual. The first and second interdigitals small and rounded or irregularly pyriform; the third subequal or larger than second, triangular with the apex distad and sometimes with an external accessory fold or heel, but never a separate satellite. General formula of the palmar pads therefore: outer carpal > inner carpal > third interdigital > or = second interdigital > first interdigital.

The *pes* has length to 18 mm.; breadth across base of digits 1-5, 3 mm. and across base of digits 2-4, 2·8 mm. Heel narrowed by infringement of hairs from both sides, and a few bristly hairs sometimes present in the main interdigital basin. Undersurface of toes lightly haired. Claws moderate, and moderately fringed. Plantar pads well raised; highly variable in size, shape and proportion. Metatarsals, small, round and subequal. First interdigital larger than metatarsals, but very variable, usually bluntly oval or rounded, sometimes divided into moities by a shallow vertical sulcus; second and third interdigitals generally pyriform and subequal; but in one or two examples 2 > 3 and bell-shaped; fourth interdigital obtusely oval or bell-shaped, normally much larger than two and three, but sometimes equal and occasionally with a postero-external heel or satellite. Immaturity chiefly shown by the smaller size of the interdigitals 1 and 4. The general formula of the plantar pads is, therefore: fourth interdigital > or = second = third > first > inner metatarsal = outer metatarsal.

Tail longer than the head and body except in one example, but variation as high as 25%; thin and tapering with the termination well haired. Scales on the mid-dorsum from 17 to 21 per cm. The posterior mammary nipples in functioning adults, 6 mm. from base of clitoris; the anterior 6 mm. from the posterior. The scrotum is pigmented almost black over the greater part of its area.

Pelage—The following description is drawn up from observation on living and recently chloroformed animals, supported by examination of field skins which have had no contact with liquid preservatives. Coat soft but sleek and not fluffy, texture varying somewhat with the proportion of guard hairs, which, however, are scarcely longer than the main pile; mid-dorsal length from 9 to 11 mm. On the dorsum, the basal two-thirds of all hairs is about blackish-plumbeous of

Ridgway, and the terminal one-third of the main pile varies from orange cinnamon in the brightest individuals to tawny olive in the dullest. The longer guard hairs are black-tipped and the intermingling of these three colours, in varying proportions, produces a general external colour which varies from warm red browns near Mikado's brown to much colder and darker tones, near bistre. Mid-ventrally the fur is 5 mm. long, the basal one-third somewhat paler than the dorsal plumbeous, and the upper two-thirds snow white, completely excluding the basal grey. The sides show a more or less decided brightening in colour due to the usual falling off in the number of guard hairs and the line of demarcation from the white belly is very sharp. Head slightly greyer than the back but still strongly grizzled; the extremity of muzzle and upper lip greyish-white. The ears sparsely clothed within the upper margins only, with greyish-white; externally varying considerably from greyish-brown to blackish-brown. Fore and hind limbs internally like the belly, externally like the sides. Manus and pes dorsally pure white, with a slight calcaneal darkening in some examples. Tail distinctly bicolor, darker above, the colour varying like the ears from greyish-brown to blackish-brown. The scales are plainly visible mid-dorsally, but distally the hairs lengthen and are more closely set, forming at the tip a minute but distinct dark brush both above and below.

Seasonal and sexual differences nil—age variation appreciable but subject to much irregularity; in general, subadult pelages are slightly darker and colder than in adults. Short-coated nestlings are pure white ventrally, but at the head and body, 50 mm. stage, when the coat has lengthened, the basal colour ventrally may be either white or grey, but no examples of the retention of white-based belly fur in adults have been observed.

The effect of alcohol immersion upon the colouration of this species has been much less than upon *Notomys alexis* from the same areas, preserved under exactly the same conditions. After eight years the dorsal colour is still quite close to that of the field skins, though the white ventrum has been stained yellow.

Skull and Dentition—Twenty examined. Range in variation in non-metrical characters is wide with several anomalies in the relation of skull size to body size, and of skull size to molar wear, etc., though these are less than in *Notomys alexis* and *Pseudomys minnie.*

Nasals generally rather short and broad in subadults, longer and without additon to width in aged skulls; their contact with the frontals is fairly wide and the width increases but slightly to its maximum at the pre-maxillary margin.

Braincase remarkably variable in width and shape even in examples of the same basal length from the same locality, though the more conspicuously swollen examples are all aged skulls. The zygomatic outline shows similar and probably sympathetic variation from an almost parallel-sided condition to one in which the anterior width is little more than half the posterior. Age changes in the inter-orbital constriction slight or largely masked by individual variation; the mean value for subadult skulls little if at all greater than for adults. Upper and lower points of the zygomatic plate usually vertical or the lower somewhat anterior, with the free margin slightly concave or nearly straight, never *convex* as given by Thomas for the subgenus (11,604). In immature skulls the lowest point is decidedly anterior to the upper and the condition then quite similar to that in *Ps.* (*Gyomys*) *apodemoides.* Anterior palatal foramina comparatively wide, the posterior extension variable; sometimes falling short of the anterior margin of M^1, but usually reaching about one-third the distance from that point to the lingual cusp of the first lamina. Mesopterygoid fossa highly variable in size and shape; parapterygoid with distinct external and internal walls, neither feature affording any appreciable distinction from such forms as *Ps. minnie, higginsi,* and *apodemoides.* Bullae large, swollen and subject to considerable age changes. In immature skulls the inflated portion rises almost abruptly from the hamular process, but in aged examples a low-set tubular portion separates the two. In the molars the antero-internal cusp of the upper M^1 varies much in size, prominence and exact position; sometimes decidedly less lingual than as figured by Waite (**14,** pl. xxvi, 5 *d*). It is, however, unmistakably present in all examples save one which is quite normal in other characteristics.

Flesh Dimensions—The following figures give, in mm., the range and mean value (in brackets) of: (1) adults selected as free from obvious immaturity in external characters; (2) subadults of slightly inferior bulk to Group 1; (3) a group definitely immature; and (4) two short-furred nestlings.

Even after minimising uncertainties as to maturity by segregation into several age groups and eliminating the geographical factor, the individual variation remains large within each group, reaching in some items as high as 25%. Moreover, the variation in any one dimension throughout the series, is complicated (as in *N. alexis* and *Ps. minnie*) by disharmonies in proportion in individuals—a maximum value for one dimension not infrequently occurring with a minimum value for another in the same example; this is particularly noticeable in the head and body: tail ratio. The tabular arrangement of four developmental stages brings out clearly the very early attainment of maximum dimensions of the pes, and to a less degree of the ear.

Waite's (**14, 405**) comparison of size of this species with *Mus musculus* is rather misleading; it should be stressed that *hermannsburgensis* is quite equal to the former in average bulk, and the four conventional measurements of the two species overlap so widely, that distinction by this means is impossible.

Skull Dimensions—the following figures give in mms. the range and mean (in brackets) for 6 ♂ and 7 ♀ skulls, extracted from examples of the series free from obvious immaturity in flesh characters and showing wear on all laminae of M^1, followed by the values for a subadult ♀ having H. & B. 69 mm., weighing 8·5 grammes, and with unworn molars.

	(1)		(2)		(3)		(4)	
	8 ♂	19 ♀	5 ♂	7 ♀	2 ♂	3 ♀	♀	♀
Tail	74–90 (81·5);	73–97 (84)	72–78 (74);	72–86 (79·5)	70–72 (71);	67–72 (72)	65	41
Head and Body	71–79 (74);	70–83 (75)	65–70 (67);	66–71 (68·5)	58–60 (59);	55–58 (57)	46	47
Pes	17–17·5 (17);	16·5–18 (17·5)	16·5–18 (17);	16–18 (17)	17–17 (17);	16–17·5 (17)	16	14
Ear: length	13–14 (13·5);	13–14·5 (14)	13–14·5 (14);	13–14 (13·5)	12·5–12·5 (12·5);	12–12 (12)	12	9
Ear: breadth	7–10 (7·5);	6–10 (8)						
Rhinarium to Eye	9·5–11 (10);	9–11 (10)						
Eye to Ear	9–10 (9);	9–10 (9·5)						
Weight (in grammes)	9·5–14·5 (12);	8–18·5[3] (12)						

[3] This maximum is from a female with four full-term embryos; excluding two such, the maximum is reduced to 14 and the mean to 11.

Greatest length	21·6–23·2 (22·1), 21·0–23·2 (22·1);	20·6
Basal length	17·0–19·5 (17·9), 17·6–19·2 (18·4);	16·8
Zygomatic breadth	10·7–11·8 (11·2), 10·7–12·2 (11·1);	11·4
Braincase breadth	10·4–11·5 (10·9), 10·5–11·8 (10·8);	10·8
Interorbital breadth	3·3–3·8 (3·5), 3·3–3·7 (3·5);	3·5
Nasals, length	7·4–8·2 (7·7), 7·2–7·9 (7·6);	6·4
Nasals, greatest breadth	2·0–2·5 (2·4), 2·1–2·6 (2·3);	2·3
Palatal length	10·5–11·7 (11·1), 10·4–11·5 (11·1);	10·7
Ant. Palatal Foramina; length	3·8–4·6 (4·3), 4·0–4·5 (4·3);	3·8
Ant. Palatal Foramina; breadth	1·4–1·6 (1·5), 1·4–1·7 (1·6);	1·4
Bullae	4·3–4·7 (4·5), 4·4–5·0 (4·8);	4·7
Upper Molars	3·4–3·9 (3·6), 3·4–3·8 (3·6);	3·5

B Ps. (Leggadina) hermannsburgensis cf. var. bolami Troughton

Four specimens from the Musgrave Range are conspicuous in possessing a very long pes associated with a very long ear. The three adults (all ♀) have the following range of dimensions: head and body 70-78, tail 81-92, pes 18-19, ear 15·5-17, and suggest affinity with the form from Ooldea, named as above by Troughton (**13**, 292). Brazenor (**1**, 10) has disputed the racial validity of this form on the grounds that local variation, both in Ooldea and in Central Australian material, is sufficiently high to embrace the dimensions given for both races, and that the pelage characters quoted for the southern form can be found much further north in specimens of normal dimensions, and the data given by Wood Jones for his Ooldea series certainly supports him so far as dimensions go. No specimens from Ooldea are available to me, but I find, on careful analysis of all relevant characters of the present series, that despite intergradation of individual characters, and a high prevailing rate of variation, the four specimens noted are easily distinguished from the rest by: (1) simultaneous occurrence of maxima for pes and ear; (2) larger size of the metatarsal pads and a more posterior site for the inner of the two, in the two specimens in which this can be tested; (3) the presence of all three of these features in a very immature example, which has head and body 66, tail 77, pes 19, ear 16·5. In pelage characters two of them are conspicuously cold in colour; the others quite normal.

This complex of characters makes an approach to *bolami*, as given by Troughton, and would appear to justify the view that two distinct strains of *hermannsburgensis* occur side by side throughout the area between Ooldea and the Musgrave Range. The absence of pure communities of *bolami* at Ooldea might well be due to the interdiffusion having taken place on an east-west, rather than a north-south axis, in which case its centre of origin may lie far to the west in the area from which unfortunately no specimens are available.

It should be noted that the skull of the long-eared, long-footed example from the Musgrave Ranges, here examined, differs in no way from that of its associates. Of the three skull characters quoted for *bolami* at Ooldea, the interorbital width and molar length are both to be found in numerous short-eared, short-footed examples of the typical race, from the localities listed above.

Pseudomys (Leggadina) waitei Troughton (13, 290)

Twelve specimens examined; one adult, one subadult, and three nestlings from Wollara in the winter of 1932; one adult and three nestlings from Macdonald Downs in the winter of 1933; one subadult and two extra skulls unlocalized, but probably from the Macdonnell Ranges.

The Wollara specimens were obtained by a group of natives from the Petermann Range, who regarded it as a rarity and called it Anoola. Unlike *hermannsburgensis* which greatly out-numbers it at Wollara, it makes no considerable burrow but lives and nests in shallow excavations at the base of *Triodia* tussocks.

The adult female of this batch was lactating and the three associated nestlings were probably hers; the subadult female was pregnant with three embryos, two in the right horn of the uterus, one in the left; the Macdonald Downs female was also lactating and associated with three nestlings. Of the nine which can be sexed, seven are females. Stomach contents in the Wollara examples consisted of coarsely granular reddish vegetable matter and some sand.

External Characters—Head and body length about as in the largest examples of *hermannsburgensis*, but the body bulkier, thicker set, with stronger limbs, Head much as in the latter species; the ear length to 14 mm.; mysticial vibrissae to 30 mm.

Manus large and heavy; length from base of carpal pad to apex of middle digit 7·5; breadth across base of digits 2-5, 3·5 mm.; third digit to 3 mm.; claws of moderate length and well fringed. Pads of medium size but sharp cut and high; outer carpal longer than inner but the disproportion in area less than in *hermannsburgensis*, and the third interdigital rounded and not triangular. Pad formula: outer carpal > inner carpal > second interdigital > third interdigital > first interdigital.

Pes—Short, broad and strong; length to 17·5 mm.; breadth across base of digits 1-5 to 3·8 mm.; middle toe to 4 mm. Pads strongly developed and high, and notable for their simple, rounded and complete outlines, without trace of heels or satellites. Somewhat variable, but in the two best preserved examples the metatarsals and first interdigital are small, round and subequal, and the second, third and fourth interdigitals larger, rounded not pyriform, and also subequal, leading to the unusual formula: fourth interdigital = third = second > first = outer metatarsal = inner metatarsal.

Tail conspicuously short, ranging from 65-77% of the head and body length; scales, 27 per cm.

In the largest lactating example the posterior mammary nipple is 9 mm. from clitoris; the anterior 11 mm. from posterior.

Pelage—No field-made skins are available, and the following description is drawn up from material preserved in alcohol for eight years. Fur moderately soft in texture, guard hairs scarcely coarser than the main pile; fluffier and more sparse than in *hermannsburgensis*. Mid-dorsally the main pile reaches 9 mm. and guard hairs 11 mm.; basal two-thirds of the former coloured a medium plumbeous; followed by a subterminal band of dull ashy buff and free tips black; guard hairs black throughout. General external dorsal colour near Ridgway's buffy brown; paler, less brown and more distinctly grizzled than in *hermannsburgensis*. Ventrum creamy white to base (probably pure white in nature). Sides clearing somewhat but still ticked with black almost to the junction with the ventrum, where a narrow band of pale buff intervenes; transition much less sudden than in *hermannsburgensis* and somewhat less than in *forresti* of the Lake Eyre Basin. Head like the back. Ears pale in substance; within sparsely haired greyish-white towards margins; externally pale ashy buff, darkening to the anterior margin, where there is a narrow border of blackish-brown. Limbs externally like the sides, internally like the belly. Manus and pes originally white or very slightly greyed, and the latter with a small area of buffy-brown on the external aspect of the ankle. Tail well covered with moderately erect hairs, which do not lengthen towards the tip to form a brush; bicolor, the dorsum buffy over a small area near the base, then greyish-brown to end; below greyish-white.

The northern specimens from Macdonald Downs are somewhat more olivaceous than those from Wollara but the detailed distribution of colour is quite the same. The six nestlings are all at the dark short-coated stage, but are all more buffy dorsally than *hermannsburgensis* nestlings of comparable growth, and the ear shows distinctly the narrow dark mark on the anterior margin.

Skull and Dentition—Two examined, both ♀; one from Wollara, one from Macdonald Downs; they are in close agreement with one another and with the example figured by Waite (**14**, pl. xxv, fig. 1 *g-h*). General features apparently very close to the form of *forresti* from the Lake Eyre Basin, of which, however, only parts of one skull are available. Skull larger than that of *hermannsburgensis* in almost all dimensions, but braincase, nasals, interorbital breadth and the bullae relatively smaller than in fully adult examples of that species. In dorsal aspect the zygomata are stronger anteriorly and wider spread in their middle course, and the braincase is more abruptly expanded, resulting in a squarer outline, as mentioned by Waite. Interorbital area strongly concave and supraorbital edges levelled off in a characteristic way by a marked muscular impression and not rounded and overhanging as in *hermannsburgensis*. Temporal and occipital muscular impressions more pronounced and in the larger of the two skulls, the former are distinctly beaded, though less so than in Waite's figure. The zygomatic plate has its upper and lower points on a perpendicular and the free margin distinctly concave in its lower course, not convex, and its completed outline a shallow sigmoid. Anterior palatine foramina narrower, especially posteriorly, where they extend almost to the lingual cusp of the first lamina.[4] Upper M^1 much larger, its length exceeding the combined lengths of M^2 and M^3. A very large elongate antero-internal cingular cusp is present on the upper M^1; it is much larger and its position more apical than in *hermannsburgensis*. Incisors long; markedly orthodont.

Flesh Dimensions—Dimensions in mms. of (1) an adult ♀ from Wollara, (2) an adult ♀ from Macdonald Downs, (3) a subadult ♀ from Wollara. Head and body, 88, 83, 79. Tail, 59, 64, 52. Pes, 17, 17·5, 16; breadth (across base of digits 1-5), 3·5, 3·8, —. Manus length, 7·5, 7·5, 7; breadth, 3, 3·5, 3. Ear, 12·5, 14, 12·5.

As shown by Waite's table and confirmed by the present material, individual variation is considerable. The dimensions of the topotype, as re-measured by Troughton, can be exactly matched in the Wollara specimens, but it should be noted that the values for head and body, tail and pes, in the type are all considerably exceeded, both in Waite's series and in the present specimens.

Skull Dimensions—Dimensions of the two above females from Wollara and Macdonald Downs, respectively; both have worn molars. Greatest length, 24·1, 25·4; basal length, 21·3, 22·6; post. zygomatic breadth, 13·3, 14·0; braincase breadth, 12·0, 11·7; interorbital breadth, 3·5, 3·6; nasals length, 8·2, 8·2; nasals breadth, 2·3, 2·3; palatal length, 12·5, 14·0; ant. palatal foramina length, 5·3, 5·5; ditto, breadth, 1·3, 1·5; bullae, 4·6, 4·6; upper molar row, 4·2, 4·5.

The Wollara specimens undoubtedly represent the typical race as defined from Alice Springs, and the agreement of the Macdonald Downs specimen is also close in essentials. It is noteworthy, however, that this specimen, like that of Troughton from the Hart Range, 50 miles south, shows minor anomalies in a longer ear and probably in colouration as well, and may foreshadow a still more marked differentiation further to the north-east. From *forresti* (**3**, 101), of the Lake Eyre Basin (to which it is much closer than to *hermannsburgensis*), it is distinguished by its darker colouration, longer and softer fur, bicolor tail, longer nasals, and, in the southern part of its range at least, by its shorter ear.

[4] Waite's figure is erroneous here, as pointed out by Troughton (13, 290).

LAOMYS PEDUNCULATUS Waite 1896

Neither specimens nor recognisable accounts of this interesting rat could be obtained during 1931-5. A special sojourn was made at Illamurta on the south side of the James Range in the hope of obtaining it, but the place is less virgin than when E. C. Cowle got his two specimens there, and trapping was without result.

In working out the relationships of the succeeding species, I have re-examined seven examples; five alcohol preserved and two skulls. Three of these are of the original series upon which Waite (**14**, pl. xxv, fig. 1 *a-f*) founded *pedunculatus*, and the others are evidently of the second collection noted by him two years later (**15**, 117). All are from Alice Springs in the central Macdonnells, except one skull representing the variety *brachyotis* which is from Illamurta.

None of the males show any external vestige of a scrotum; in two females the mammary nipples are moderately prominent, but neither uteri are pregnant. The stomachs of the five in alcohol have all been skilfully extracted through a small incision in the lateral abdominal wall—probably by natives, as I have seen a similar embalming trick practiced by their children upon lizards. The sex ratio in the combined series recorded is 8 ♂ : 3 ♀.

The following notes are supplementary to Waite's generally excellent description, and may serve to bring the account of this interesting species into uniformity with those dealt with in this series of papers.

External Characters—Four of the alcohol specimens are evidently adult and are uniform in bulk and dimensions; the fifth is slightly smaller and apparently subadult. Form rather stout and short-limbed, an appearance heightened by the profuse pelage and swollen tail. Head large and long muzzled with a well-developed though not swollen upper lip and moderately prominent rhinarium. Ears large and broad. Eye apparently prominent in life. Mystical vibrissae strongly developed, stout basally and the longer members reaching 65 mm.; smaller anterior members white, the rest black with the terminal one-quarter white. The general aspect of the head in these specimens is not especially anomalous, very much as in the larger *Pseudomys* spp.

Manus stout, with conspicuously short digits and small though prominent pads. Length to 11 mm.; breadth across the base of digits 2-5, 5 mm.; middle digit, 4 mm. Backs of digits strongly haired and the short, weak claws well fringed. Palm and undersurface of digits quite naked. Outer carpal considerably exceeding inner both in length and area, and the inner faintly heeled. Interdigitals much smaller than carpals, rounded or roughly heart-shaped, and the third always with a distinct satellite postero-laterad; their relative size somewhat variable, but in the majority: outer carpal > inner > third interdigital > second > or = first. Pes very stout and tapering strongly to heel. Length to 27·5 mm.; breadth at base of digits 1-5; 6·5 mm.; middle digit to 5·5 mm. Pads, except for lower metatarsal, short, rounded, but well raised. The lower metatarsal with a variable and low posterior prolongation and a somewhat crescentic or comma shape. The upper metatarsal much smaller and rounded; first and fourth interdigitals equal, bell-shaped or rounded, with the base heeled, especially in the fourth, where it is almost a separate satellite pad in some examples. Interdigitals, second and third bluntly pyriform, subequal, or the second the larger. Formula of pedal pads, therefore: inner metatarsal > fourth interdigital = first > second = third > outer metatarsal.

Tail slightly longer than head and body, as high as 114%. Detailed shape as given by Waite, and much as in *Chaetocercus cristicauda;* incrassation variable, reaching a maximum diameter of 12 mm.; scales ventrally about 12 per cm. Integument over the swollen portion thick and fibrous but not fragile; below the derma the tail tissues are of normal diameter and apparently devoid of fat (in alcoholic material).

Posterior mammary nipple 6 mm. from base of clitoris, anterior 8 mm. from posterior.

Pelage—Rather harsh but quite profuse; mid-dorsally the main pile averages 18 mm. with guard hairs up to 25 mm., but a proportion of them are co-terminous with the main pile; ventral fur 10 mm. Distribution of colour, in the main as given by Waite, but in the unfaded examples there is a marked increase in the richness of the ground colour upon the crown and nape and tail base (clay colour to cinnamon), and the resulting external colour varies from tawny olive on these parts to Saccardos umber on the mid-back. The external colour over the whole of the ventrum is creamy white; basally it is pale plumbeous on thorax and mid-belly, pure white on gular, sternal and inguinal areas. The dark markings on the originally buffy manus and pes are still plain in four of the five specimens. The tail brush reaches 15 mm. beyond tail tip.

Skull—The two skulls examined are those used by Waite, and of these his excellent figures are apparently based upon the larger, the measurements of which are given below. The *brachyotis* skull is definitely young and with less worn molars, but does not differ in any important way; its incisors have been destroyed. In general structural characters the skull of *Laomys pedunculatus* is quite similar to that of *Leporillus* (as pointed out by Thomas (**10**, 372)), and is still closer to the larger species of *Pseudomys* s.str., such as *higginsi*. The striking molar characters of parallelism of laminae and reduction of buccal cusps are shown in about the same degree by both skulls; in the larger the incisors are stout and strongly opisthodont.

Flesh Dimensions—The following are the results of the re-measurement of (1) two adult ♀ and (2) two adult ♂, from Alice Springs: Head and body, 137, 124; 120, 119. Tail, —, 128; 130, 126. Pes length, 27, 27·5; 27, 27; breadth at base of digits 2-5, 6·5, 6·5, 6·5, 6. Manus length, 11, 10; 11, 11; breadth at base of digits 2-5, 5·5, 5·0; 5·0, 5·0. Ear, 23, 22; 23, 20. Rhinarium to eye, 20, 19; 20, 19. Eye to ear, 12, 11; 13, 11.

Skull Dimensions—Re-measurement of the skulls "F" and "B" studied by Waite gives the following figures. "F" represents *brachyotis* from Illamurta. Greatest length, 35·0, 36·8; basal length, 28·9, 31·1; zygomatic breadth, 17·0, 17·6; braincase breadth, 15·6, 16·0; interorbital breadth, 5·0, 5·2; nasals, length, 12·6; 13·3; nasals, greatest breadth, 3·5, 3·8; palatal length, 18·1, 19·3; anterior palatal foramina, length, 7·0, 7·3; ditto, breadth, 1·9, 2·1; bulla, 5·1, 5·3; upper molar series, 6·6, 6·5.

In his key to the genera of South Australian Muridae, Wood Jones (**6**, 296) makes use of the incrassation of the tail as a differential generic character. In the five examined there is marked variation in this feature and Waite mentions that the form *brachyotis* is less incrassated, as is also, apparently, the later species *woodwardi* of Thomas. While the dermal thickening is perhaps less subject to change than the fat deposits of thick tailed marsupials, it seems nevertheless an uncertain character to use in such a connection. The ear length of *Laomys*, also used in this key, is inferior to that of *Ps. minnie* and *Ps. auritus*.

Pseudomys (Thetomys) nanus Gould

Mus nanus Gould, 1857, P.Z.S. 243; Waite, 1897, Proc. Roy. Soc. Vic., N.S., **10**, 127, pl. vi, fig. 4 a-d

Mastacomys sp., Waite, 1896, Rpts. Horn Expd., II, 406, pl. xxvi, fig. d-f; *ibid*, 1897, Proc, Roy. Soc. Vic, N.S., 10, 128

Rattus or *Pseudomys* sp., Thomas, 1922, A.M.N.H., **10**, (9), 550

Pseudomys (*Thetomys*) *nanus*, Wood Jones, 1925 (in part), Mamms. S. Aust., 314-315

Pseudomys (*Gyomys*) *desertor* Troughton, 1932, Rec. Aust. Mus., **18**, (6), 293

Gyomys desertor, Iredale and Troughton, 1934, Check List Aust. Mamms., 79

Pseudomys (*Gyomys*) *desertor*, Brazenor, 1936, Mem. Melb. Mus., **10**, 74

Seven specimens examined; two skins and skulls, three in alcohol and two skulls without skins. Of these, two were obtained in January 1933, about 10 miles south of Koonapandi on the southern front of the Musgrave Range, in an area of sandy loam covered by giant spinifex, which was being worked at the time for the Maala (*L. hirsutus*). One specimen was dug by a native boy from a shallow hole, and the other I trapped some days later with a witchetty larva bait set for *Chaetocercus cristicauduta* which was plentiful in the vicinity. Of the others, one is from near Mount Crombie in the same area as the above, two more are of the Horn Expedition material from the localities in and north of the Macdonnell Ranges, listed by Waite, and two are unlocalised but are probably also from the Macdonnell Range area.

Little data is available on reproduction or habits. Of the six which can be sexed, three are ♀, three ♂. All but one are adult or advanced subadults. Two of the males have prominent testes in conspicuously dark pigmented scrota. Stomach contents were not examined, but the modification of manus and the success of the larva bait on traps, suggests that the diet may be partly insectivorous.

It is a species of strikingly distinctive characters. The Pitchenturra name is Entroota.

External Characters—Form in fully adult examples stout, short-limbed, powerful. The head with short pointed muzzle and bowed profile. Eye and ear small; the latter to 14·5 mm. with a breadth of 9·5 mm. across the trough of the pinna; rounded in outline and thick in substance; relatively shorter than recorded for any *Gyomys*. Mysticial vibrissae weak, the longest ca. 25 mm.

Manus—Details of manus and pes are based chiefly upon a subadult example in alcohol (figured) in which these features are well preserved; but the condition in adults is evidently very similar though the parts are stouter and the digits less attenuated.

Length from base of carpal pads to apex of third digit 7 mm.; width across base of digits 2-5, 3 mm.; middle digit 4 mm. Claws remarkably long, slender, sharp, and strongly curved even in the oldest examples. Undersurface of digits naked and strongly ridged; palms dusky. Pads small but fairly high and well developed; carpals plain, the outer slightly larger both in area and length than the inner; first interdigital small, rounded; second pyriform, third crudely triangular, and with a distinct heel or satellite postero-externally. Outer carpal > inner > second interdigital = third > first.

The modification of the manus, in the great length of the central digits and their claws, suggests a specialization to a probing and piercing function, though this is somewhat discounted by a similar if less extreme condition in the pes.

Pes—Tapering to the heel from an interdigital breadth of 4 mm.; third digit 5 mm. Undersurface of toes as in manus; claws sharp and long, but less so than in the manus. Plantar surface irregularly pigmented and mottled, and the pads made conspicuous by still darker pigmentation. Pads small and weakly developed; metatarsals and lateral interdigitals bell-shaped with apex distad; second and third interdigitals elongate pyriform; fourth with a low satellite; fourth interdigital = inner metatarsal > third interdigital = second > outer metatarsal

> first interdigital. Tail shorter than head and body; its length from 88 to 93% of same; mid-dorsal scales 14-15 per cm.

Pelage—The following description is drawn up from field notes upon chloroformed animals, and upon a field-made skin, having had no contact with preservatives.

Fur harsh, coat dense. Mid-dorsally the main pile is about 11 mm. long, the guard hairs 18 mm. The colour of the basal half is blackish-plumbeous, the broad subterminal band about clay colour, and the extreme tip of about 1 mm. black. The guard hairs are black throughout or have the extreme tip pale buff, and the resulting external colour is a strongly grizzled rich brown near Saccados umber, but the exact colour, as in all strongly grizzled pelages, depends on the angle of view. The dorsum of head grizzled like the back, but the ground colour both here and on the rump slightly richer than mid-dorsally. Ear, both within and without, well covered with cinnamon buff hairs; externally the buff is mixed with a sprinkling of blackish-brown especially towards the anterior margin, but there is no localized dark marking on the margin. Eye conspicuously ringed with an area of rich cinnamon. Sides somewhat paler than the back but still strongly grizzled; the transition to the belly gradual. The basal colour on the ventrum for the most part paler than on the back; the external colour at the margins of the belly similar to the sides—a lightly grizzled cinnamon buff with the slate basal colour showing through, but in the centre of the belly there is an irregular-shaped area of bright unmixed cinnamon buff; remainder of ventral surface greyish buff with the basal colour showing through. Limbs externally like the sides; internally like the margins of the belly. Carpus and manus cinnamon buff with irregular markings of blackish-brown covering a large part of both; digits greyish-white. Pes, generally cinnamon buff but a dark blackish-brown marking on the outer aspect of tarsus; digits of pes changing sharply to greyish-white, then to black at the base of the claws. Tail well haired throughout and forming an incipient brush terminally; the basal 5 mm. a rich cinnamon on all surfaces; the rest strongly bicolor, with the dorsal hair jet black and ventral, cinnamon buff fading distally into greyish-white.

Seasonal and sexual variation apparently nil, but individual variation appreciable though not great. The orbital ring which is a very conspicuous marking in the living animal, is present in all the specimens, as are also the dark markings on manus and pes. However, in one subadult example in alcohol, the curious midventral chestnut patch is absent, and in another (skinned from alcohol) the chestnut areas of ear and tail base are grizzled with black.

Skull—Five examined, including specimens C and E figured by Waite. In general aspect and many details of structure and dentition, very unlike the skulls of *Gyomys* available to me. It is strongly, even massively, built and densely ossified, and in general outline and form of braincase and nasals reminiscent of *Mus* and *Rattus*, respectively. The braincase is tapered anteriorly, not globular, and the interorbital space in adults is narrow and tubular, but not bevelled at the edges. The nasals peculiarly shaped, with a bulbous expansion anteriorly, from which they narrow rapidly posteriorly, terminating well in advance of the main labyrinth of the fronto-maxillary suture. The nasals and muzzle short and broad, and in profile strongly arched down. Lacrymals moderately large and rounded Zygomatic outline strongly tapered forward, the anterior width only half the posterior; the individual zygomata stout and strong. In the zygomatic plate the upper and lower extremities are vertically situated and the edge evenly concave in two, nearly straight in two others, and terminates above a well-marked masseteric tubercle. Anterior palatal foramina short and narrow, barely reaching the molars, their maximum width anterior to their mid-point. Parapterygoid fossa well developed and deep, with a well-marked external wall, in the only adult (figured) in which this region is undamaged, shallower in immature skulls. Bullae large, broad and much inflated. Upper molars heavy and broad, with the laminae of M^1 and M^2 feebly cusped and but slightly arched; in worn examples (as figured), the laminae are almost transverse as in *Laomys*. A variable but sometimes well-marked cingulum extends around the posterior and lingual margins as far as the first lamina, where (in the example figured) a distinct low level cusp is developed. This is absent in the other four, where, however, rugosities are sometimes developed on the same site. In the lower molars the supplementary posterior cusp is present but very reduced. Incisors short, stout and opisthodont.

Flesh Dimensions—The following figures give the dimensions in mm. of (1) an adult ♂ from Koonapandi, (2) an adult ♀ from Mount Crombie, and (3) an adult ♂ unlocalized but probably from the Macdonnell Range. Head and body, 101, 98, 107; tail, 88, 92, 97; pes, 21·5, 21, 21·5; ear, 14 x 9·5, 14·5, 13 ca.; rhinarium to eye, 14, —, —; eye to ear, 12, —, —; weight in grammes, 28·5, —, —.

Skull Dimensions—The following are the skull dimensions in mm. of (1) the above ♂ from Koonapandi, (2) the above ♀ from Mount Crombie, (3) the ♀ skull "E" figured by Waite. Greatest length, 26·6, 27·5, 25·9; basal length, 23·0, 23·6, 21·8; zygomatic breadth, post., 14·3, 14·2, 14·0; braincase breadth, 13·4, 12·9, 12·9; interorbital breadth, 3·4, 3·5, 3·6; nasals length, 9·2, 9·0, 9·1; nasals breadth, 2·6, 2·8, 2·5; palate length, 14·1, 13·9, 13·9; anterior palatal foramina, length, 4·4, 4·6, 4·4; ditto, breadth, 1·4, 1·4, 1·3; bulla, 5·5, 5·6, 5·4; upper molar row, 4·7, 5·0, 4·9.

The material here reviewed undoubtedly represents the species from Central Australia identified by Waite as *Mus nanus* Gould and re-named *Pseudomys* (*Gyomys*) *desertor* by Troughton in 1932 on the grounds of subgeneric unconformity with *Thetomys*, in which group Thomas had meantime (1910) placed Gould's *nanus*. I am unable at present to follow Troughton in this, however, both through doubt as to the unconformity with *Thetomys* and belief in its unconformity with *Gyomys*.

Under the first head, the following points may be noted: (1) Gould's plate of *nanus* illustrates the living Central Australian animal closely both in general aspect and detail; the discrepancies that exist might reasonably be attributed to omissions by the artist; the description and dimensions are also in agreement. (2) Thomas, in 1910 and in subsequent contributions, did not dispute Waite's identification of the adult Central Australian specimens, though the immature *were* questioned. (3) No description, dimensions, or figures of the skull of *nanus* appear to have been published, but Thomas's definition of the *Thetomys* skull (with *nanus* as genotype) agrees with the present material in the majority of points raised; particularly in the more normal (*i.e.*, *Rattus* or *Mus* like) form of skull, in the frequent concavity of the zygomatic plate and the deeper excavation of the parapterygoid fossa.

The evidence of the supplementary cusp on M^1 seems to me much less conclusive of affinity here than is believed. Thomas omits any mention of the number of skulls examined, and in view of the varying incidence of the cusp already shown in *Notomys*, *Pseudomys*, and even *Leggadina*, this doubt must continue until series are examined. It may be recalled that a cingular cusp does occur on one of the five skulls here examined, and that in the two examples of *Thetomys gouldi* which have been figured, it is quite absent from that of Waterhouse.

There is little evidence of regional variation. Specimens here noted are from localities about 300 miles south-west of the most southerly of Waite's series, but the agreement in all characters is close. Some minor differences in dimensions are evidently due to condition of material or method of observation; for example, the very short ear given by Waite is no doubt due to the older method of measuring the back of the pinna, and in the holotype of *desertor* (a mounted specimen) to shrinkage. No really large specimens (judged by externals) seem to have been examined hitherto, though the above holotype skull is as large as any of the present five.

Brazenor has recorded an interesting extension of the range of this species, to the Murray River in north-west Victoria, nearly 1,000 miles from the Central Australian sites.

Leporillus apicalis Gould 1853

Though the types of the species described by Gould were said to be from South Australia, its position in the fauna of the southern portions of this State remains very obscure, as records and material alike are entirely lacking. That the original specimens were from northern mallee or Upper Murray districts and not from the far north or centre is rendered very probable, partly by the circumstance that these latter were at that time for the most part unknown, and partly from the records of its plentiful occurrence ten years later in the contiguous Victorian mallee, provided by Krefft (**7**, 64) and Brazenor (**2**, 77).

The first reference to the presence of *Leporillus* in Central Australia (exclusive of the Lake Eyre Basin) is provided by Ernest Giles, who, in the summer of 1872-73 near Mount Peculiar in the north-west Macdonnells, records having seen nests of "*Mus conditor*" in a dense mixed mulga scrub. The nests were 15-20 feet in diameter and 4 feet high and contained sticks up to 3 feet long and 1 inch in diameter (**4**, 101). A month or two later, having crossed the Amadeus Basin, he again records the presence of these stick nests along the 26° parallel between Ayers Range and the Cavanagh Range. It was not till 23 years later that specimens obtained by Mr. Field at Alice Springs enabled Waite (**15**, 115) to identify the species as *apicalis*. In 1903, Basedow recorded a nest-building rat as occurring plentifully near his camp 68, south of the Mann Range.

Recent interrogation of blacks by Mr. Bowman at Glen Helen in the western Macdonnells indicates that it may still be extant in the country west of Mount Peculiar along the north border of the Aboriginal Reserve, and the Pintubis hereabouts call it Tweealpi, and the west Aruntas Turulpa. But over the greater part of the country traversed by Giles between the Macdonnells and the 26° parallel and as far west as the West Australian border, it now seems to have become rare to vanishing point, and though the blacks are well acquainted with it still and give consistent descriptions of it, I failed to secure specimens on any of the routes personally travelled during 1931-35. Several white residents, however, particularly A. Brumby of Ernabella, who had travelled much along the southern part of the Mann and Tomkinson, assured me that some of the colonies mentioned by Basedow and Giles south of the Mann and Musgrave, were still extant, and in the winter of 1933 while conducting Dr. Cecil Hackett and Mr. N. B. Tindale through the area, he found a nest under a kurrajong on limestone country eight miles west of Mount Crombie. From this two specimens were secured by the time-honoured method of firing the pile and allowing the natives' dogs to sieze the inmates as they fled.

As pointed out in discussing the disappearance of *L. conditor* from the Lake Eyre Basin, the usual explanation given by settlers of the disturbing effect of introducing stock into the rats' habitat, is quite insufficient to account for the facts. In the western centre the argument fails altogether, since the chief known former habitats of *apicalis* have never been stocked. On the other hand, a sparse but active hunting aboriginal population persisted here much later than in the Lake Eyre Basin, and the stubbornly colonial and gregarious habits of the rats render them very vulnerable to the attack by fire; there seems little doubt that the native has been the chief factor in their disappearance.

All specimens of *Leporillus* from the western centre so far examined have proved to be *apicalis*, and the most westerly record for *conditor* in these latitudes is the west shore of Lake Eyre, 450 miles east-south-east of the locus of the specimens here described. It is quite possible, however, that formerly both species occurred in the central areas; overlapping of their former habitats in Victoria and New South Wales seems well attested.

Both Mount Crombie specimens were adult non-pregnant females, with mammary nipples strongly contracted. The stomach contents were voluminous but little characteristic; for the most part finely comminuted as in such small species as *Notomys alexis* and quite without recognisable vegetable fragments or sand. The rich oily seeds of the local kurrajong (*Brachychiton Gregorii*) no doubt contribute to the diet. The dung pellets are short and obtusely oval; the largest about 7 x 5 mm. No external parasites were taken upon the preserved material.

External Characters—The only alcohol preserved material of other species available for comparison is the series bred in captivity from Lake Eyre Basin stock which I have already reviewed (**3**, 111). Compared with these, the present form is light and slender limbed. Head relatively longer and narrower muzzled and profile straight. On preservation the head has "set" upon the vertebral column almost at right angles and the ears are pricked, faithfully reproducing the characteristic "alert" stance apparently adopted by all the species. Ear apparently of much the same relative size as in *conditor;* longer than in *jonesi;* mysticial vibrissae strongly developed, as stout as in the much larger *conditor* and much longer; to 83 mm.; black with a long attenuated white tip.

Manus—Length to 16 mm.; breadth to 6·5; third digit to 6·5. Pads relatively smaller than in *conditor* of the Lake Eyre Basin and their shape more angular and puckered, though this may be due to plasmolysis. Outer carpal larger than inner, both in length and area; first and third interdigitals crudely triangular and both with heels or satellites; second crudely tetrahedral. Outer carpal > inner > second interdigital > third = first.

Pes—Much lighter than in *conditor* of the Lake Eyre Basin and with pads simpler, especially the lateral interdigitals which are less hollowed out at the base; differing in detail on the two sides of the same specimen. The inner metatarsal on the right side crescent-shaped with the concavity laterad; on the left side much straighter though of the same overall length. The outer metatarsal much smaller, evenly oval; second and third interdigitals irregularly oval, first and fourth with well marked postero-laterad heels and their completed outline bell-shaped. Fourth interdigital > second = third > first > inner metatarsal > outer metatarsal.

Tail decidedly longer than the head and body (1 : 1·2); rather thinly haired anteriorly; scales showing through plainly, 10 per cm.

Mammary nipples very posterior and close together; posterior 9 mm. from base of clitoris; anterior 9 mm. from posterior.

Pelage—In dealing with the colouration of the Alice Springs material, Waite limited himself to a reference to Gould's plate (**5**, pl. ii, 3), with which he found agreement. Brazenor (**2**) does not mention the preservation of his material nor its location, and Troughton's notes (**12**, 32) are based on old faded mounted specimens. The following description is drawn up from the skin of the larger of the Mount Crombie specimens made up after six weeks in alcohol, and it shows minor discrepancies with each of the foregoing, the importance of which it is difficult to assess at present.

Fur comparatively soft and dense and of even texture; the two constituent piles differing in length and colour, but not greatly in the thickness of the hairs.

Mid-dorsally the shorter is 18 mm. long, with its basal two-thirds dark plumbeous followed by a subterminal band of warm buff, and the extremity dark brownish black. The second pile reaches 23 mm. (though a proportion is scarcely longer than the first) and is similarly plumbeous at the basal two-thirds and the rest shining black. The resulting external colour from crown to tail base is a strongly grizzled brown near Prout's Brown, the general effect browner and less yellow than in *conditor*, and still more so than in *jonesi*. On the sides the subterminal colour fades to ivory and the black overlay is reduced, leading to a much paler and greyer grizzle. Belly fur 14 mm.; creamy white to base; junction with sides sharp. Dorsum of head like back or with a slightly richer ground colour; muzzle and cheeks like the sides with a rather conspicuous paler patch infraorbitally. Chin and throat like belly. Ears very sparsely covered within with greyish-white, externally well and evenly haired with a fine grizzle of near black and silvery-grey darkening only very slightly at the anterior margin; the ear back as a whole near fuscous and much colder and darker and more contrasted with the crown than in either *conditor* or *jonesi*. Outer aspect of fore limb like sides but with a wash of pale buff sharply interrupted by a narrow oblique grizzled black marking extending quite across the carpus; manus and digits white. Hind limb similar but with a browner wash; a grizzled black marking extending irregularly right round the tarsus, but not produced along sides of pes, which is quite white. Tail sparsely haired proximally, but lengthening distally and culminating in a pure white pencil extending 25 mm. beyond the terminal vertebra. Dorsum of tail blackish-brown for three-quarters of its length, changing abruptly to white without intermingling; lateral and ventral surfaces white throughout.

Skull and Dentition—Two skulls have been examined; the larger of the Mann Range specimens and one from Alice Springs figured by Waite. The former is considerably more aged, and is narrower, has narrower anterior palatal foramina and lighter molars, but the agreement in diagnostic features is close. The general structural characters of the *apicalis* skull are close to those of *jonesi* and *conditor*, the slight but apparently valid differences being a narrower braincase and posterior zygomatic width, narrower lacrymals, deeper muzzle, a nearly vertical and straight zygomatic plate, and anterior palatine foramina which are slightly longer than the molar rows. The lengths of molars and nasals are also lower than have been recorded for other species, and the bullae are smaller. The interorbital condition is not appreciably different. Waite's reference to horn coloured molars is evidently meant to apply to incisors. His (**15**, pl. v, fig. 1 a-c) figure does not agree very well with the skull on which it is based; the outlines of nasals and zygomata are appreciably different and the bullae are less globular.

Flesh Dimensions—The following are the dimensions of the two Mount Crombie specimens, both adult ♀: head and body, 184, 175; tail, 217, 238; pes length, 43, 44; pes, breadth across base of digits 1-5, 9, —; manus, 16, —; manus, breadth across base of digits 2-5, 6·5, —; ear, 33, 32; rhinarium to eye, 21, 22; eye to ear, 16, 15.

Skull Dimensions—The following are the dimensions of the skull from Alice Springs figured by Waite (re-measured), and that of the larger Mount Crombie ♀: greatest length, 40·5, 43·2; basal length, 35·1, 36·2; zygomatic breadth, 20·4, 20·1; braincase, breadth, 17·4, 17·9; interorbital width, 5·1, 5·2; nasals, length, 15·5, 15·4; nasals, breadth, 4·5, 4·6; palatal length, 21·3, 21·8; ant. palatal foramina, length, 8·0, 8·0; ditto, breadth, 3·3, 3·0; bullae, 7·1, 6·8; upper molar series, 7·5, 7·7.

While easily distinguished from *conditor* and *jonesi* by its much longer and pencilled tail, by its pure white belly fur and somewhat lighter build, all three species are evidently very closely allied; one of the above specimens is larger than has previously been recorded and still further closes the gap in dimensions between the species; attention may be drawn to the misprint in Brazenor's dimensions. The specimens here described show certain minor discrepancies with existing accounts, which are difficult to interpret owing to the widely different condition of the material on which they have been founded. As compared with Gould's plate of the types, the Mount Crombie examples are more grizzled dorsally, their ear backs and tail tops are definitely darker and the tail much better brushed. The colouration is definitely darker and more grizzled than the specimens of *conditor* and *jonesi* available to me, and not lighter as given by Troughton (*loc. cit.*), and the dorsal colour is browner than the tawny olive given by Brazenor.

Brazenor (*loc. cit.*), who alone seems to have examined both central and south-eastern specimens, considers them identical.

Hydromys chrysogaster Geoffrey

No specimens of this rat could be obtained, and so far as numerous enquiries show, it is unknown in the western centre by settlers and natives alike. Songer's (**8**, 9) record, quoted by B. Spencer, applies to the Lake Eyre Basin where the prevailing form has south-eastern affinities, as I have elsewhere shown (**3**, 114).

Introduced Species

Of exotic murids, *Mus musculus* seems to be the only representative. It was common, though much less so than in the Lake Eyre Basin and its numbers have never yet, I think, assumed plague proportions in the western centre. Those taken were nearly all of the dark-bellied greyish, urban types and were probably recent intruders. Several examples examined had entirely unnotched incisors as in *Pseudomys*, and rapid distinction from the duller examples of *Ps. hermannsburgensis* was not always easy.

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EXPLANATION OF PLATES

Plate X

A: Right pes of *Pseudomys (Leggadina) hermannsburgensis* cf. var. *bolami*. Imm. ♀. Erliwunyawunya. Musgrave Ranges. x 4·0. B: Right pes of *Ps.* (*Leggadina*) *hermannsburgensis typicus*. Adult ♂. Ayers Rock. x 4·0. C: Right pes of *Ps.* (*Leggadina*) *waitei*. Adult ♀. Wollara. x 4·0. D: Right pes of *Ps.* (*Thetomys*) *nanus*. Subadult ♀. Koonapandi. x 3·3. E: Right pes of *Laomys pedunculatus*. Adult ♀. Alice Springs. x 2·5. F: Right pes of *Leporillus apicalis*. Adult ♀. Mount Crombie. x 1·7. G. Right manus of *Ps.* (*Leggadina*) *hermannsburgensis typicus*. Adult ♀. Ernabella, Musgrave Range. x 5·7. H: Right manus of *Ps.* (*Leggadina*) *waitei*. Adult ♀. McDonald Downs. x 4·8. I: Right manus of *Ps.* (*Thetomys*) *nanus*. Subadult ♀. Koonapandi. x 5·5. J: Right manus of *Laomys pedunculatus*. Adult ♀. Alice Springs. x 3·0. K: Left manus of *Leporillus apicalis*. Adult ♀. Mount Crombie. x 2·3.

Plate XI

A and B: Dorsal aspects of skulls of an aged and adult female, respectively, of *Ps.* (*Leggadina*) *hermannsburgensis typicus*, both from Wollara; to show the extremes of variation in braincase development and zygomatic outline. x 3·2 and 3·4. C: Dorsal aspect of skull of *Ps.* (*Thetomys*) *nanus*. Adult ♂. Koonapandi. x 2·8. D: Lateral aspect of right manus of same. Subadult ♀. Koonapandi. x 11 ca. (The digits are artificially flexed for purposes of illustration.) E: Palatal aspect of B. x 3·4. F: Palatal aspect of C. x 2·7.

Plate XII

A: Dorsal aspect of skull of *Ps.* (*Leggadina*) *waitei*. Adult ♀. Wollara. x 2·9. B: Dorsal aspect of skull of *Laomys pedunculatus*. Adult ♂. Alice Springs. x 1·9. C: Dorsal aspect of skull of *Leporillus apicalis*. Adult ♀. Mount Crombie. x 1·6. D: Palatal aspect of A. x 2·9. E: Palatal aspect of B. x 1·9. F: Palatal aspect of C. x 1·6.

Plate XIII

A: Lateral aspect of skull of *Leporillus apicalis*. Adult ♀. Mount Crombie. x 1·6. B: Lateral aspect of skull of *Laomys pedunculatus*. Adult ♂. Alice Springs. x 1·9. C: Lateral aspect of skull of *Ps.* (*Leggadina*) *waitei*. Adult ♀. Wollara. x 2·9. D: Lateral aspect of skull of *Ps.* (*Leggadina*) *hermannsburgensis typicus*. Adult ♀. Wollara. x 3·4. E: Lateral aspect of *Ps.* (*Thetomys*) *nanus*. Adult ♂. Koonapandi. x 2·8. F: Right molars of same. Adult ♂. Koonapandi. x 8·2. G: Right molars of *Laomys pedunculatus*. Adult ♂. Alice Springs. x 5·7. H: Right molars of *Ps.* (*Leggadina*) *waitei*. Adult ♀. Wollara. x 10·0. I: Right manus of *Ps.* (*Leggadina*) *hermannsburgensis typicus*. Subadult. x 10·5.

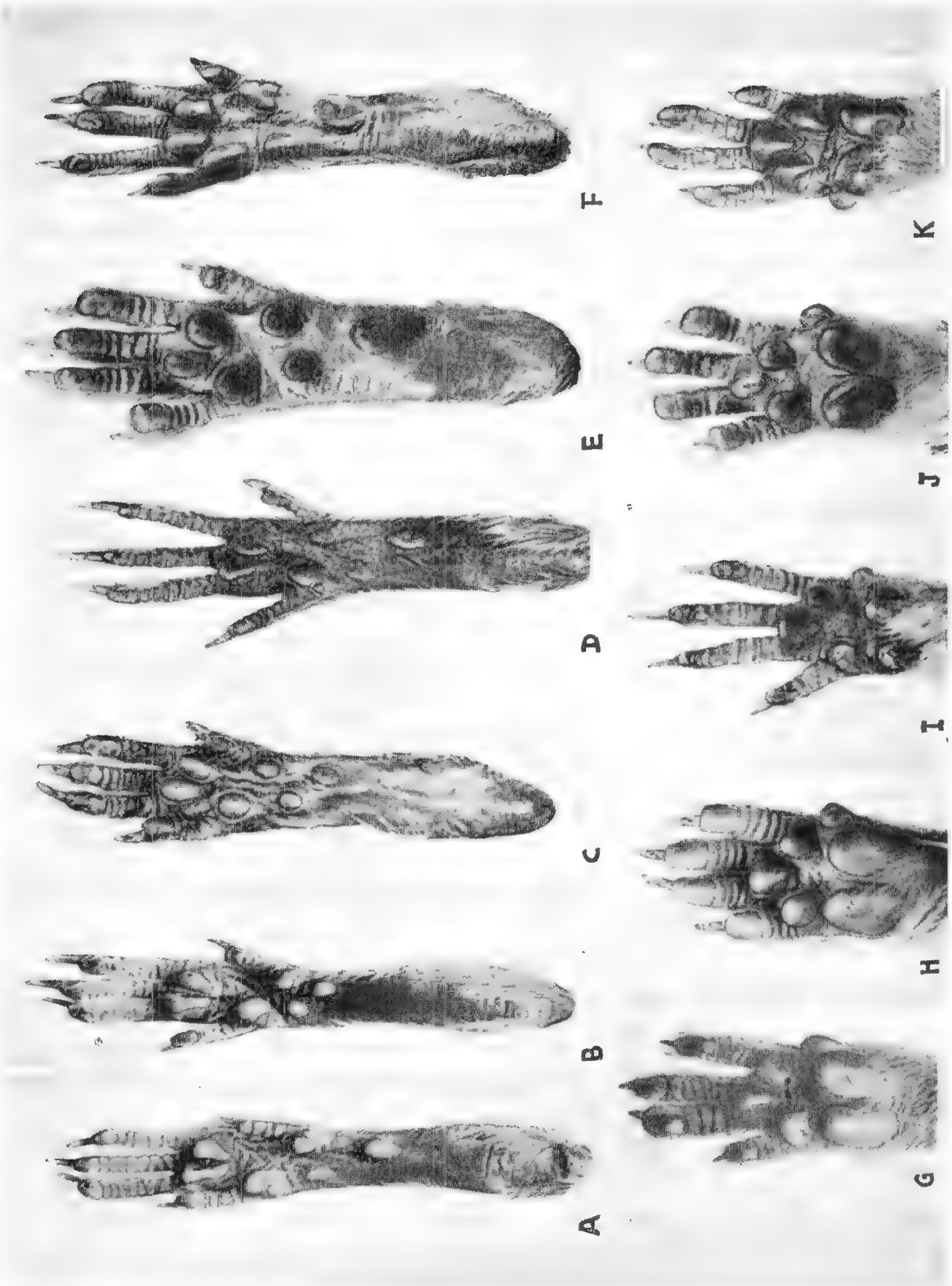

Photo by H. H. Finlayson

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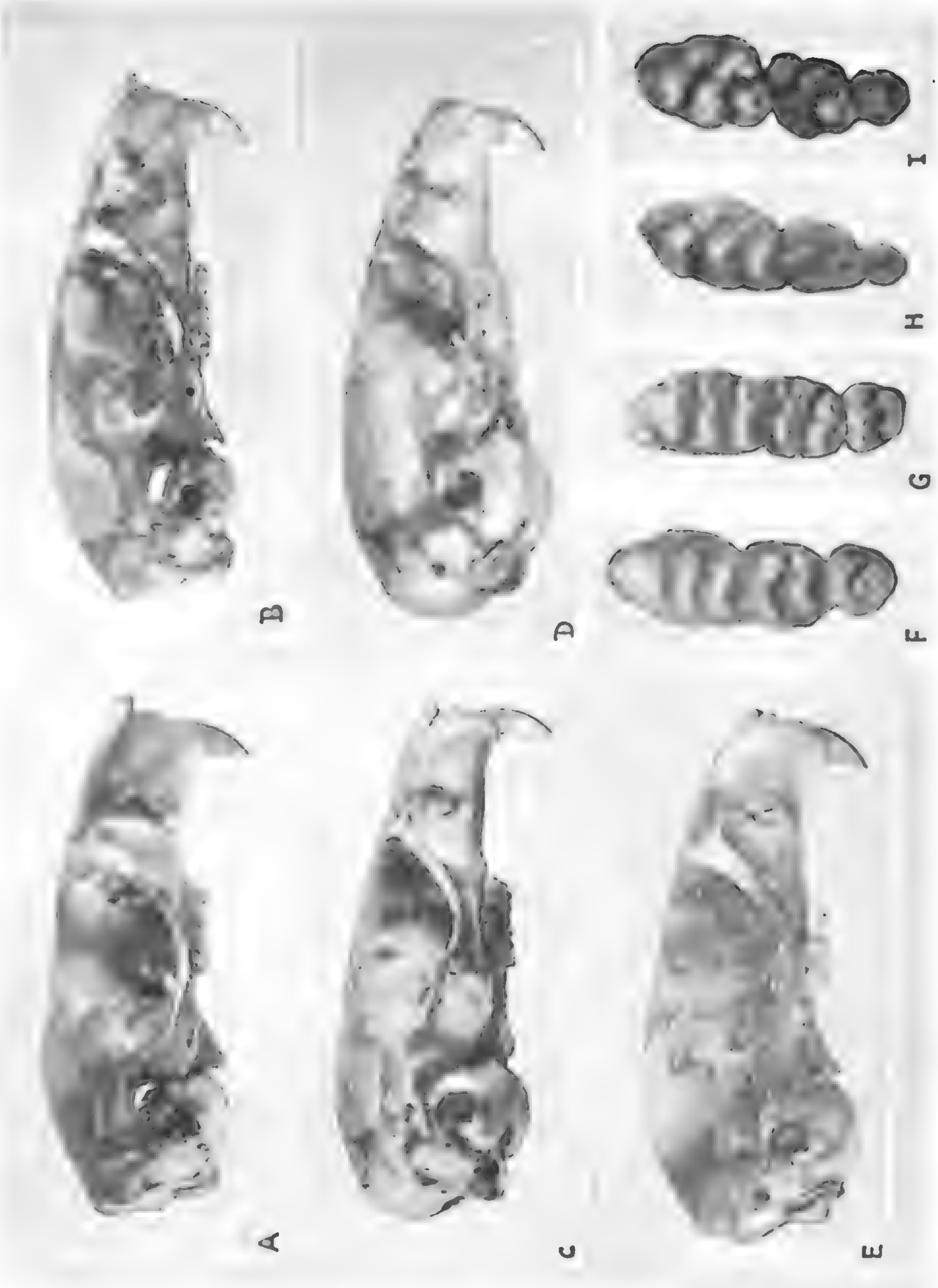

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NATIVE SONGS OF THE SOUTH-EAST OF SOUTH AUSTRALIA PART II

By NORMAN B. TINDALE

Summary

Nineteen songs obtained from Milerum of the Tanganekald tribe were described in a previous paper in these Transactions (61, 107-120, 1937). Further work has since been carried out with the same informant, whose recent death, at the age of approximately seventy-two years, removes one of the last links with the old life of the people of the South-East of South Australia

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[Read 10 July 1941]

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Electrical recording devices having become more readily available in South Australia, six double-sided discs were prepared between November, 1937, and January, 1938. The present paper presents the contents of five of these; the sixth forms part of a series belonging to the Crow Legend, which is being separately prepared. Brief notes are included concerning fresh recordings of nine of the songs mentioned in Part 1.

The fifteen new songs belong to tribes between Rapid Bay and Mount Gambier. Many belong to the Buandik ['Buŋanditj] tribe, but in one the subject matter belongs to Rapid Bay among a southern horde of the Kaurna ['Kaurna] tribe, although its language is that of the Ramindjeri ['Ra:mindjeri] of Encounter Bay. Two are of post-European origin, one describing the opening of Murray Bridge to railway traffic (about 1886) and the other recording the making of a road at Guichen Bay (Robe) in the south-east of our State, about 1865.

Several tribes are mentioned, their boundaries being defined in a paper in the previous volume of these Proceedings; where the phonetic system used is also set out.

The older (pre-European) songs of the present series are associated with: 1, sickness and death; 2, hunting; 3, mythological and totemic stories; 4, magic; 5, personal experiences and adventures; 6, drama. They touch on many aspects of native life and throw much light on the culture of the vanished folk, memory of whom has lingered only in the minds of the few survivors of the aborigines.

Disc. No. 1, entitled "Clarence Long Series, 9 November 1937."

A Dream Song

ŋ'gaw'ereila ðamburaŋal **d**'oropoalni 'bunareilar 'winmaŋal 'wereiŋ'galowei 'wudkeilin **d**'oropoalnal 'mantalaŋanar 'kulkeilin 'arupulnal 'ŋonaŋ'galowei.

This Tanganekald song has been described as No. 12 of the first series (*loc. cit.* 109); there are some variations in the transcriptions of this rendering, while ['**t**ambarŋgal] and [**t**oropoalna] were also given as variants of words in the song.

Song about Death

'Maŋgei 'nar 'galmur	'jere'gara:ŋal	'goŋaŋuna	'kara'gar
Away-in-the-west	he-made-it	listen	a-big-noise
'meiwurina:nd			
set-your-mind-on-it (beware)			

repeat these two lines then:

'Nukanji 'barnd	'bikul'aŋal	'minjuŋgul
around-and-behind	look-back	minjungulum
(Thinking about the noise)		

'na:'ramaŋg	'maldawul'u:l
what-are-they-going-to-do	ancestral being

repeat second verse. At end of the song all the men make, in unison, an explosive bo! sound.

A Marntandi (McGrath Flat) clan song, sung in Tanganekald.

This song is generally sung when people are worried and ill-at-ease, or when anyone is sick. Men and women congregate together near the camp, in the vicinity of which two rather long and heavy wooden spears have been placed up-right in the ground. These special spears [parmuri] are made of *Callitris* wood and decorated with tufts of emu feathers. Such a spear is in the South Australian Museum (registered No. A 20696). Men and women then sing this song in unison. Milerum first heard it when, as a little boy, he sat quietly in camp, while people congregated and sang it.

The meaning is: "Away in the west he makes it; listen to the great loud noise; look around about you; what is the maldawuli going to do?"

The [maldawuli] or ancestral being referred to is ['Kulda], who in native legend is believed to have come out of Ju:ki or the Southern Cross (*loc. cit.*, p. 112). Although we have no knowledge of the origin of this song, there is a possibility that it might be based on the recollections amongst the natives of very early casual visits to the Australian mainland by European vessels seeking a way to the China Seas. The appearance of the strange "being" from the south, the reference to the great noises, and the explosive sounds made at the end of the song, tend to suggest a sailing ship whose arrival or departure from the coast was signalled by gun-fire. In the original legend about Kulda, his appearance was stated to have been followed by sickness and death, and the early smallpox epidemic which swept through the Murray River districts of South Australia in the early years of the nineteenth century was also attributed to this evil being.

Song of Murray Bridge

Berntein	'geitjað	'munak':alni	'nunakunað	'jer
"It's-coming"	bridge	high-up-one	equally-high	
(the railway train)				

Tarewele'ma:ŋk	ta:'rilen	we'reindaŋ	Lenteilin
the cliffs opposite Murray Bridge township	wonderfully	made like	Long Island (a place name)

ta:'rilen	'minindjun	'ditju:ndu
wonderfully	strong	solid

This may be rendered as: "The train is coming to the great high bridge; as tall as Tarawalamank; wonderfully made like Long Island; strong and solid like Lanteilin."

This song was made between the time of the building of the first Murray Bridge in 1876 and the laying of the railway line in 1886. It was one of the last songs made by the Tanganekald people; its author was an aborigine named George Spender. Sung at a dance, it contrasts the native crossing with the white man's bridge.

Song of Njengari ['njeŋari]

'Min'arta:ŋgalau	'ŋareilkundaŋal	'kundaraŋalilau	'jiŋgaraŋal
Glad (start dancing)	dance	make-a-level-place	dust rises

'ŋeitambara	'ŋalau	'Watwardok
set-the-nets	around	'Watbardok (a fishing place north of Cape Jervis)

'ŋandei'wat	'(h)elda:nji	'wa:waŋk	'jan'a:wiŋ.
tide-rising	go-up	go-up	go-back.

Rejoice, clear the place for dancing; make a level place—see the dust fly! we set the nets around at Watbardok; the tide rises, we climb the cliffs again.

In former times an ancestral being, now the star called [Njeŋari], a great man of the Kaurna Tribe, assisted by his companions, made a dancing place on the coast at ['Watbardok]. A relative of ['Tji:rbuki] (*vide* Tindale and Mountford 1936, Rec. S. Aust. Mus., **5**, 500), he was of happy disposition and was so pleased with the place after it was clear of all bushes and rubbish, that he made a dance. Today this ancestral place is covered by the sea, and even in recent aboriginal times it was a famous netting beach. The smooth sand enabled the nets to be successfully drawn during the first hour of the rising tide. To engage in fishing one climbed down the cliffs. The fish were taken, and as the tide rose men climbed the cliffs again or risked being cut off by the rising waters. At ['Jana:wiŋ] (lit., turn back) people walking along the shore had to detour; thus the place obtained its name. ['Watbardok] is on the coast between Sections 60 and 207, Hundred of Yankalilla, close to the so-called cave of Tjirbuki, which opens on the cliff a little to the north of it.

Disc. No. 2 (22 November 1937).

Storm Song (*loc. cit.*, 110)

Words spoken, then sung. Milerum was a little uneasy with his voice and recording was abandoned until 25 November, when this song was repeated much more successfully.

Mimikur or Bullroarer Song (*loc. cit.*, 111)

This was sung as two rounds. The spoken words were not recorded.

On the reverse side.

Tanganekald Death Fear Song (*loc. cit.*, 111)

In singing this song, Milerum was uneasy and somewhat uncertain, as was indicated by his subsequent comment: "I nearly went out of tune."

Song to Force a Widow to Re-marry (*loc. cit.*, 117)

This was sung through and recorded twice, the second time with hand clapping; the conclusion seems rather uncertain, but Milerum claimed that it was correctly executed.

Tanganekald Growling Song (*loc. cit.*, 117)

Milerum was well satisfied with his new rendering of this song.

Disc. No. 3—"Clarence Long Series, Coorong, South Australia, 30 November 1937."

Tanganekald Song about Ngurunderi (*loc. cit.*, 115)

In singing this Milerum used the forms [Toŋga'reinar] and ['Taŋga'reinar] for the word previously transcribed as [Thuŋareinar].

Tatiara Song Condemning the Tanganekald (*loc. cit.*, 117)

At the conclusion of the new rendering of this song, accompanied by boomerang clapping, he shouted vigorously [ne'rokan], *i.e.*, die!

Meintangk Answer to the Tatiara Song (*loc. cit.*, 118)

Tanganekald Song which Embittered the Quarrel (*loc. cit.*, 119)

Disc. No. 4—Same series. Songs of the Buandik ['Buŋanditj] Tribe, Robe. South Australia, 2 December 1937.

Song of Guichen Bay

'Endjeligatjun	ŋarum	gamun 'ga:wun (repeat)	'mola'pan
Place-name-at		stand-and-look-around	(mo:lakinju, to turn when walking)

'Wiŋgau	'gaduba	'kutjubei.
Place-name	moving towards	Guichen Bay.

"Standing on the hill (at Watul, swamps on Section 472, Hundred of Waterhouse), we see the winding track. To walk around to Wingau we head for Kutjubei."

This song of the Post-European period tells of the old road to Guichen Bay (Kutjubei, as pronounced in this song) and was originated by Patpul, of the ['Buŋanditj] Tribe, whose home was at Robe.

The old native track from Watul to Wingau wandered through the sandhills and along the beach. White men cut a new road to the Salt Lakes where it turned west towards Wingau. The construction was authorised in 1865, and this dates the song as in the late '60's. ['Wingau] is the old native camp within the present township site of Robe, beside the fresh water lake. The Tanganekald called the place Windau. ['Kutjubei] = ['Kutjubeia] (native acceptance of Baudin's name, Guichen Bay) was applied by the natives to the vicinity of the salt lake near Section 299, Hundred of Waterhouse, its former name having been lost or discarded. Incidentally, [Pa'ram:eja] or ['Purami'ja] was the name for the Bluff at Robe, the former camp was where the old jail stands.

Song of Baudin Rocks

'Tuŋuna	'bial 'bial	'ŋawurinje
Look-out (from Kripangulu, near Mount Benson)	Place name (Baudin Rocks)	"big island"

'gari bu:l	(h)'edno	'garibi'o:ŋi	'maiba.
a few long steps (emu strides)	etenoija full of rage	and stepping out. (gari = emu)	

The meaning of this song, word for word, was obscure to Milerum. It has only a few words in it but "a great deal of meaning." It is connected with a legend of the "Emu and the Native Companion." The song tells how the emu people were trapped on Baudin Rocks by a sudden rise of water, supposed to have been caused by the native companions, who watched from Kripangulu and saw the enraged male parading about ("stepping out") in a display of anger at the trick played on him by his traditional enemies.

A Bunganditj Mimikur (or Bullroarer) Song from Mount Gambier

'Matujeire	'wat paiju	baŋara:na:	'anjaŋ	'koinja
A woman's name			came home at last	

'mor 'waŋunjup		'je:garam 'muŋungein	
they've come together		woman departs from camp (seen by husband)	

'weijan'gori	dolamboinja	anjeŋkoinja	*repeat.*	Ne'rokan!
weijankar	refuses	come back to her home		Die!

This song has come down from the remote past. It tells of an ancestral woman, Matujeire, who abandoned her husband and went with another man; it is a bullroarer-magic-song, sung whenever there is any trouble between man and wife which may lead to boning and revengeful killings. Matujeire left her husband; she went with another man; her friends said, "Carry on, we will keep your husband's anger away." A quarrel developed. Other friends said, "Listen to your husband, you have a good man, don't heed those bad men friends of yours." The incidents of this traditional event were enacted as a dance, made topical by being applied to new instances, "pieces" being put in to "make it fit." "Old songs properly used mean a great deal" and make the new troubles "come right." In singing the song Milerum ended it with the appropriate expression of condemnation.

As remarked previously, the force of community control was strongly fortified by the use of song and the power of ridicule in them.

A Bunganditj Hunter's Song from Millicent

'Wialpunul	'gurinje	'galpe'mun	'wareindji
Rise-early	good hope	crawling	thighs and knees
	full of hope		crawling on knees

'buri:n bar'elinje	danbalawan
could not get near	something follows
	(bad spirit or bad will of someone on camp)

'galajeir.
pick up (weapons, galajera) for a quarrel.

"Early morning, rising full of hope for game, crawling on knees all in vain; evil wishes are following; pick up weapons for a quarrel."

An old song, first heard by Milerun when a youth. It was sung by old men of Reedy Creek, who obtained it from the Bunganditj people at a gathering at Millicent. It describes how early in the morning a man goes out hunting full of hope; he smokes himself over a fire to remove scent and evil influences, prepares and smokes his weapons also; with sufficient weapons to ensure good fortune, he sets out in high spirits; unable to come near game even by crawling, he returns to his camp in quarrelsome mood. With its staccato and impressionistic recording of the changing moods of a hunter's day, this native song reveals a mature, if primitive, style.

This hunting song was followed by an associated dancing song:

Bunganditj Dancing Song from Millicent

'Wiraŋinj 'go:ta	'Moro'bia	Moto:n
What's wrong?	I'll fight him!	come here
(says the wife)	(says the man to himself)	

'golen'en	'waðaware	'iŋama:	'denmau
man's name	everyone	watches	comes out
			(the other man)

laŋenje	'warai 'warai denbula 'waŋan 'warai 'warai
rush together	what's the trouble about (they ask)

'denbula	wananji	bulinji.
what's the trouble		dust.
(others come to fight)		

"What's wrong?" asks the wife. "I'll fight him!" he mutters. "Come here, Golangolan." Everyone watches; out they step; they rush together. "What's the trouble?" they cry. All rush to fight. "What's the trouble?" Dust flies.

The song describes how the unsuccessful hunter vents his spleen and causes a general fight among those in camp; some rush into the scrimmage even before they have learned its origin.

Bunganditj Emu Song from Mount Benson

(one of a type called ['Wakan'ŋadeik] ([menpurumi] of the Tanganekald), sung and acted, like a staged play).

'Waŋaja:ndjelaŋ	'waiga'waren	'gol'gol	*repeat*
Early-morning	I cannot travel far	eggs	
	(says emu female)	(within me)	

liŋamun	'ŋidia	'gindawiri:ŋ	'ga:wen
beware	eagle	don't go far away	be careful

'waŋejaindjela	'waiga'waren	'gulu:r	'liŋamun	'ŋidia
early morning	not travel far	eggs	beware	eagle
		(gol gol)		

'gandawereiŋ	'ga:wen.
don't go far	be careful.

This describes incidents in the "Story of the Emu," an important myth of the Buandik people. Two emus were walking along the Mount Benson Range. The female was heavy with eggs.

"We will go to that range and make a nest," she said. It was a rather open place with a few mallee trees and bushes. From the next range she saw a place with bracken ferns ['mol:ari], "That will do." At the same moment she saw an eagle's nest above it in the trees.

"He will not harm us," they said to themselves, and made their nest. One egg came. The male eagle swooped down and looked at the emu woman. The other eggs came. She used to feed all day while the male sat on the nest. He went out at night to feed, returning by devious tracks to the nest at dawn. With the young ones came trouble; the emus were kept busy defending their young from the eagle. The song is one of warning. "Women, beware of the 'eagle' who comes to look at you."

Disc No. 5—"Tanganekald Tribe, Coorong, South Australia, 21 December 1937."

A Second Bunganditj Emu Song, called Kupabina, from Biscuit Flat

'waŋa 'jandjelaŋ	'waigawaren	'golu:r	a:n 'dakinjin
Early-in-the-morning		eggs	look-around-quickly
(hear noise of eagles)			

'jira	dumaŋi	'ŋiraŋgo:nj	jondinj	'baŋar 'baŋar
start-up	rush-in	fighting	jumps	determined
(to guard)			(eagle)	

ŋawei we:r	'dakinjin	'jira
return to attack	look around	start up (take up position of guard when surprised)
(giving no peace)	(as if surprised)	

dumaŋi	'ŋiraŋgo:nj.
rush in	fighting.

This is a short song; sung through once. Sticks were used to beat time. It ends with the [wi! wo!] flourish common to several other songs.

Both male and female emu had to share in the defence of their young; the female broke her rule of staying away and feeding all day, for both birds had to protect their young ones against the onslaughts ("jumps") of the eagle. The emu man who sang it was Patpul's brother (sociological) who was also a brother to Wati, the hero of several songs mentioned in Part I of this series.

A Third Bungonditj Emu Song, called Wirawiruk

Bapindj	garapun	maŋin	ŋidi	bapindj	garapun
mother	emu	hovering	eagle	mother	emu

warawara	garibun	moribi ŋawuru.
legs	emu	defeated.
(legs fighting)		

Sticks were used to beat the time; the tempo slows towards the end and terminates with the wi! wo! flourish.

When an emu falls down on its back and strikes out with its feet it can hit with considerable effect. The emu man who made this song watched one in combat with the eagle and sang this song about the adventure.

"The mother emu and the hovering eagle; the mother emu and her fighting legs; the emu has defeated it."

These three emu songs (Discs 4 and 5) form a suite which were sung at an emu dance. The names applied to them have the following significance and the same terms are, in general, used for the three recognised types of dancing song:

['kupabina]—imitative dances in which the performers simulate the movements of the emu, prancing about, growling and making noises; the song is a general accompaniment.

['wakan'ŋadeik]—the ['menpurumi] of Tanganekald, also called ['ŋuluŋulu-kana:mb] because each part of the song is enacted. In the present case they dramatise the behaviour of the emu and the eagle when in opposition.

['wire'wiruk]—the songs of the true dancing climax; the men stand in one place with legs outspread, vibrate their legs and give loud grunts as the chorus of women chant the ['wire'wiruk].

Marditjali Tribe Song of Wanangan, from Wirriga

'Gumba'wanaŋg 'bere	'gumba'wanaŋg	zbere'il	(*repeat*)
(meaning uncertain)			

'jurupe'na	'wiri'gara	'peire'gara(ŋ)	'wanaŋgan
for a little while	from Wirriga	for always	man's name

'Wiri'gara.
from Wirriga.

In the [Kaŋgarabalak] language. It is sung through twice; the second time is merely a repeat to fill this disc.

['Wanaŋgan 'Wirigar], a man of Wirriga Siding (*lit.* Wanangan, of Wirigar), a place near Bordertown in the Marditjali (Kangarabalak) country, left his home intending to stay for a short while on the Coorong at Woods Well to try and obtain a wife, eventually marrying a father's sister of Milerum. He was old when Milerum was a boy and never went back to his own country. There were many quarrels with his people because of his departure and because the taking of the Tanganekald woman as wife upset arrangements for marriages in his own country. Many "strong words" were said about him and there was a "native court case." The Tanganekald people would not allow their woman to be taken inland because of the trouble her marriage had aroused.

Wanangan sang this song whenever he was asked why he had left his own country. From his father's sister's husband Milerum learned this and several other songs. The refrain is probably old, having been sung in the "wild" times before the Coorong was settled by white people.

Reverse side.

Challenge Song of the Pot-bellied Dwarf, Banguni

'ŋiltji aŋunum	buŋun'a:ndu	'ŋeitje'ŋampen
No-fear	come-on	preparing for action (quivering his body)

'ŋeitje ŋampen	'ŋoroi	uru	'ŋanin'au
	"Look	at him!	he is clever"

(An onlooker says, "Look at him (dodging those spears), he is good!)

'lunel	'ŋana(m)bitj	'gamp	'wutiŋkari	'ma:k
move on	they say	daring (taking chances)	frog	jaw

'ban'gunul	ai	'ta:wen.
pot-belly	it weighs him down.	

It belongs to the ['Poŋora:rpuli] clan of Milang, one of the clans of the [Warki] or [Warkend] tribe on the eastern side of Lake Alexandrina. Their language is scarcely more than a dialect of ['Jarilde'kald].

Banguni, swollen belly, was a dwarf with distended abdomen and heavy hanging jaw. This song is attributed to Banguni and his brother ("men from the same fire"). The incident it records happened when Banguni challenged a group of ['Ra:mindjeri] men, from Goolwa, his [wurek:end], who came to quarrel with him because "of woman trouble." He had married a Ramindjeri woman named ['Regul'dindjeri] and had severely punished and injured her in a quarrel, and they wished to retaliate.

Milerum's explanation was: "I have no fear, I don't care for them," said Banguni, and prepared for action, "cutting capers" and "rolling himself up," ready for a spear-fight. His actions made them frightened; he stood still while they threw spears at him, never flinching although they came right up to him (*i.e.*, to within about ten yards). "Look at him, isn't he good at dodging them," shouted the onlookers. His enemies shouted, "Move on!—look out for side shots!" and tried to trick him by making him glance aside. They shouted in derision, trying to break his defence. "Look at him, the frog-mouthed man with the pot-belly, it weighs him down."

Banguni proved that he was a man who could not be caught with spears; afterwards he and his brothers made this song about the incident. He lived to be a very old man and sang the song of his own prowess until his death, about the year 1915.

Keinindjeri asks for His Brother's Widow—A Ramindjeri Song from Encounter Bay

'Moŋein	a:	wereindeŋ	(ai)	'ŋalai'keren
Wondering	what	is holding	her	of Nalaikorombar
'kalde	'einaŋand	'meiŋga:	'joroi'jot	'to ðel
talk	says	inside me	influences (someone else's word is persuading her)	

'ŋarail'keili	(h)iar	'toil'kolon
those of Ngarailkeili (A place at or near Section 191, Hundred of Waitpinga)	their camp	their talking (persuasion)

wa'reindelen	'teibangani	'kuin'kunj	'monak':alen
holding her (they've persuaded her)	(teipak:ani)	Bluff	high up one.

A ['Loŋoni] clansman, of Goolwa (Ramindjeri tribe), and ['Keinindjeri], a youth of the [Kaŋgeilindjeri] clan (Tanganekald Tribe), were made "red men," *i.e.*, were initiated and painted with red ochre, together. They were thus [wu'rek:uðulu] or [wu'rek:udulu] and called each other [we'rek:nd] or ['wurekend], *i.e.*, brothers. The Longoni man received in marriage a Rapid Bay tribeswoman whose country was west of ['ŋalai'korombar] (West Island) at [Tarewareŋ]. This woman's totem ['naitje] or ['ŋartjeank] was the ['ŋarak:ani] or gummy-shark and her totem place was [ŋalaikorombar] (also called ['ŋarailkeili] and ['ŋalaikeren] in the song). It was in her right to give men permission to go to West Island on rafts to kill seals.

It is the privilege of a man's brother, his ['la:wari], to say whether or not he will take his brother's widow as wife. When the Longoni man died she was Keinindjeri's by right and it was recognised by her relatives that she should go up the Coorong to Keinindjeri when her period of mourning was over.

Keinindjeri went to Rapid Bay to fetch her but he had no chance to get near her and was too frightened to ask, leaving it to the woman to come to him, when she willed to do so. But she kept away.

So Keinindjeri sang this song at a gathering of people at Goolwa. He wanted to make her explain why she had not come to him when he had come to Rapid Bay to marry her.

The song says:

"I wonder what holds her; holds that woman of Ngalaikaran; inside me I feel that someone is pursuing her; those people of Ngarailkeili hold her in their camp with their talk. I wait high up on the Bluff Lookout; watching for her."

In the song he mentions no names, only the woman's country; everyone knew for whom it was intended.

The widow answered the challenge of this song. She said she was waiting for another old man, ['Djorok:ori] to claim her; he already had a wife but wanted the widow as well. She hadn't told Keinindjeri and now, she complained, he had made it all public in song.

Keinindjeri then challenged Djorokori, who after a quarrel cleared himself of any imputation or intention of taking the woman as wife. It had looked rather bad for him because he had lived with the Rapid Bay people quite often. People said, "Keinindjeri is the right man." So the widow went to Keinindjeri and lived with him for many years; sometimes together along the Coorong.

Milerum first saw this Ramindjeri woman when he was a small boy (about 10 to 12 years of age); she was then old and had been married to Keinindjeri for many years.

The Ramindjeri people along the south coast of Fleurieu Peninsula possessed different species of shark as totems.

In the song there are several indirect references. For instance ['Kuinkunj] meaning a "lookout"; in this instance it refers to the Bluff at Encounter Bay; the Tanganekald word is ['pop:aldi] and along the Coorong this term is applied to certain high sandhills (such as the one just above Cantara Station House); the term there belongs especially to inland sandhills where men kept watch and had their camps.

SONG OF THE SWALLOW, WATIARI AND THE RING-TAILED MOUSE, LEPIDAWI

'Tawa'lanar	'garndindj	'nane'pundun	'kandjalje'arnd
How-far	how-much	set-off-again	look-back

'monak':al the-high-up-one (anything high up, *e.g.,* Mt. Lofty)	(ai)	'Watare'beriŋ Mt. Hayfield (whence the ancestral being Tjirbuki emerged)

'tetjo:nda	'malant	a	'wata'jarul
stopped	"all-of-us"		the-two

'tawula'nan	'nambar	'niŋgi'leir
distant-noise-away-in-the-scrub	what's that	I wonder

'tawul	'narnamb.
distant noise (contrast with tawalan = "how far?")	what is it?

This song was listed without description (*loc. cit.,* 120).

It belonged to an old man named ['Kaltaŋanuru] who originally came from the Coorong at McGrath Flat. He was a mother's brother of Milerum (classificatory, or in informant's words "near enough," as her father and his father used to "sit around the same fire").

He married a woman from "Cape Jervis, near Yankalilla," and lived with her at ['Lat:arŋg] (Section 19, Hundred of Goolwa). His father died, and his father-in-law was good to him. He asked his son-in-law to go with him to ['Jankalja'wa:ŋk] (Yankalilla), where he lived for so many years that he learned to talk their language better than his own. They were good to him, and kept him. He liked them. When he was an old man he sang this song in his own language (Tanganekald). Men who heard him sing it were surprised because they had thought he only spoke Merildakald. Milerum saw him when he was an old man. He did not return to the Coorong until he was old, when he died there.

The song he kept as a secret for a long time, only singing it publicly when he was an old man; he made it because he was frightened by his experiences in a strange country. It may be freely translated as follows:

I

"How much further must we go? Come on—it's a long way yet. I look back to high Watarabering."

II

"The clatterings of the departing hunters cease; swallow and ringtail mouse break the silence. What's that strange noise? A lonely stranger—left wondering what the noises mean."

The first part tells of his secret fears as he travels with his new kinsfolk from ['Latarŋg] to ['Nibielarŋk] (Crozier's Hill), thence to ['Towara:ŋk] (a hill three miles north of Inman Post Office), passing ['Wata'bareiŋgi] or [Watareberiŋg], Mount Hayfield.

"How much further will they take me?" he cries, and looks back over his shoulder at the high hill which is his last known landmark. He camped at [Jankaljawa:ŋk]. Then his companions took him out to hunt in the wooded mountain gullies; he was a "sandhill-man," lost in the forest. It seemed that he kept on walking in the same place. He moved in circles; then he heard strange noises and became frightened. This is told to us in his song.

His companions found him. "Ah! Next time you had better make a smoke-fire. The swallows and the ring-tailed-mice have fooled you with their noises." His fears became a song which he sang to himself as he learned to hunt in the forest, returning to his smoke-fire whenever he was in danger of being lost.

It is to the mischievous Watiari and Lepidawi that unaccountable noises in the scrub are attributed, for it was in their totemic country, ['Watareberiŋg], that he was wandering.

The Lepidawi and Watiari are together known as ['Watajarul], a word in the dual form, meaning "the two." The Jarildekald know them as ['Lepuldawi] and ['Watiriorn]. They were ancestral men of the forest who were turned into animals.

AN ENUMERATION OF THE VASCULAR PLANTS OF KANGAROO ISLAND ADDITIONS AND CORRECTIONS

By J. B. CLELAND and J. M. BLACK

Summary

In the Transactions of the Royal Society of South Australia, 51, 1927, we gave an enumeration up to that date of the vascular plants of Kangaroo Island. Since then a few new species have been discovered there, many new plants have been recorded for the Island and various changes in nomenclature have taken place. During the visit of the Tate Society of the University of Adelaide in January 1940, further additions, were made, and this list in part prepared. The present is an attempt to bring the list as far as possible up to date.

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[Read 14 August 1941]

In the Transactions of the Royal Society of South Australia, **51**, 1927, we gave an enumeration up to that date of the vascular plants of Kangaroo Island. Since then a few new species have been discovered there, many new plants have been recorded for the Island and various changes in nomenclature have taken place. During the visit of the Tate Society of the University of Adelaide in January 1940, further additions were made and this list in part prepared. The present is an attempt to bring the list as far as possible up to date.

Introduced plants are indicated by *, and a record not appearing in the previous list by †. In our previous list there were 653 native species, of which 8 were doubtful, with 19 varieties in addition, and 72 introduced plants with 1 additional variety, giving a total of 725 species and 20 varieties.

The total now consists of 708 native species, of which 7 are very doubtful, with 23 additional varieties, and 108 introduced plants with 2 additional varieties. Three of the 8 previously doubtful species, *Gleichenia circinata*, *Casuarina Muelleriana* and *Ranunculus trichophyllus* are now recorded.

FILICALES—†*Asplenium flabellifolium* Cav., Ravine de Casoars. *Gleichenia circinata* Swartz (previously recorded as doubtful), luxuriant (5 ft. high) at Rocky River, Breakneck River. †*Todea barbara* (L.) T. Moore, Rav. de Casoars (Recorded by Wood, Trans. Roy. Soc. S. Aust., **54**, 1930.

PINACEAE—*Callitris tasmanica* (Benth.) Baker et Smith replaces *C. Cupressiformis* var. *tasmanica*.

POTAMOGETONACEAE—†*Potamogeton javanicus* Hasskarl, Karatta (in Black's Flora, (4)).

GRAMINEAE—†*Zoysia Matrella* (L.) Merrill, not *Z. pungens* Willd., as recorded in Black's Flora; forming a dense sward in damp soil, Rocky River, Karatta. †*Stipa tenuiglumis* Hughes, Kingscote, near Eleanor Station, Rocky River, December. †**Oryzopsis miliacea* (L.) Aschers et Schweinf. Many-flowered Millet Grass, Kingscote. †*Amphibromus recurvatus* J. R. Swallen, in swamps, Vivonne Bay, December 1934. *Danthonia geniculata* J. M. Black (in Black's Flora (4)—replaces the record of *D. carphoides* F. v. M.) †*D. semiannularis* (Labill.) R. Br. (in Black's Flora (4)), Vivonne Bay. †*D. setacea* R. Br. (in Black's Flora (4)), Rocky River, Hawk's Nest. †**Koeleria Michelii* Cosson, near Eleanor Station, December 1934. †**Bromus madritensis* L. †**Bromus scoparius* L., recorded by Black (1934), Kingscote, November 1933 (coll. A. B. Cashmore). †**Cynodon dactylon* Rich., Cape Borda. †**Hordeum maritimum* With.

CYPERACEAE—†*Cyperus tenellus* L.f., Cygnet River (coll. A. B. Cashmore, recorded by J. M. Black, 1935). †*Schoenus foliatus* (Hook. f.) S. T. Blake (= *S. axillaris* (R. Br.) Poir. in Black's Flora); Squashy Creek, 27 miles east of Cape Borda, March 1926, Rocky River. †*S. Carsei* Cheeseman (=*Tetraria* (*Cladium*) *monocarpum* J. M. Black) Breakneck River (in Black's Flora). †*Eleocharis* (*Heleocharis*) *acicularis* (L.) R. Br., Rocky

River (in Black's Flora). †*E.* (*H.*) *halmaturina* J. M. Black, Rocky River (in Black's Flora). *E.* (*H.*) *gracilis* R. Br. replaces *H. multicaulis* Sm. †*Scirpus fluitans* L. var. *terrestris* F. Muell., swamp at mouth of South-West River (the type already recorded). †*S. stellatus* C. B. Clarke, Rocky River, November 1924. †*S. calocarpus* S. T. Blake, Hog Bay River, 17 November 1883 (*vide* Proc. Roy. Soc. Qld., **51**, No. 11, 1940, 180). *S. productus* C. B. Clarke, for *S. inundatus* (R. M.) Poir; Squashy Creek, 27 miles east of Cape Borda, March 1926. †*Cladium rubiginosum* (Soland.) Domin, in Black's Flora, Breakneck River. †*C. Huttonii* T. Kirk, forming extensive masses in swamp near mouth of South-West River (identified by Mr. S. T. Blake). †*C. gracile* J. M. Black, in Black's Flora for Breakneck River. *Gahnia hystrix* J. M. Black, already recorded, also on limestone cliffs at the mouth of Rocky River. †*Carex inversa* R. Br., Western River (coll. A. B. Cashmore, recorded by Black, 1935).

Restionaceae—*Leptocarpus tenax* R. Br., already recorded, also Bull's Creek in Flinders Chase, December 1934. †*Hypolaena lateriflora* (R. Br.) Benth. (in Black's Flora (4)). †*Restio complanatus* R. Br., Bull's Creek, Flinders Chase, December 1934.

Centrolepidaceae—*Trithuria submersa* Hook. f., already recorded, Vivonne Bay, December. *Centrolepis polygyna* (R. Br.) Hieron. already recorded, Vivonne Bay., December. †*C. glabra* (F. v. M.) Hieron (in Black's Flora, (4) , Vivonne Bay, December.

Xyridaceae—†*Xyris operculata* Labill. (in Black's Flora, (4)), Rocky River.

Liliaceae—†**Asphodelus fistulosus* L., Wild Onion, Kingscote.

Orchidaceae—†*Orthoceras strictum* R. Br., Vivonne Bay, December. *Pterostylis furcata* Lindl., already recorded, also Rocky River (id. by Dr. R. S. Rogers). †*Pterostylis parviflora* R. Br., Emu Bay (Tepper Herbarium).

Casuarinaceae—*Casuarina striata* Macklin for *C.* sp.. *C. Muelleriana* Miq., previously recorded as doubtful.

Proteaceae—*Hakea vittata* R. Br., already recorded, scrub near C. de Couedic (as shrubs up to 4 ft. high). †*Grevillea muricata* J. M. Black (1939), a new species collected between Vivonne Bay and Kingscote, 16 November 1924, and by J. G. O. Tepper at Birchmore Lagoon and near Western Cove in 1884. †*G. lavandulacea* Schl. var. *sericea* Benth., between Kingscote and American River (coll. A. B. Cashmore, recorded by Black, 1935).

Loranthaceae—†*Loranthus miraculosus* Miq. var. *Melaleucae* Tate on *Melaleuca* at MacGillivray, recorded by E. H. Ising (S.A. Naturalist, (14), 1933, 67 and 127).

Polygonaceae—†*Polygonum prostratum* R. Br., edge of swamp, mouth of South-West River, December.

Chenopodiaceae—†**Beta vulgaris* L., Common Beet, Kingscote. †*Salicornia Blackiana* Ulbrich (= *S. pachystachya* J. M. Black) apparently, but no ripe fruits, cliffs near mouth of South-West River, January 1940.

Aizoaceae—*Carpobrotus aequilateralis* (Haw.) J. M. Black instead of *Mesembrianthemum aequilaterale* Haw. *Disphyma australe* (Soland) J. M. Black instead of *M. australe* Soland. †**Cryophytum crystallinum* (L.) N. E. Br., Hog Bay.

Caryophyllaceae—†**Silene nocturna* L., Kingscote.

Ranunculaceae—*Ranunculus trichophyllus* Chaix, previously recorded as doubtful, Rocky River.

Papaveraceae—*Papaver aculeatum* Thunb., already recorded, also at South-West River, December 1934. †**Fumaria muralis* Sond., Kingscote.

Cruciferae—†*Cardamine hirsuta* L., Rav. de Casoars, December 1934. †**Sisymbrium orientale* L., C. de Couedic. †**Diplotaxis tenuifolia* DC., Penneshaw (coll. H. Rischbeith, recorded by J. M. Black, 1935). †*Lepidium halmaturinum* J. M. Black, a new species, discovered at Rav. de Casoars, December 1934. †**Rapistrum rugosum* All. †**Cakile maritima* Scop. var. *pinnatifida* Paoletti, Antechamber Bay (recorded by J. M. Black, 1935—the typical form already recorded).

Leguminosae—†*Acacia rhetinodes* Schl. var. *uncinata* J. M. Black, growing with a few plants of the typical form at the edge of limestone at the mouth of the South-West River. *Gastrolobium elachistum* F. v. M. replaces *Pultenaea cymbifolia* J. M. Black (*vide* J. M. Black, Trans. Roy. Soc. S. Aust., 1939, 245). *Pultenaea scabra* R. Br., in opened pod, Breakneck River, Flinders Chase. (Has also been found in opened pod in abundance at Deep Creek, Fleurieu Peninsula, Tate Soc. Exped., December 1938). †**Trifolium dubium* Sibth., C. de Couedic. †**T. tomentosum* L., Rocky River. †**T. glomeratum* L., Rocky River.

Geraniaceae—†**Geranium molle* L., Rocky River.

Linaceae—†*Linum marginale* A. Cunn., Snug Cove. †**Linum gallicum* L., Kingscote.

Rutaceae—*Zieria veronicea* F. v. M., already recorded, Rocky River.

Sapindaceae—†*Dodonaea attenuata* A. Cunn. var. *linearis* Benth. In Black's Flora.

Malvaceae—†**Lavatera arborea* L., Tree Mallow, *Kingscote*. **Malva parviflora* L. (for *M. rotundifolia* L.), Rocky River.

Frankeniaceae—*Frankenia pauciflora* DC. var. *fruticulosa* Summerhayes (for *F. pauciflora*), also mouth of Rocky River.

Thymelaeceae—*Pimelaea flava* R. Br., flowers and bracts yellow, rather tall upright stems, already recorded, Vivonne Bay, December 1934. †*P. dichotoma* Schlechtd. (= *P. flava* var. *diosmifolia* Meisn.), flowers white, plants less tall and more spreading), Rocky River, December 1934.

Myrtaceae—†*Baeckea crassifolia* Lindl., Stokes Bay (coll. A. B. Cashmore, recorded by Black, 1935). †*B. crassifolia* var. *pentamera* J. M. Black (a new variety collected by A. B. Cashmore and described by J. M. Black in 1935). †*Eucalyptus remota* Blakely, Mount Taylor and North Coast.

Oenotheraceae—**Oenothera odorata* Jacq., previously doubtfully recorded Rocky River.

Halorrhagidaceae—†*Myriophyllum integrifolum* Hook f., in Black's Flora; also Vivonne Bay, December 1934. *M. Muelleri* Sond., already recorded; also Rocky River.

Umbelliferae—*Hydrocotyle laxiflora* DC, already recorded; also Rocky River, January 1940. *H. comocarpa* F. v. M., already recorded; also Rav. de Casoars, in swampy ground, December 1934. *H. tripartita* R. Br., already recorded; also Rocky River, March 1929 and January 1940. *Lilaeopsis Brownii* (L.) A. W. Hill, recorded in Black's Flora, 440, for Harriet River is considered further on 694, on Sir A. W. Hill's authority, to refer here to *L. australica* (F. v. M.) A. W. Hill. *L. australica* also occurs at Rocky River, January 1940. †**Conium maculatum* L., Hemlock, Kingscote.

EPACRIDACEAE—†*Leucopogon australis* R. Br., Rocky River, Ravine de Casoars. *L. costatus* F. v. M., already recorded, near Kelly's Hill Caves and mouth of South-West River. †*Acrotriche affinis* DC., Flinders Chase. *Acrotriche fasciculiflora* (Regel) Benth., recorded by Tate and Tepper, appears as a small form 9 inches high, with the fruit clusters less numerous than in mainland specimens; on laterite hill tops near Bull's Creek and Rocky River, Flinders Chase; it has not yet been found in flower and may be a new variety. *Brachyloma ericoides* (Schlechtd.) Sond., already recorded, Rocky River, December.

GENTIANACEAE—*Erythraea australis* R. Br., already recorded, also Rocky River (March, December). *Villarsia exaltata* (Sims) F. v. M., already recorded, appears at Rocky River in a large form and a small one—the latter perhaps *V. parnassifolia* (Labill.) R. Br., but probably from the length of the corolla *V. exaltata*.

CONVOLVULACEAE—†**Convolvulus arvensis* L., Lesser Bindweed, Western River. *Wilsonia rotundifolia* Hook., already recorded, Vivonne Bay and near mouth of South-West River, December.

BORRAGINACEAE—†**Echium plantagineum* L., Rocky River, Cape Borda, Western River.

LABIATAE—†**Salvia verbenacea* L., Wild Sage, Kingscote.

SOLANACEAE—†*Solanum fasciculatum* F. v. M., Bay of Shoals near Kingscote, January. †**Nicotiana glauca* Grah., Tobacco Tree, Kingscote.

SCROPHULARIACEAE — †**Linaria Elatine* (L.) Mill. var. *lasiopoda* Vis., Pointed Toad-flax, Kingscote. †**Bartsia latifolia* (L.) Sibth. et Sm., Kingscote.

MYOPORACEAE—†*Eremophila Weldii* F. v. M., near Kingscote (in Black's Flora).

PLANTAGINACEAE—†**Plantago Coronopus* L., Buck's-Horn Plantain, Bay of Shoals (J. G. O. Tepper, November 1886), Kingscote, Cape Borda.

RUBIACEAE—*Opercularia hispida* Spr., doubtfully recorded by J. H. Maiden, does not appear in Black's Flora for South Australia and had better be deleted. *Asperula scoparia* Hook. f., already recorded, also Rocky River (Dec.). *A. euryphylla* var. *tetraphylla* Shaw et Turrill replaces *A. Gunnii* Benth. partly. †**Sherardia arvensis* L., Field Madder. †**Galium divaricatum* Lamk., Vivonne Bay, December 1934. *G. australe* DC., already recorded, Kelly's Hill Caves, December 1934.

CAMPANULACEAE—*Wahlenbergia multicaulis* Benth., Ravine de Casoars, December 1934. This species and the next replace the record of *W. gracilis* DC. †*W. quadrifida* (R. Br. A.DC., Ravine de Casoars, December 1934.

GOODENIACEAE—*Scaevola linearis* R. Br., should be var. *confertifolia* J. M. Black.

STYLIDIACEAE—†*Stylidium perpusillum* Hook. f., in Black's Flora. *Levenhookia pusilla* R. Br., should be *L. dubia* R. Br.

COMPOSITAE—†*Lagenophora Huegelii* Benth., in Black's Flora. †*Brachycome neglecta* J. M. Black, in Black's Flora. †*B. debilis* Sond., in Black's Flora. *Achnophora Tatei* F. v. M., already recorded, Vivonne Bay, December. †**Erigeron crispus* Ponnet, Kingscote. *Vittadinia triloba* (Gaudich.) DC., for *V. australis* Rich. †*Olearia lepidophylla* (Pers.) Benth., in Black's Flora. †*O. microdisca* J. M. Black, in Black's Flora. †*O. glutinosa* (Lindl.) Benth., in Black's Flora. *O. rudis* (Benth) F. v. M., should be var. *glabriuscula* Benth. †*O. ciliata* (Benth.) F. v. M., also var. *squamifolia* Benth., in

Black's Flora. †**Achillaea tomentosa* L., Kingscote, December 1934, January 1940. †*Centipeda minima* (L.) A. Br. et Aschers., in dry swamp, mouth of South-West River, December, January. †*Erechtites arguta* (A. Rich.) DC., var. *dissecta* Benth., in Black's Flora. †*Cassinia complanata* J. M. Black, in Black's Flora. *Helipterum demissum* (A. Gray) Druce replaces *H. exiguum*. *Helichrysum decurrens* F. v. M. replaces *H. retusum* (*vide* J. M. Black, 1939). †*Rutidosis multiflora* (Nees) Robin, in Black's Flora. †**Carthamus lanatus* L., Woolly Star Thistle, Kingscote. †**Hedypnois cretica* (L.) Willd. Kingscote. †**Lactuca saligna* L., Willow Lettuce, Kingscote. *Sonchus megalocarpus* (Hook. f.) J. M. Black for *S. asper* var. *littoralis*, limestone cliffs at mouth of South-West River, January. †**Sonchus asper* Hill.

Doubtful Species—The following seven species, recorded in our previous list and in our total of 707 native species, should probably be deleted: *Zostera tasmanica, Vallisneria spiralis, Themeda triandra, Schoenus brevifolius, Zygophyllum prismatothecum, Pimelea microcephala* and *Scaevola humilis*.

ALGAE from the mouth of South-West River, Kangaroo Island:

Collected in December 1934 and identified by the late A. H. S. Lucas

Ulva Lactuca L. *Caulerpa hypnoides* (R. Br.) Ag. *Sargassum bracteolosum* J. Ag. *Cystophora platylobium* (Mert) J. Ag. *C. uvifera* (Ag.) J. Ag. *Pachydictyon paniculatum* (Harv.) J. Ag. *Ecklonia radiata* (Turse) J. Ag. *Perithalia inermis* (R. Br.) J. Ag. *Plocamium preissianum* Sond. *Ballia callibricha* (Ag.) Mont. *Nizymenia australis* Sond.

THE VARIABILITY OF THE LENGTH OF THE RAINFALL SEASON AND THE AMOUNT OF INFLUENTIAL RAINFALL IN SOUTH AUSTRALIA

By D. C. WARK, M.Ag.Sc., Waite Agricultural Research Institute

Summary

The concept of the "rainfall period," as a controlling factor in agriculture was developed by Trumble (1) (2). who regarded as "influential" all rain falling within that period. Under South Australian conditions the rainfall period, or "period of influential rainfall" was defined as that interval of time in which monthly rainfall exceeded one-third the monthly evaporation. The evaporation was determined from saturation deficiency records, where these were available, or was interpolated from reference sites. The State was divided into climatic zones, based on mean monthly figures for rainfall and evaporation, attention being drawn to the need for studies of variability within each zone.

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The concept of the "rainfall period," as a controlling factor in agriculture was developed by Trumble (1) (2), who regarded as "influential" all rain falling within that period. Under South Australian conditions the rainfall period, or "period of influential rainfall" was defined as that interval of time in which monthly rainfall exceeded one-third the monthly evaporation. The evaporation was determined from saturation deficiency records, where these were available, or was interpolated from reference sites. The State was divided into climatic zones, based on mean monthly figures for rainfall and evaporation, attention being drawn to the need for studies of variability within each zone.

The present paper gives the results of such studies, as applied to stations, with their locations in Trumble's edapho-climatic zones (1), as follows:

Edapho Climatic Zone	Agricultural and Pastoral Use	Mean Rainfall Season (Months)	Stations
1–2	Intensive agriculture, with seeded pastures and livestock husbandry	9.0	Stirling West, Mount Gambier
3–4	Livestock husbandry with seeded pasture and some mixed farming	7.5 9.0	Robe, Mount Barker, Cape Borda, Clare
5 6	Heath –5– ; cereal production and mixed farming –6–.	6.0–7.5	Strathalbyn, Port Lincoln, Waite Institute, Kapunda, Yongala, Roseworthy College
7	Cereal production, with sheep and cattle	5.0–7.5	Kingscote, Snowtown
8	Cereal production with some livestock	5.0–6.0	Streaky Bay, Fowler's Bay, Kyancutta
9	Marginal	5.0	Port Pirie, Berri
10	Arid pastoral or desert		Farina

Records were examined for fifty years or for the maximum time available. As few stations record wet and dry bulb temperatures, the choice of centres was limited. The complete absence of such records from Yorke Peninsula and from much of the South-Eastern and Murray Mallee districts was especially unfortunate.

Individual seasons were observed to be of several types:

(a) A sharp winter rainfall season as indicated from the mean monthly values.

(b) A month, in autumn or spring, with rainfall below one-third evaporation, but with overlap of rainfall from two adjacent months. (A dry period in autumn or spring is indicated.)

(c) A period of effective summer rainfall, in addition to the normal winter period.

(d) In zones 1-2 there are occasional summers, in which the rainfall exceeds one-third the evaporation for every month (*i.e.*, the rainfall is continuously effective for more than twelve months).

(e) In zones 9-10 there are some years with the rainfall for no month exceeding one-third the evaporation.

The winter rainfall seasons, including the period of overlap under *(b)* above, were examined separately and the variability of the rain period and of the effective rainfall were calculated.

The percentage distributions of the periods of various length are shown for ten selected stations in fig. 1. The greater number of these curves approximate to the curves of normal distribution, and for these the mean and standard deviation were calculated. In some cases, however, it was necessary to transform the figures to a suitable form before proceeding with this calculation. For example, in the case of Port Lincoln, the square root was used; in the case of Port Pirie, the logarithm.

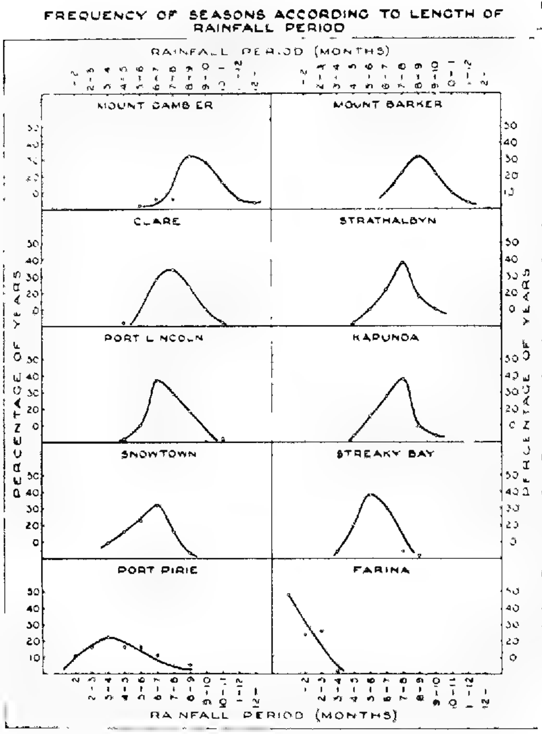

Fig. 1

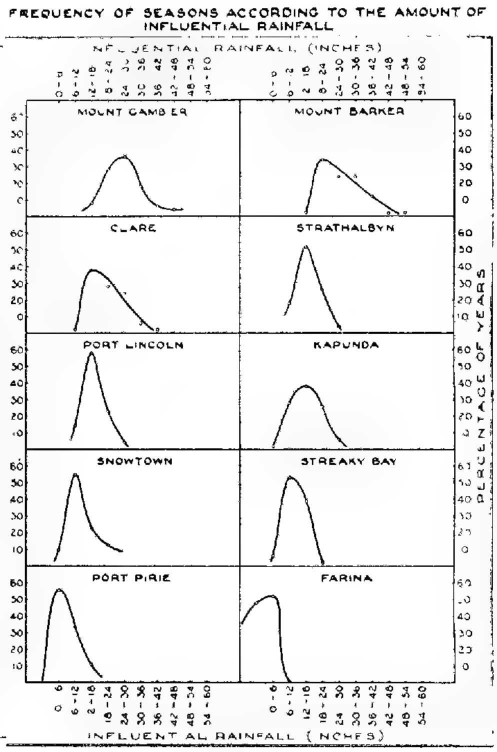

Fig. 2

The mode, and the values which will probably be exceeded in 20, 10 and 5% of the seasons have been determined for each centre. To conserve space, ten only of these centres are included in the Appendix, Table A. Thus, at Mount Gambier, the majority of years have a rainfall period of the order of 9·3 months. On the average, one year in five can be expected to have a rainfall period less than 8·1 months, and one year in the same five, a period greater than 10·6 months. In 60% of the years, the rainfall season will probably be between 8·1 and 10·6 months; in 80% between 7·4 and 11·3 months; and in 90% between 6·8 and 11·8 months.

In the case of Farina, the large proportion of years with no effective rainfall precludes the use of statistical methods employed for the other centres.

The percentage distributions of the influential rainfall, for representative centres, are shown in fig. 2. Where these differ markedly from the normal distribution, the rainfall figures were transformed to a suitable value before the mean and the standard deviation were calculated.

The mode, and the values likely to be exceeded in each direction in 20%, in 10%, and in 5% of the years are shown for ten stations in Appendix, Table B.

As certain months of the year may be critical for agricultural plants, each month was next considered separately, and individual wet months were grouped into *(a)* those within a period of winter rainfall, and *(b)* those forming a part of a short period of effective rainfall outside the winter period. The following examples (Table I) illustrate that only in occasional years does the rainfall period extend to the summer months (*e.g.*, January) in the wettest parts of the State, such as Mount Gambier.

TABLE I

Station	Percentage of years with rainfall for month included in rainfall season. Jan.	Mar.	April	July	Sept.	Oct.
Mt. Gambier	6·0	42·0 (4·0)	94·0 (4·0)	100·0	98·0	86·0
Mt. Barker	—	28·0 (2·0)	80·0	100·0	100·0	82·0 (4·0)
Kapunda	—	4·0	50·0 (2·0)	100·0	86·0 (4·0)	56·0
Streaky Bay	—	4·1	20·4	100·0 (2·0)	55·1	10·2 (2·0)
Farina	—	—	2·0	10·0	—	2·0

The figures in brackets indicate the percentage of seasons, in which the month is dry, but included in the winter rainfall season by virtue of the overlap effect.

In the agricultural districts, the winter months (*e.g.*, July) are practically always within the period of effective rainfall. The autumn (*e.g.*, March and April) and spring months (*e.g.*, September and October) show a gradation from the wetter districts to the drier agricultural districts, in the percentage of years, in which they are included in the winter rainfall period. The rainfall of the arid interior is spasmodic, but that which occurs during the winter months is most likely to be effective, on account of the lower evaporation.

Short periods of effective rainfall, outside the winter rainfall period, may occur. These are of some importance during the summer months in the higher rainfall areas. At Mount Gambier, the months December, January and February have an effective rainfall of this type in 12%, 5% and 8% of the years, whilst at Robe 16% of Decembers have an effective rainfall of this type.

Prolonged periods of favourable rainfall conditions and prolonged periods of dry weather greatly influence the production of pastures and agricultural crops, and the critical periods of the year vary from species to species. The percentage of years with the rainfall *(a)* continuously effective and *(b)* continuously non-effective (*i.e.*, drought conditions) for periods of two, three, four, and five months commencing with each month of the year, have been determined. The examples shown in Table II illustrate the trends shown by the tri-monthly periods.

TABLE II—TRI-MONTHLY PERIODS

(a) Percentage of years with rainfall effective for 3 months.

Station	Months Dec.-Feb.	Feb.-Apr.	March-May	June-Aug.	Aug.-Oct.	Sept.-Nov.
Mt. Gambier	6·0	12·0	38·0	98·0	84·0	46·0
Mt. Barker	—	6·0	24·0	98·0	76·0	36·0
Kapunda	—	—	2·0	94·0	52·0	10·0
Streaky Bay	—	—	2·0	87·7	8·2	—
Farina	—	—	—	—	—	—

(b) Percentage of years with continuous drought for 3 months.

Station	Dec.-Feb.	Feb.-Apr.	March-May	June-Aug.	Aug.-Oct.	Sept.-Nov.
	Months					
Mt. Gambier	50·0	4·0	—	—	2·0	2·0
Mt. Barker	64·0	10·0	2·0	—	2·0	6·0
Kapunda	92·0	40·0	6·0	—	2·0	8·0
Streaky Bay	89·8	73·5	16·3	—	2·0	42·8
Farina	100·0	96·0	84·0	58·0	90·0	96·0

They show that even in the wettest districts in the State only occasionally are the rainfall conditions favourable to plant growth during the three summer months, whereas a dry period of three months occurs at this time in one-half the years. All the agricultural areas are free from a prolonged dry period during the winter months.

The higher rainfall areas, such as Mount Gambier and Mount Barker, show a higher percentage of favourable conditions and a lower percentage of drought conditions at all times of the year than do the wheat-belt areas, including Kapunda and Streaky Bay.

The trends shown by the five-monthly periods in Table III are similar. Only in one-third of the years does a favourable period of five months occur at Streaky Bay, whereas at Mount Gambier 1914 was the only year in fifty in which a five month period of favourable rainfall did not occur during the winter months (May-September).

TABLE III—FIVE-MONTHLY PERIODS

(a) Percentage of years with rainfall effective for 5 months.

Station	Nov.-Mar.	Jan.-May	Feb.-June	May-Sept.	July-Nov.	Aug.-Dec.
	Months					
Mt. Gambier	2·0	4·0	12·0	98·0	46·0	14·0
Mt. Barker	—	—	6·0	92·0	36·0	6·0
Kapunda	—	—	—	68·0	8·0	—
Streaky Bay	—	—	—	34·7	—	—
Farina	—	—	—	—	—	—

(b) Percentage of years with continuous drought for 5 months.

Station	Nov.-Mar.	Jan.-May	Feb.-June	May-Sept.	July-Nov.	Aug.-Dec.
	Months					
Mt. Gambier	18·0	—	—	—	—	2·0
Mt. Barker	32·0	2·0	—	—	—	—
Kapunda	72·0	6·0	—	—	—	2·0
Streaky Bay	83·7	14·3	2·0	—	—	2·0
Farina	100·0	84·0	54·0	50·0	82·0	90·0

The percentage of years in which the summer drought extends to include the month of May varies from 0% at Mount Gambier to 14% at Streaky Bay. At Farina prolonged droughts occur at all times of the year.

The information discussed in this paper is of value in determining the frequency with which conditions favouring the growth of specific crop and herbage plants are likely to occur. The data have already furnished information as to the suitability of areas for spring-sown flax and to indicate the limits of areas of use for the raising of fat lambs.

Space permits only a limited number of tables to be included, and those included give data for only half the stations. However, a set of tables complete for all stations, and containing information on periods of two and four months, is available at the Waite Institute and will be supplied on request.

REFERENCES

(1) TRUMBLE, H. C. 1937 Trans. Roy. Soc. S. Aust., **61**, 41
(2) TRUMBLE, H. C. 1939 Trans. Roy Soc. S. Aust., **63**, 36

APPENDIX

TABLE A

Rainfall period, expressed as the mode and the probable extremes in 5, 10 and 20 per cent. of years, together with the percentage occurrence of seasonal types.

Edapho-Climatic Zone	Station	Record (years)	Mode	Rainfall Period 20% <	20% >	10% <	10% >	5% <	5% >	Percentages of Seasonal Types* (a) Temp. dry spell during rainfall period	(b) Effect. rainfall outside winter period
1–2	Mt. Gambier ..	50	9.3	8.1	10.6	7.4	11.3	6.8	11.8	16.0	16.0
3 4	Mt. Barker	50	8.5	7.5	9.6	6.9	10.2	6.4	10.7	12.0	22.0
	Clare	50	7.6	6.8	8.6	6.4	9.1	6.0	9.5	22.0	14.0
5 6	Strathalbyn	50	7.5	6.4	8.5	5.9	9.1	5.4	9.6	32.0	20.0
	Pt. Lincoln	48	7.3	6.4	8.3	6.0	8.8	5.6	9.9	25.1	22.9
	Kapunda	50	7.0	6.1	7.9	5.6	8.4	5.2	8.8	16.0	18.0
7	Snowtown	31	6.0	4.8	7.2	4.1	7.8	3.6	8.3	19.1	9.7
8	Streaky Bay	49	5.7	4.9	6.5	4.5	6.9	4.1	7.3	14.2	14.3
9	Port Pirie	18	4.0	2.7	6.0	2.1	7.4	1.8	9.0	27.9	22.2
10	Farina	50	insufficient years with rainfall effective							—	8.0

*In addition to the Seasonal Types included, 4 per cent. of the years at Mount Gambier had continuous seasons *i.e.*, there was no summer drought. No continuous seasons occurred at the other stations. 48 per cent. of the years at Farina had no effective rainfall. No year of this type occurred at the other stations.

TABLE B

Influential rainfall, expressed as the mode and the probable extremes in 5, 10 and 20 per cent. of years.

Station	Mode	Effective Rainfall 20% <	20% >	10% <	10% >	5% <	5% >
Mt. Gambier ..	26·76	20·88	32·64	17·76	35·76	15·16	38·36
Mt. Barker	28·08	22·65	35·27	19·55	38·14	17·37	41·34
Clare .	20·21	15·35	26·01	13·11	29·50	11·27	32·65
Strathalbyn .	16·08	12·22	19·94	10·18	21·98	8·47	23·69
Pt. Lincoln	17·37	13·77	21·55	12·09	24·01	10·79	26·20
Kapunda	15·14	10·51	19·77	8·06	22·22	6·01	24·27
Snowtown .	10·49	7·00	15·72	5·64	19·51	4·70	23·43
Streaky Bay	11·26	8·44	14·07	6·95	15·56	5·70	16·81
Pt. Pirie	6·00	3·10	9·71	2·27	13·25	1·73	17·35
Farina		insufficient years with rainfall effective					

ADDITIONAL NEMATODES FROM AUSTRALIAN BIRDS

By PROF. T. HARVEY JOHNSTON and PATRICIA M. MAWSON,
University of Adelaide

Summary

The nematodes recorded in this paper are mainly from water-birds. Some of the parasites were collected by Dr. J. B. Cleland, the late Dr. T. L. Bancroft (Eidsvold, Queensland) and the late Dr. MacGillivray. We are also indebted to Messrs. G. and F. Jaensch and L. Ellis for help in obtaining material from Tailem Bend, South Australia. The work was assisted by the Commonwealth Research Grant to the University of Adelaide. Types of new species are deposited in the South Australian Museum.

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The following is a list of the parasites studied, recorded under their hosts:

Pitta mackloti Temm. (North Queensland)—*Thelazia pittae* n. sp.

Chlidonias leucopareia Temm. (Tailem Bend) — *Chevreuxia australis* n. sp.; *Acuaria* (s.l.) sp., larva.

Hydroprogne caspia strenua Gould (Tailem Bend)—*Trichostrongylus* (s.l.) *incertus* n. sp.; *Acuaria* (s.l.), sp., larva.

Pelagodroma marina Lath. (Flinders Island, Bass Strait)—*Seuratia marina* n. sp.

Threskiornis (Carphibis) spinicollis Jameson (Eidsvold)—*Physaloptera* sp., immature.

Microcarbo melanoleucus Vieill. (Adelaide; Tailem Bend)—*Eustrongylides phalacrocoracis* n. sp.

Phalacrocorax carbo (Linn.) (Tailem Bend; Adelaide) — *Eustrongylides phalacrocoracis* n. sp.; *Echinuria squamata* Linst.; (Tailem Bend) *Cosmocephalus jaenschi* n. sp.

Anhinga novae-hollandiae Gld. (Burnett River)—*Eustrongylides plotinus* n sp.; (Thompson River) *Acuaria* (*Dispharynx*) sp..

Podiceps poliocephalus Jardine and Selby (Tailem Bend)—*Streptocara recta* (Linst.).

Podiceps ruficollis novae-hollandiae Stephens (Tailem Bend)—*Streptocara recta* (Linst.).

Chenopsis atrata Lath. (Tailem Bend)—*Tetrameres australis* n. sp.

Anas superciliosa Gmel. (New South Wales)—*Physaloptera* sp.

Biziura lobata Shaw (Tailem Bend)—*Tetrameres biziurae* n. sp.

Aegotheles cristata White (Tailem Bend)—*Habronema aegotheles* n. sp.

Pomatostomus superciliosus Vig. and Horsf. (Elwomple,)—*Spirura* (s.l.) sp., larva.

Trichostrongylus (s.l.) incertus n. sp.

(Fig. 1)

From the Caspian tern, *Hydroprogne caspia strenua*, from Tailem Bend. One male present, its anterior end missing; part available 2·9 mm. long, ·06 mm. wide. Dorsal lobe of bursa small; right side of bursa rather larger than left, rays on that side stouter but similar in form. Ventro-ventral rays narrow, straight, reaching bursal edge, separated from latero-ventrals; latter tapering at extremities, bent ventrad, not quite reaching bursal edge; lateral rays not reaching bursal edge; ventro-lateral blunt-tipped; medio-lateral longest, tapering to narrow tip; postero-lateral shortest, narrowest, tip bent dorsad; externo-dorsal ray not arising from dorsal, narrow, not reaching edge of bursa; dorsal reaching nearly to bursal edge, bifurcating near its tip into two short cloven branches. Spicules ·12 mm. long, with alae and ridges giving them a contorted appearance, but ending in a blunt simple tip. Gubernaculum absent. Prebursal papillae present. The form of the bursal rays and the shape of the spicules suggest that the species is closest to *Trichostrongylus*, although it differs from members of that genus in the absence of a gubernaculum and in the separation of the externo-dorsal rays from the dorsal ray. In view of the condition of the material it seems unwise to attempt to assign it more definitely in the Trichostrongylidae.

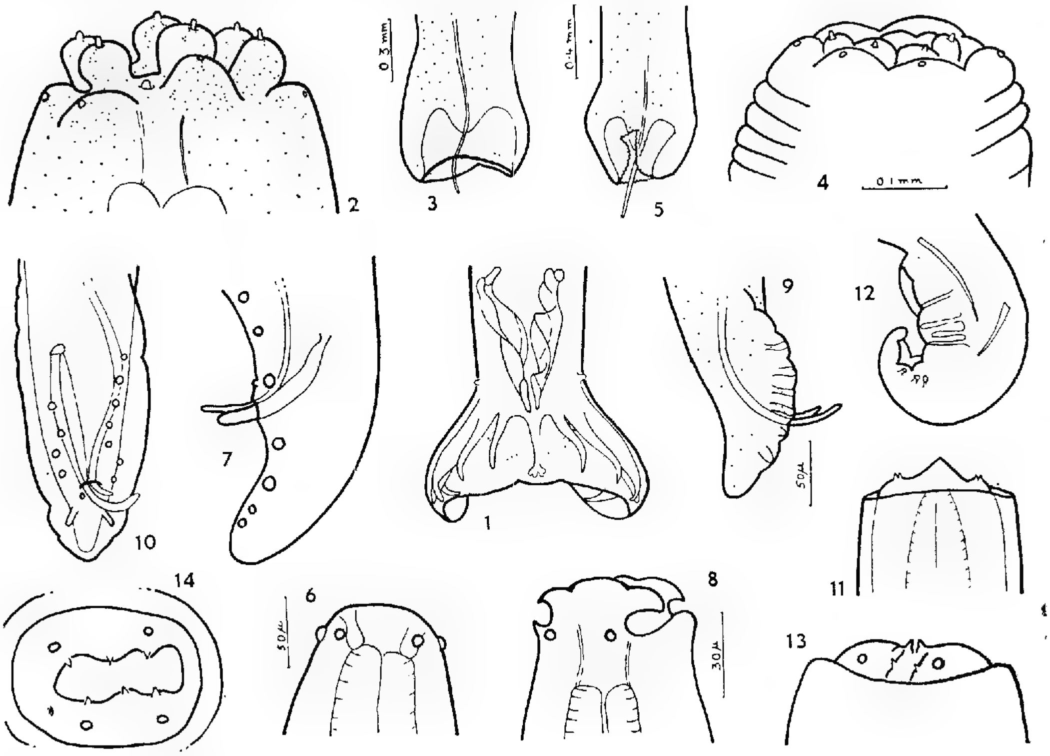

Fig. 1, *Trichostrongylus* (s.l.) *incertus:* bursa. Fig. 2-3, *Eustrongylides phalacrocoracis:* 2, head; 3, bursa. Fig. 4-5, *Eustrongylides plotinus:* 4, head; 5, bursa. Fig. 6-7, *Thelazia pittae:* 6, head; 7, male tail. Fig. 8-10, *Habronema aegotheles:* 8, head; 9, lateral, and 10, ventral, views of male tail. Fig. 11-12, *Physaloptera* sp., from *Anas:* 11, head; 12, male tail. Fig. 13-14, *Physaloptera* sp. from ibis, subventral and face views of head. Fig. 1, 9, 10, 13 and 14 to same scale; fig. 2, 4, 7 and 11; fig. 3 and 6; fig. 5 and 12.

Eustrongylides phalacrocoracis n. sp.

(Fig. 2-3)

Taken from the subperitoneal tissue of the stomach of *Microcarbo melanoleucus* from Tailem Bend (type locality) and Adelaide; and from *Phalacrocorax carbo* from Tailem Bend. Males up to 100 mm. long, ·8 mm. wide; female ranging to 130 mm. long, 1 mm. wide. Papillae around mouth very large and prominent, those of inner circle distinctly larger than those of outer circle. Six of inner circle of same size, each bearing anteriorly a short prolongation of the pulp in form of a spine; six papillae of outer circle not of equal size, the laterals taller; each papilla with small rounded prolongation of pulp anteriorly. Between each lateral and submedian papilla of outer ring is a very small rounded projection of hypodermis forming an accessory papilla. Buccal cavity ·12-·14 mm. long; oesophagus twisted, terminating 13 mm. from head, about one-sixth to one-eighth body length.

Bursa with finely notched edge; slight ventral cleft; cuticle roughened on inside. Spicule very thin, 10·2 mm. long, 1:10 of body length.

Anus in female terminal. Vulva not observed. Eggs 65 μ by 40 μ, with pitted shells.

The species most closely resembles *E. africanus* Jaegerskiold, differing in the size of the papillae, the lengths of the buccal cavity and oesophagus, and in the shape of the eggs.

Eustrongylides plotinus n. sp.

(Fig. 4-5)

From *Anhinga novae-hollandiae,* from the Burnett River, Queensland (coll. Dr. Bancroft). Males only present; the largest whole specimen 81 mm. long, 1 mm. wide. Head papillae resembling those of *E. phalacrocoracis* in shape and relative sizes, but all are smaller in relation to size of body, and therefore less conspicuous. Buccal cavity ·08-·1 mm. long, oesophagus much twisted, occupying first sixth of body length.

Bursa with finely notched edge and very deep ventral cleft. Spicule 13 mm. long in 81 mm. specimen (1:6 of body length), but in a broken worm it reaches 15·4 mm. The species is distinguished from *E. phalacrocoracis* by the relatively smaller oral papillae, the more deeply cleft bursa, and longer spicules. The two species are, however, very close, and some of the differences may be due to the method of preservation in case of *E. plotinus.* Pending the examination of fresher material it is considered wiser to erect a new species for the specimens from *Anhinga.*

Thelazia pittae n. sp.

(Fig. 6 7)

From *Pitta mackloti,* North Queensland, coll. Dr. MacGillivray. Males 14-16 mm. long, ·4 mm. wide; females 18-20 mm., by ·54 mm. Head with six papillae. Buccal cavity 25 μ long and 30 μ wide in male, 30 μ long and 35 μ wide in female, with walls about 10 μ thick. Oesophagus ·95-1 mm. long in both sexes. Nerve ring ·46 mm., cervical papillae ·56 mm., from head end.

Male—Tail curved ventrad, ·18-·2 mm. long; single median and seven to ten pairs preanal papillae, four or five pairs postanal. Spicules ·18-·2 mm. and ·26 mm. long; the longer very fine, not strongly chitinised; the shorter blunt and massive.

Female—Tail ·2 mm. long; vulva ·75-·9 mm. from head end. Uteri containing larvae.

The species is distinguished from others of the genus by the number and position of the caudal papillae and by the relative lengths of the spicules.

Habronema aegotheles n. sp.

(Fig. 8-10)

From the owlet nightjar, *Aegotheles cristata,* from Tailem Bend. Male 2·5 mm., female 4·8 mm., in length. Lateral lips trilobed, with long dorsal and ventral processes; interlabia not seen since head viewed only from lateral elevation, but probably short and simple. Vertical thickened ridges (probably two) on inside of each lip, projecting anteriorly as teeth. Buccal capsule 27 μ long in male, 33 μ long and 10 μ wide in female. Anterior part of oesophagus ·2 mm. long in female; ·14 mm. in male; posterior part ·81 mm. in male.

Male—Caudal alae not wide, united posterior to end of body. Spicules ·18 mm. and ·7 mm. in length; the shorter with rounded tip; the longer needle-like. Four pedunculated preanal papillae on same side as shorter spicule, six on other side; one pair small sessile papillae immediately posterior to anus, and a pair large pedunculated papillae behind these. Male tail bent dorsad. Anus 70 μ in front of rounded tip of tail.

Female—Tail ·16 mm. long, narrowing suddenly after half length. Position of vulva not seen. Body filled with thick-shelled eggs, 20 μ by 45 μ, containing embryos.

The species most closely resembles *H. magnilabiatum* Maplestone in the shape of the lips. The worms are, however, shorter, the lateral lips more deeply lobed; the spicule lengths, and the ratio between them, are different, and there are more caudal papillae in the male of *H. aegotheles.*

Physaloptera sp.

(Fig. 11-12)

From *Anas superciliosa* (New South Wales). One male present, so preserved that only lateral views of the head and tail could be obtained. Lips each bearing two bipartite teeth in dorsal and ventral positions; in median position an outer single tooth and an inner much smaller one, either bipartite or quadripartite. Collar at base of lips, shallow. Exact position of anus and length of spicules not determined satisfactorily. At least four pairs pedunculate preanal papillae and three pairs shorter postanal papillae. Spicules at least ·3 mm. and ·6 mm. long, the longer very fine and poorly chitinised. It is possible that the worm is not a normal parasite of ducks. We have refrained from naming it. The presence of prominent bicuspid teeth in dorsal and ventral positions on lips has not been described for any species of *Physaloptera* from birds.

Physaloptera sp., immature

(Fig. 13-14)

From the black ibis, *Threskiornis spinicollis,* from Eidsvold, Queensland, coll. Dr. Bancroft. Immature specimens up to 15 mm. in length, ·52 mm. wide. Head with very loose "collar" and shallow lips. Each lip with two papillae externally and three teeth internally, latter in dorsal, ventral and median positions. Oesophagus 2·24 mm. long. Tail conical, ·56 mm. long. The arrangement of the teeth is apparently unique among *Physaloptera* from birds.

Acuaria (Dispharynx) sp.

Three poorly preserved specimens from *Anhinga novae-hollandiae,* Thompson River, Queensland. Length, 19-23 mm. Cordons about ·9-1·5 mm. long, recurrent end reaching mouth region. Vestibule ·25 mm. long, anterior part of oesophagus ·6 mm. long, termination of posterior part not seen. In 19 mm. specimen, vulva 2·4 mm. from tip of tail; latter ·12 mm. long. Recurrent branches of cordons apparently longer than in previously described species, but in view of the condition of the material it is considered wiser not to erect a new species.

Echinuria squamata Linst.

(Fig. 15-19)

A young male 3·3 mm. long, a young female 4·4 mm. long, a female 20 mm. long, and the anterior end of another large female, from *Phalacrocorax carbo,* Tailem Bend; and a young male from same host species from the Hope Valley Reservoir, Adelaide. Lips prominent, each with two papillae and an amphid. Cervical papillae large, tricuspid, ·35 mm. from head in male, ·4 mm. in young female, 1·1 mm. in adult female. Cordons prominent, wider posteriorly, not recurrent, uniting immediately anterior to cervical papillae. Cordons striated transversely, each stria consisting of a row of about eight posteriorly-directed spines; spines on dorsal or ventral respective edge of each cordon larger than others in the row and sometimes bifid. At junction of cordons, spines single and large. Lateral alae extend from immediately posterior to cervical papillae. Vestibule with striated walls, 140 μ, 150 μ, and 480 μ, long in male, young female, and adult female, respectively. Anterior part of oesophagus ·26 mm. long in young female, ·25 mm. in male; posterior part slightly wider, 2·35 mm. long in young female. Nerve ring ·16 mm. and ·18 mm. from head end in young male and young female, respectively. Excretory pore ·27 mm. from head.

Male—Caudal alae wide, ·28 mm. long, meeting posterior to body. Cloaca ·09 mm. from tip of tail. One median sessile preanal papilla, four pairs preanal and seven pairs postanal pedunculated papillae (fig. 18). Spicules ·45 mm. and

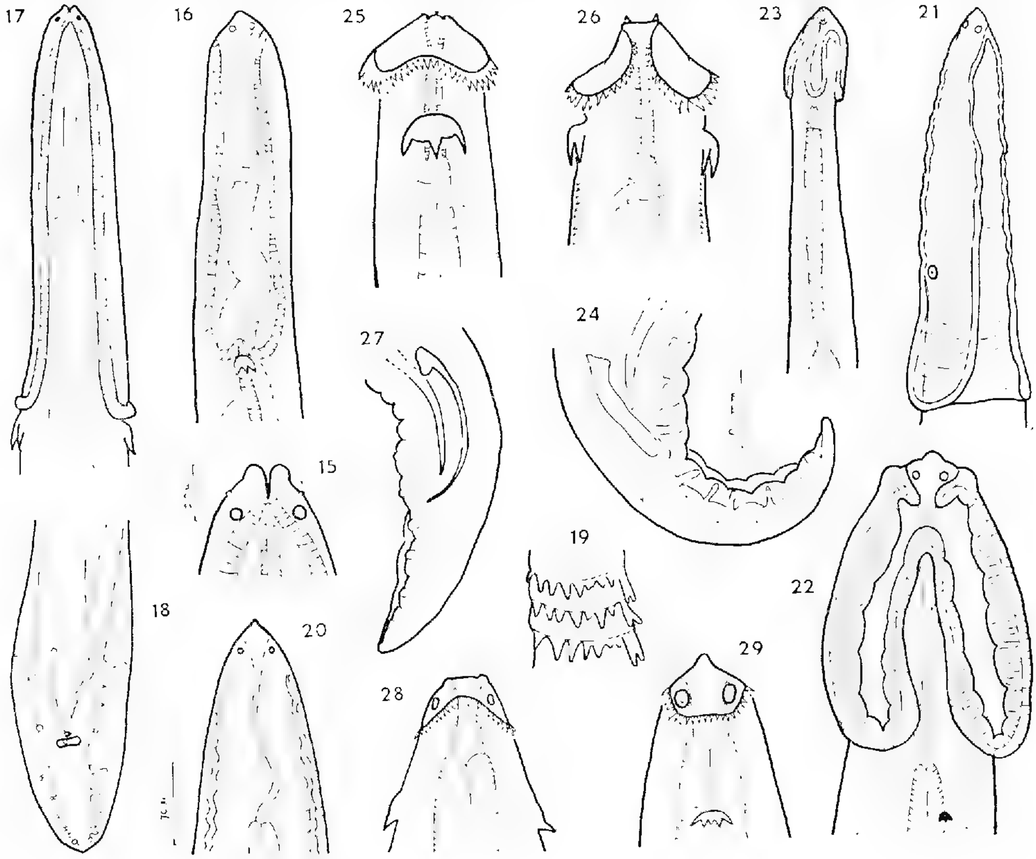

Fig. 15-19, *Echinuria squamata:* 15, male head; 16, female, and 17, male anterior ends; 18, male tail; 19, part of a cordon. Fig. 20-21, *Chevreuxia australis,* anterior end, showing, 20, vestibule; 21, cordons. Fig. 22-24, *Cosmocephalus jaenschi:* 22-23, anterior end; 24, male tail. Fig. 25-27, *Seuratia marina:* 25, lateral, and 26 dorsal, views of head; 27, male tail. Fig. 28-29, *Streptocara recta:* ventral and lateral views of head. Fig. 15 and 19 to same scale; fig. 17, 18 and 20; fig. 21, 22, 24, 25, 26 and 27; fig 28 and 29.

·07 mm. in length, shorter spatulated and blunt tipped; longer tubular in proximal quarter, remainder needle-like almost to the end which is somewhat broadened.

Female—Body much wider posteriorly, tapering to head. Anus subterminal. Vulva ·18 mm. from posterior end. Eggs thick-shelled, 33-35 μ by 24-25 μ.

The present specimens agree with the limited description of the species given by Linstow (1883), whose specimens came from *Phalacrocorax carbo,* from Central Asia.

Chevreuxia australis n. sp.

(Fig. 20-21)

One female 12·3 mm. long, obtained from a marsh tern, *Chlidonias leucopareia,* from Tailem Bend. Two large lips each with anterior projection and two large papillae. Cuticular "collar" extending backwards from level of cervical papillae, ·34 mm. from head, for ·18 mm. Each of the dorsal and ventral cordons joining laterally on free border of this collar. Cuticle over cordons not striated, but somewhat twisted; inter-cordon area markedly striate. Vestibule ·17 mm. long, 5 μ wide except near mouth where it widens. Anterior part of oesophagus ·61 mm. long, posterior part obscured by uteri. Tail ·36 mm. long, tapering to blunt point. Vulva 6·3 mm. from head end, *i.e.*, just posterior to middle of body. Eggs thick-shelled, 18-19 μ by 30-31 μ.

The species is closely related to *C. revoluta* (Rud.) from *Himantopus*, the distinguishing features of the new species being the unstriated cordons, striated inter-cordon areas, and the rather longer and less conspicuous "collar," or cuticular flap, which characterises the genus. These differences are, however, small.

Cosmocephalus jaenschi n. sp.

(Fig. 22-24)

From *Phalacrocorax carbo,* Tailem Bend. Two males present, about 10·5 mm. long. Lips shallow, each with prominent anterior projection and two large papillae. Rounded cuticular expansion dorsally and ventrally between cordons. Cordons voluminous, scalloped on inner edge, forming immediately after origin on lips a postero-lateral narrow loop about 30 μ long, then continuing back to a point ·39 mm. from head; front of recurrent loop ·9 mm. from head. Cervical papillae tricuspid, ·46 mm. from head end. Vestibule ·39 mm. long, 20 μ wide. Anterior part of oesophagus ·9 mm., posterior 3·7 mm., in length; nerve ring ·45 mm. and excretory pore ·53 mm. from head end. Spicules ·61 mm. and ·15 mm. in length. Caudal alae present, supporting four pairs preanal and five pairs postanal pedunculated papillae, the final pair being stouter than the others. Tail ·29 mm. long.

The species resembles *C. capellae* Yamaguti very closely in general features but differs in the lengths of the spicules and in the number of postanal papillae. It differs from *C. aduncus* (Creplin) in the length of the cordons; from *C. asturis* Y. and M. in the shape of the cordons, length of the vestibule and the position of the excretory pore; and from *C. obvelata* (Creplin) in the length of the vestibule relative to the cordons and cervical papillae and in the number of postanal papillae and the relative lengths of the spicules.

Seuratia marina n. sp.

(Fig. 25-27)

From the stormy petrel, *Pelagodroma marina,* from Flinders Island, Bass Strait, coll. Dr. Cleland. Spinous collar and large tricuspid papillae as in *S. shipleyi;* collar with about 34 teeth on each side. Upper border of cervical papillae 130 μ from head in female, 90 μ in male. Hooks on body in four sub-lateral rows, small. Mouth surrounded by six shallow lips, two laterals each with a prominent papilla. Vestibule in female 180 μ long, transversely striated; walls about 5 μ thick, lumen 9 μ wide; in male, 140 μ long. Anterior part of oesophagus ·62 mm. long in female, posterior part at least 1·6 mm., its posterior end obscured by other organs. Nerve ring ·23 mm., and excretory pore ·31 mm., from head end in female.

Male—5·5-6 mm. long; tail with narrow alae supporting two pairs preanal and four pairs postanal papillae. No other caudal papillae observed. Spicules

1·4 mm. and 2·4 mm. in length, longer tapering to a point, shorter more massive with large head and blunt tip.

Female—7·4-8 mm. long, ·42 mm. wide. Anus about ·1 mm. from rounded posterior end; vulva ·4 mm. in front of anus; eggs about 18 μ by 40 μ.

The species differs from *S. shipleyi* as described and figured by Stossich and by Seurat, in the relative positions of the posterior end of the vestibule and the cervical papillae; in the number of preanal papillae in male; in the position of vulva; and in the absence of a terminal multicuspidate papilla in male.

Streptocara recta Linstow

(Fig. 28-29)

This species was taken from *Podiceps poliocephalus* and *P. ruficollis novaehollandiae*, Tailem Bend. Figures are given of the anterior end of a female to show the vestibule.

Acuaria (s.l.) sp., larvae

(Fig. 30)

(a) From a marsh tern, *Chlidonias leucopareia,* from Tailem Bend. Anterior end conical, apparently protected by two cuticular "plates" posterior borders of which are shaped to uncover four submedian papillae. Long vestibule present; oesophagus divided into anterior and posterior parts; nerve ring just posterior to vestibule. Tail tapering, its tip wrinkled and ending bluntly. This larva occurred in the same host as *Chevreuxia australis* described above.

(b) From a Caspian tern, *Hydroprogne caspia strenua,* from Tailem Bend. Appearance identical with (a).

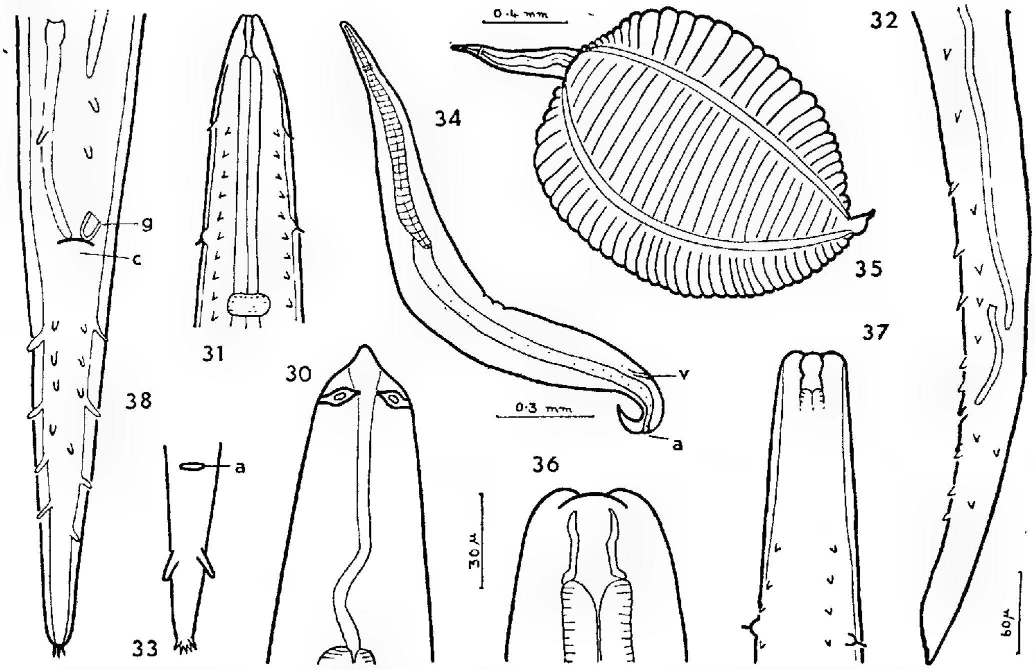

Fig. 30, *Acuaria* (s.l.) larva: from *Retropinna*, anterior end. Fig. 31-35, *Tetrameres biziurae:* 31, anterior end of male; 32, male tail; 33, tail of larva; 34, young female; 35, adult female. Fig. 36-38, *Tetrameres australis,* male: 36, head; 37, anterior end; 38, tail. Fig. 31, 32, 33, 37 and 38 to same scale; fig. 30 and 36. a, anus; c, cloaca; g, gubernaculum; v, vulva.

The larvae found in terns had probably been ingested with small fish.

(c) From a fresh water fish, *Retropinna semoni*, Murray Bridge, South Australia (fig. 30). Appearance identical with (a) and (b).

Although cordons were not seen on any of these larvae, it is possible that the worms are young stages of one of the species of Acuariinae found in birds of the Tailem Bend region. The measurements in mm. of our specimens are given below.

Host	Marsh tern	*Retropinna*	Caspian tern
Length - - - - -	2·65	2·3-2·8	3
Breadth - - - - -	·072	·096	·104
Vestibule - - - - -	·15	·11	·12
Oesophagus (anterior part) -	·25	·23	·3
Oesophagus (posterior part) -	1·5	—	1·26
Head to cervical papillae - -	·19	·15	—
Head to excretory pore - -	·22	·18	—
Tail - - - - -	·12	·11	·12

Spirura (s.l.) sp., larva

From *Pomatostomus superciliosus*, Elwomple (near Tailem Bend). Length 5·68 mm., breadth ·24 mm.; anterior end rounded, without lips or papillae. Buccal capsule 80 μ long. Tail ·48 mm. long, ending in rounded knob.

Tetrameres biziurae n. sp.

(Fig. 31-35)

From the musk duck, *Biziura lobata*, from Tailem Bend. Material comprises males, females, and fourth stage larvae.

Male—4·2-4·4 mm. long; lateral alae present; in each a long spine bifid posteriorly, its termination ·08 mm. from head, a structure apparently similar to that described by Seurat (1918) for *T. fissispina* and suggested by him to be a specific character. Four longitudinal rows of spines beginning at level of tips of the bifid spines, and extending throughout body length. Cervical papillae at slightly different levels, ·15 and ·16 mm. from head end. Four distinct lips. Buccal capsule 30 μ long, about 4 μ wide. Oesophagus 1 mm. long; nerve ring ·2 mm. from head. Tail ·15 mm. long, narrowing suddenly near tip. Four ventral and three lateral papillae on each side of tail. Spicules ·25-·26 and ·07 mm. in length.

Female—Lips not distinguished; buccal capsule more subglobular than cylindrical. Young female: body very little swollen; dimensions as follows: 2 mm. long, ·2 mm. wide; oesophagus ·8 mm. long; tail ·15 mm. long, vulva ·22 mm. from posterior end. Two long ventral spines 60 μ from tip of tail, and two terminal spines. Adult female with following dimensions: body longer than wide; narrow projecting anterior part ·6 mm. long, posterior part ·15 mm. Swollen part 1·5 mm. long, 1·2 mm. wide. Buccal capsule 20 μ long, 10 μ wide at centre, narrower at top and bottom. Swollen part almost entirely filled by saccular intestine containing dark granular material. Vulva at posterior end of swollen part; anus ·5 mm. from tip of tail. Eggs not visible.

Larvae—About 2·4 mm. long; no spines on body except group of five at end of tail and two prominent subventral spines 60 μ from tip of tail. Buccal capsule 18 μ long; oesophagus ·73 mm. long; nerve ring at ·15 mm., and cervical papillae at ·09 mm., from head end.

The species is apparently very close to *T. fissispina* (Diesing), differing in the length of the bifid spines as described by Seurat, the length of the buccal capsule, the position of the most anterior body spines, the length of spicules (shorter than observed for *T. fissispina* by any author), and the size of the female worm. *T. fissispina* has been recorded by Canavan (1931) from the Australian pied goose, *Anseranas semipalmata,* from the Zoological Gardens, Philadelphia, U.S.A.

Tetrameres australis n. sp.

(Fig. 36-38)

From Black Swan, *Chenopsis atrata,* from Tailem Bend. Male worms collected, 7·8-9 mm. long. Lateral alae from ·02 mm. behind head to ·15 mm. Two rows sublateral spines on each side of body; spines closer together and larger anteriorly, becoming very thin and sparser posteriorly. Spine-like cervical papillae 170 μ behind head; body spines beginning 140 μ from head end. Long bifid spines in lateral alae (observed by Seurat in *T. fissispina*) present in this species, though not so well marked. Head bearing six lips; mouth leading into chitinized buccal cavity 28 μ long, 10 μ wide. Several (3-5 pairs) small teeth on inner side of lateral lips; dorsal and ventral lips with large papillae, others with smaller. Oesophagus 1·7 mm. long. Longer spicule needle-like, proximal end about 30 μ posterior to oesophagus, *i.e.,* length about 5·8-6·3 mm. Shorter spicule wider, ·8 mm. long, with blunt tip. Gubernaculum present, 20 μ by 15 μ. Tail ·3 mm. long. Body spines anterior to cloaca small and blunt, those posterior modified into papillae and lying in lateral or subventral lines. Tip of tail bearing several (probably five or six) small spines, as described for fourth stage larva of *T. fissispina* and *T. biziurae*. In the relative lengths of the spicule and body, this species comes closest to *T. tetrica* Travassos 1917. It is, however, much shorter than that species, and differs also in the number of caudal papillae in the male.

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THE SOILS AND VEGETATION OF PORTION OF KANGAROO ISLAND, SOUTH AUSTRALIA

By J. G. BALDWIN and R. L. CROCKER

Summary

This paper deals with the principal vegetation and soil relationships of the Hundreds of Menzies, Cassini, Duncan, Seddon, Newland and MacGillivray, Kangaroo Island. It is the result of two reconnaissance surveys; the first carried out by J. G. Baldwin in 1939, and the second by R. L. Crocker in November, 1940.

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[Read 14 August 1941]

Plates XIV to XVII

Introduction

This paper deals with the principal vegetation and soil relationships of the Hundreds of Menzies, Cassini, Duncan, Seddon, Newland and MacGillivray, Kangaroo Island. It is the result of two reconnaissance surveys; the first carried out by J. G. Baldwin in 1939, and the second by R. L. Crocker in November, 1940.

Geology and Physiography

The dominant physiographic feature of this portion of the island is the low-level lateritic peneplain. This is the backbone of the island, although it has in places undergone considerable dissection. This plateau capping of lateritic ironstone gravel and laterite overlies altered Precambrian sedimentaries—micaceous sandstone, schists and quartzites. Recent calcareous dunes are prominent along the southern coast, particularly in the neighbourhood of Cape Gantheaume, where they reach their greatest development. They overlie an older consolidated dune formation which is exposed to the north and which gradually gives way to lateritic ironstone and solonetzic soils. Consolidated dune limestone also occurs widely in the area surrounding the Bay of Shoals. Limited Upper Tertiary basalt, principally on plateau remnants, the Gap Hills, and glacial beds of doubtful Permo-carboniferous age occurs in the Hundred of Menzies. Polyzoal Miocene limestone, apparently of erratic occurrence, is found in this area also.

The rocks exposed on the break-away from the peneplain along the north coast, Hundred of Cassini, are largely sandstones, conglomerates and sandy shales, considered by Wade (4) as of doubtful Cambrian age.

Along the southern coast, west of Vivonne Bay, there are numerous small outcrops of pegmatite and granite.

Climate

The whole of Kangaroo Island has been placed by Davidson (2) in his warm temperate semi-humid zone with $P/E > 0{\cdot}5$ for seven months of the year. One of the notable features of the climate of the island, however, is its milder winter and much cooler summer temperatures than adjacent regions on the mainland. This considerably extends the actual growing period and period of effective rainfall.

Unfortunately, rainfall records of a reliable nature and extending over a sufficient length of time are very limited. Great difficulty, therefore, attends the establishment of any relationship between rainfall and vegetation, but several local rainshadow effects, as that along the coast near the Middle River Range, are paralleled by vegetation changes and supported by local rainfall records. The average annual rainfall at Kingscote is 19.10 inches, but it is very much higher on the lateritic plateau, and in the area under consideration here reaches its maximum in the vicinity of the headwaters of Middle River (Starvation Creek), Hundred of Duncan, where it is probably about 27-28 inches.

The Soils

The soils of this area can be considered as falling into six large groups:

A The lateritic soils of the peneplain and the slopes:
  (1) elevated peneplain;
  (2) gravelly slopes;
  (3) grey sandy slopes with variable lateritic gravel.

B Grey and light grey siliceous sands.

C Brown soils associated with older sedimentary rocks.

D Solonetz soils.

E Soils associated with dunes:
  (1) consolidated dunes;
  (2) unconsolidated calcareous dunes.

F Basaltic soils.

A *The Lateritic Soils.*

Soils characterised by considerable percentages of lateritic gravel are very widespread and are associated with the old peneplain that forms the backbone of the island. The southern slope from the old peneplain level is more gradual than the northern where the old level frequently extends almost to the coast before dropping away suddenly. The principal soils associated with this area show some variation in texture and amount of lateritic gravel, while phosphoric acid and nitrogen levels are of the same order—exceedingly low. This and the constancy of the associated vegetation indicate quite clearly that most of these variations are not significant agriculturally, and from the point of view of future development can be considered as one general type. (The very shallow soils associated with dense conglomerate laterite and some of the sandy grey soils of valleys are excluded from this generalisation.) This general type has a grey-brown loamy sand to loam surface soil with variable amounts of lateritic gravel, and increases in texture with depth to a yellow and yellow-grey clay at usually less than 27 inches. The upper clay horizons almost always include much gravel, but this decreases with depth. The clay frequently shows red-brown inclusions or is mottled. The analytical data on the profiles sampled within this type are given in Tables I, II and III. The type is invariably associated with dry sclerophyll forest or, towards its drier limits, sclerophyll scrub.

Very dense ironstone gravel and laterite, exposed at or very near the surface, and associated with a rare mallee, *Eucalyptus remota,* occur in the north-west portion of the Hundred of Newland and south-west Hundred of Duncan and become increasingly important in the adjacent western areas.

B *Grey and Light Grey Siliceous Sands.*

The sandier grey soils associated with slopes and valleys where the lateritic peneplain is dissected frequently support modified vegetation associations. These soils, however, usually contain some ironstone gravel and are very closely related to the lateritic soils described above. Their phosphoric acid and nitrogen status is of the same order, though slightly lower.

In the vicinity of Mount Taylor and Mount Stockdale grey, light grey and white sands overlie dense cemented ironstone gravel, known locally as "conglomerate ironstone." The overlying sand is of very variable depth but most frequently about 30 inches, and may include some ironstone gravel. Sometimes it shows evidence of slight organic staining and the development of an organic gravel pan above the conglomerate ironstone. These soils are the poorest sampled, with nutrient levels ranging between 0·002–0·003% phosphoric acid and 0·033% nitrogen. They support a very depauperate and open stringybark (*E. Baxteri*) and white mallee (*E. diversifolia*) association which, because of the sparseness and stunted nature of the dominants, often appears heathlike. These grey and white siliceous sands are probably re-sorted (aeolian) leached upper horizons of the consolidated dune limestone to the south. They were first recognised by Wade (*loc. cit.*) as "blown sand."

C *Brown Soils Associated with some of the Underlying Sedimentaries.*

The rocks underlying the lateritic gravels on the peneplain belong to an older sedimentary series that has undergone slight metamorphism. For the most part they are altered shales and sandstones and quartzites. Some of these rocks produce a brown loamy soil usually overlying brown or even red-brown clay at a shallow depth. Although varying in profile they are characterised by considerably higher fertility than the ironstone types and are associated with a savannah dominated by sugar gum (*E. cladocalyx*). These soils are principally developed on the Middle River Range and near Stokes Bay. In two very different profiles sampled, the fertility levels are considerably higher than any of the lateritic types (see Table I). There is a remarkable difference in relative proportions of the replaceable cations in these two profiles (Table II).

D *Solonetz Soils.*

In much of the Hundred of Menzies solonetz soils carry narrowleaf mallee (*E. cneorifolia*) and black mallee (*E. rugosa*). The surface is usually a brownish-grey and yellow-grey sandy loam which overlies a well-structured columnar and nutty clay usually at less than 10 inches. Sometimes the sandy loam horizon is lacking, and in this case the soils may show "melon-holey" tendencies. There is usually evidence of some free lime in the subsoil, and for the most part these soils are developed over limestone or boulder clay. No laboratory analyses have yet been made of this type, although analyses have been made of the solonetz soils associated with narrowleaf mallee and broombush.

Shallow solonetz soils also occur in the flat, fairly low-lying areas between the Cygnet River (Hundred of Menzies) and the peneplain in the Hundred of MacGillivray and are associated with stunted narrowleaf mallee (*E. cneorifolia*) and broombush (*Melaleuca uncinata*).

On most of the Hawk's Nest—Birchmore Lagoon area (Hundred of MacGillivray) there are solonetzic soils with variable admixture of ironstone. But there is also considerable complexity in this region and it is frequently difficult to distinguish these intermediate soils from the ironstone gravel soils carrying white mallee. Every gradation between the two types exists and the delineation on the accompanying vegetation map should not be interpreted too rigidly.

E *Soils Associated with Dunes.*

Near the coast in the Hundreds of MacGillivray and Seddon there are extensive calcareous sand dunes. These are fairly well known because of "coastiness" in sheep associated with them. Although containing an appreciable percentage of quartz sand, the dune material is predominantly calcareous. Being principally composed of marine shell fragments they are particularly high in phosphates. These dunes abut against and overlie the older consolidated formation. The distribution and extent of these dune formations are shown on the accompanying vegetation map.

Some consolidated dune limestone also occurs in the Hundred of Menzies near the Bay of Shoals.

F *Basaltic Soils.*

Limited areas of basaltic soils occur in the Wisanger-Retties Bluff region (the Gap Hills) Hundred of Menzies and near The Bluff, Bay of Shoals, but they are relatively unimportant and have not been sampled.

Table I

Range of Phosphoric Acid, Copper and Nitrogen Content and pH of Principal Soil Groups

Locality (Hundreds)	Vegetation	Soil Groups	Soil Phases	P_2O_5* %	Cu p.p.m.	N %	pH Surface	pH Subsoil
Seddon, Duncan, Cassini, Newland	Stringybark forest	Lateritic gravel soils	(a)	0.009–0.021	4–14	0.015–0.083	6.1–6.5	5.0–6.2
			(b)	0.003–0.005	0.5–1	0.074–0.077	5.2 5.9	5.4–5.6
	Mallee Scrub	Lateritic gravel soils	(a)	0.006–0.013	4 12	0.069–0.109	6.4	5.4–6.7
			(b)	0.004–0.005	1–3	0.044	6.8	5.6
Newland (Mt. Taylor)	Depauperate stringybark forest	Aeolian grey siliceous sands	—	0.002 0.003	0.3–1	0.033	5.9	5.8
Menzies	Stunted narrowleaf mallee and broom	Solonetz	—	0.003–0.005	0.4 1	0.046	6.6	7.0–8.4
MacGillivray	Narrowleaf mallee and broom	Solonetz	—	0.003–0.006	0.3 1	0.037	6.4	7.7–8.9
MacGillivray (South)	Black mallee (*E. rugosa*)	Calcareous† dune sand	—	0.12 0.09	—	0.02 0.01	8.2	8.6
Cassini	Sugar gum associations	Brown Soils on old Sedimentaries	—	0.013–0.039	5.8	0.138 0.152	6.3 6.9	4.7–5.2

(a) Normal phases. (b) Phases admixed with grey siliceous sands.

* The P_2O_5 figures range through both surface and subsoil.

† These analyses of the Cape Gantheaume sand were made by Mr. J. S. Hosking.

Laboratory Examination of the Soils

Standard methods of analysis were used for the determinations to be briefly described.

Mechanical Analysis.

Mechanical analyses of 92 samples from 15 profiles show a consistent predominance of fine sand over coarse sand. The analyses of representative profiles are given in the appended tables. The high percentage of lateritic gravel is a feature of most types.

Soil Reaction.

Soil reaction, pH, for surface soils is alkaline in the calcareous dunes but in all the other types is acid. The highest value recorded is pH 8·2 for the upper horizons of the calcareous dunes, and the lowest pH 5·2 for siliceous sandy soil in the lateritic regions. The markedly alkaline subsoils of the solonetz soils is a noteworthy feature and contrasts strikingly with the other soil types.

Nitrogen.

Total nitrogen determined on a number of surface and subsurface soils is extremely low. The low figure of 0·033% was recorded for the siliceous sands in the neighbourhood of Mount Taylor and Mount Stockdale.

The determinations are summarised in Table I.

Phosphoric Acid and Potash.

Analyses of hydrochloric acid extracts for phosphoric acid (P_2O_5) and potash (K_2O) were made on a number of samples. The phosphates (P_2O_5) are very low except in the case of the brown, sugar gum soils, where they are low to moderate, and the calcareous dunes in which they are high for Australian soils. Potash (K_2O), as to be expected, shows a general relationship with clay content. It is lowest in the grey siliceous sands of the Mount Taylor—Mount Stockdale region, and the mixed grey sandy and lateritic soils. The solonetz soils are also fairly low in potash. The potash levels in the brown and grey-brown lateritic soils, and the brown soils associated with sugar gum, however, are moderate to high. For example, one lateritic gravelly soil analysed, ranged between 0·184% K_2O in the surface horizon to 0·735% in the clay of the B_2 horizon at 12-14 inches.

Copper.

Spectrochemical analyses for copper were made on the hydrochloric acid extracts of a number of samples from 15 profiles. There are two well-marked levels for copper. The grey-brown and brown lateritic gravel soils, and the brown soils associated with sugar gum are higher with 4-14 parts per million of copper over the first foot. The grey and white siliceous sands and the solonetz soils range between 0·3-1 p.p.m. at the lower level. The copper status of the mixed lateritic gravel and siliceous sand soils is intermediate between these two. The analyses are summarised in Table I.

Soluble Salts.

Total soluble salts and chloride content is low and practically negligible. The highest value recorded was in the deep subsoil of a solonetz soil sampled near the old MacGillivray School, but even here at a depth of 17-30 inches there was only 0·272% total soluble salts and 0·115% chlorides (as Cl).

Replaceable Bases.

Representative results of some of the replaceable base analyses are set out in Table II. Magnesium is the dominant base, although the proportion of calcium cations is frequently higher in the surface horizons. Potassium is more prominent than sodium in the ironstone (lateritic) soils and the brown (sugar gum) soils, but the proportion of replaceable sodium cations is greater in the solonetz types.

TABLE II

Replaceable Bases in Kangaroo Island Soils

Soil Type	Soil No.	Depth (inches)	pH	Clay %	Total bases m.e./100 gm. Soil	Percentage of total bases Ca	Mg	K	Na
1 LATERITIC SOIL: (*a*) Stringybark	6088	0–2	6.1	10.2	4.0	55	30	10	5
	6089	2–7	6.2	14.4	3.9	31	51	13	5
	6090	7–12	6.1	16.3	3.7	19	60	16	5
	6092	14–18	5.8	58.2	7.0	10	73	11	6
	6093	19–26	5.0	69.7	5.4	6	78	11	5
(*b*) *E. diversifolia*—mallee	6105	17–22	6.7	52.1	11.1	30	56	9	5
	6111	10–14	6.0	62.5	8.6	22	58	13	7
2 SOLONETZ	6169	6–12	7.7	58.5	17.5	36	36	15	13
	6170	12–17	8.2	80.4	20.8	29	41	14	16
	6171	17–30	8.9	85.1	20.6	31	31	18	20
	6163	11–16	7.4	62.5	15.9	25	42	13	20
3 BROWN SOILS (sugar gum)	6174	4–13	4.6	14.6	1.0	20	0	60	20
	6178	5–10	6.2	52.6	26.8	29	61	4	6

Table III

Mechanical Analysis of Kangaroo Island Soils

Soil Type	Lateritic gravelly soils (*E. Baxteri–E. obliqua*)						Lateritic gravel soil (*E. diversifolia–E. cosmophylla*)					
Locality	Junct. Border Rd.-Wallis Rd. (Hd. Duncan)						Eleanor Stn., Hd. Seddon					
Soil No.	6088	6089	6090	6091	6092	6093	6101	6102	6103	6104	6105	6106
Depth (inches)	0–2	2–7	7–12	12–14	14–18	19–26	0–2	2–7	7–12	12–17	17–22	22–40
	%	%	%	%	%	%	%	%	%	%	%	%
Gravel	35.3	42.7	70.6	58.6	13.1	28.1	63.4	77.7	77.6	81.0	18.8	3.6
Coarse sand	19.0	17.6	20.3	20.2	7.4	4.6	10.4	11.1	16.9	28.7	9.4	6.6
Fine sand	58.0	55.7	52.0	43.8	22.2	13.5	47.3	39.6	53.5	47.2	25.1	15.1
Silt	7.9	7.0	7.0	6.9	6.8	8.1	13.5	10.8	6.1	6.7	7.9	7.8
Clay	9.7	13.5	15.5	24.0	50.7	60.4	17.2	24.6	18.0	13.2	45.9	55.6
L. on acid treat.	1.2	1.2	0.7	0.2	0.4	0.9	1.3	1.0	0.6	0.4	0.4	0.3
Moisture	1.9	3.9	4.0	5.5	13.4	13.3	5.2	10.4	4.6	3.9	12.3	15.2
L. on ignition	5.5	5.0	4.5	5.1	9.0	11.0	9.7	9.5	4.5	4.9	9.2	10.4
Total sol. salts	0.020	0.027	0.023	0.021	0.023	0.060	0.014	0.014	0.006	0.005	0.012	0.011
Chlorides (Cl)	0.008	0.010	0.008	0.008	0.011	0.009	0.040	0.037	0.022	0.020	0.032	0.023
Reaction pH	6.1	6.2	6.1	5.8	5.7	5.0	6.4	6.3	6.6	6.9	6.7	6.8

Table III (continued)

Soil Type	Siliceous sand				Solonetz						
Locality	Mt. Stockdale (Hd. Newland)				Sect. 3, Hd. MacGillivray						
Soil No.	6154	6155	6156	6157	6165	6166	6167	6168	6169	6170	6171
Depth (inches)	0–4	4–8	8–12	12–18	0–2	2–4	4–6	6–11	11–12	12–17	17–30
	%	%	%	%	%	%	%	%	%	%	%
Gravel	—	1.8	37.5	73.4	44.4	49.8	67.0	46.9	3.1	3.4	4.0
Coarse sand	29.5	29.7	30.3	31.8	18.7	14.7	13.3	13.7	5.7	2.7	1.6
Fine sand	65.1	66.3	65.5	61.6	72.1	77.9	79.6	77.6	26.9	12.0	9.1
Silt	0.9	1.0	0.8	1.1	3.4	3.5	3.8	4.8	3.1	1.8	1.3
Clay	2.3	2.6	5.3	4.9	3.8	3.0	2.9	3.6	50.5	67.6	68.6
L. on acid treat.	0.2	0.2	0.3	0.4	0.4	0.4	0.3	0.4	1.2	1.4	5.3
Moisture	0.4	0.3	0.3	0.5	1.1	0.6	0.6	0.7	11.3	15.1	14.7
L. on ignition	1.9	1.2	1.2	1.7	2.4	1.6	1.3	1.1	6.9	7.9	9.7
Total soluble salts	0.023	0.029	0.020	0.020	0.022	0.020	0.020	0.022	0.122	0.182	0.272
Chlorides (Cl)	0.014	0.010	0.005	0.004	0.006	0.004	0.004	0.005	0.060	0.086	0.115
Reaction pH	5.9	5.8	5.8	5.8	6.4	6.7	7.0	7.3	7.7	8.2	8.9

Table III (continued)

Soil Type	Brown soil (sugar gum)				Brown soil (sugar gum)			
Locality	Sect. 38, Hd. Duncan				Sect. 75, Hd. Cassini			
Soil No.	6172	6173	6174	6175	6176	6177	6178	6178A
Depth (inches)	0–1	1–4	4–13	13–20	0–2	2–5	5–10	10–17
	%	%	%	%	%	%	%	%
Gravel	39.9	32.1	29.9	12.0	13.6	13.9	13.9	7.1
Coarse sand	16.4	14.2	11.0	6.4	13.1	15.3	7.9	5.3
Fine sand	47.5	44.4	41.2	44.7	57.8	60.0	28.0	15.7
Silt	22.4	28.3	30.5	34.8	7.2	7.2	7.1	3.8
Clay	6.8	9.0	14.1	14.9	12.6	12.2	47.5	59.6
L. on acid treat.	1.8	1.5	1.1	0.4	1.0	0.9	0.7	1.4
Moisture	2.5	2.7	2.6	1.7	4.5	2.8	9.7	14.0
L. on ignition	8.0	6.0	6.0	5.0	6.6	3.9	7.5	8.8
Total soluble salts	0.025	0.024	0.034	0.028	0.025	0.024	0.034	0.028
Chlorides (Cl)	0.011	0.010	0.015	0.011	0.011	0.010	0.015	0.011
Reaction pH	6.9	5.3	4.6	4.7	6.3	6.2	6.2	5.5

The Vegetation

The ecology of Kangaroo Island has always been recognised as a very complex problem. This has been due to the scarcity of accurate soil and climatic data and the fact that many of the dominant species have a wide potential edaphic habitat, though under the prevailing climate and the very poor soil conditions they frequently border their environmental limits. The principal factors controlling the distribution of vegetation in the six Hundreds surveyed are undoubtedly edaphic. Climate is of secondary import and has a more gradual effect as species reach their edapho-climatic limits. As species approach these limits they become more depauperate and stunted and slowly disappear altogether. If soil changes were as gradual as climatic progression, their effect on vegetation would doubtless be similar, but they are usually more clear-cut.

The general ecology of Kangaroo Island has already been included in a paper by Wood (5). The emphasis, however, was then on climatic control and the soils were not understood. The paper was of great importance in elucidating the geographical affinities of the flora and the light it threw on vegetation migrations. It stressed the very high percentage of endemic species on the island and their concentration in the central and western regions. A detailed ecological survey has been made in the very complex area about Hawk's Nest Station by Cashmore.(1) Professor J. B. Cleland has also collected very widely in the region.

Unfortunately, very widespread bushfires swept over more than a third of the area some six months before this survey was conducted and made the establishment of soil and vegetation relationships exceedingly difficult and the floristics far from complete.

Eleven important associations are recognised in this central portion of Kangaroo Island and are summarised below in Table IV. Most of them are mapped on the accompanying vegetation map, but as climatic complexes(2) are involved the boundaries are in these cases somewhat arbitrary.

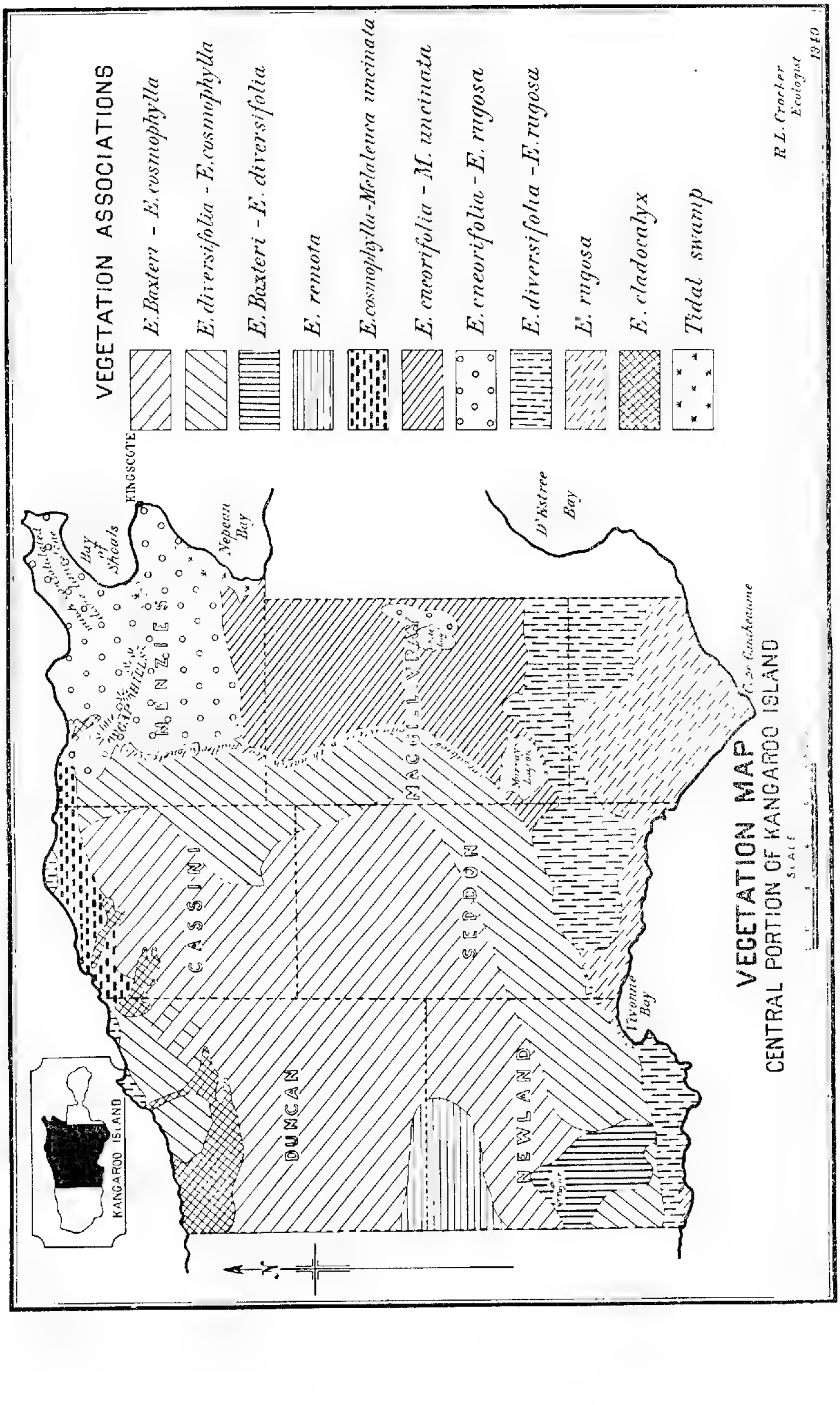
Table IV

The Vegetation Associations

Association	Soil Type	Edaphic complex or climatic complex	Formation
E. obliqua	Lateritic soils (with some siliceous sand)	*E. Baxteri—E. cosmophylla* climatic complex	Dry sclerophyll forest
E. Baxteri—E. cosmophylla			
E. diversifolia—E. cosmophylla		*E. Baxteri—E. cosmophylla—E. diversifolia* edaphic complex	Sclerophyllous scrub
E. remota	(heavy laterite)		
E. Baxteri—E. diversifolia	Siliceous sand		
E. cosmophylla—M. uncinata	Cambrian (?) sedimentaries		
E. cneorifolia — Melaleuca uncinata	Solonetz	*E. cneorifolia—M. uncinata*	
E. cneorifolia—E. rugosa	Solonetzic	*E. cneorifolia—E. rugosa*	Mallee scrub
E. diversifolia—E. rugosa	Consolidated dunes	*E. rugosa—E. diversifolia* edaphic complex	Sclerophyllous mallee scrub
E. rugosa	Calcareous dunes		
E. cladocalyx (sugar gum)	Brown soils (old sedimentaries)	*E. cladocalyx*	Savannah woodland

(1) Cashmore, A. B.—Unpublished Report.

(2) The concept of *climatic complex* is used where soil type remains relatively uniform and vegetation association changes are an expression of climatic factors. This may be considered analogous to Wood's *edaphic complex*.


VEGETATION ASSOCIATIONS
E. Baxteri - E. cosmophylla
E. diversifolia - E. cosmophylla
E. Baxteri - E. diversifolia
E. remota
E. cosmophylla - Melaleuca uncinata
E. cneorifolia - M. uncinata
E. cneorifolia - E. rugosa
E. diversifolia - E. rugosa
E. rugosa
E. cladocalyx
Tidal swamp
R.L. Crocker
Ecologist
1940
KINGSCOTE
Bay of Shoals
Nepean Bay
D'Estree Bay
Vivonne Bay
MENZIE
MACGILLIVRAY
CASSINI
SEDDON
DUNCAN
NEWLAND
KANGAROO ISLAND
VEGETATION MAP
CENTRAL PORTION OF KANGAROO ISLAND
SCALE

1 *E. Baxteri—E. cosmophylla* climatic complex.

This complex is associated with the lateritic and gravel soils and their variants admixed with grey siliceous sands, on the plateau and plateau slopes. Where rainfall conditions are high enough (24-25"), *E. obliqua* becomes a co-dominant with *E. Baxteri* and under optimum conditions may replace it altogether, as in the Starvation Creek area (not mapped separately).

Over a great part of the plateau region *E. Baxteri, E. obliqua* and *E. cosmophylla* are co-dominants, although frequently stunted. The undershrubs are typically sclerophyllous. Of the taller undershrubs *Casuarina striata* (bulloak) is often abundant and may form a dense society, varying between three and eight feet high. Other tall shrubs of wide occurrence are *Banksia marginata* (honeysuckle), *Banksia ornata* (broad-leaved honeysuckle), *Hakea rostrata* and *Xanthorrhoea Tateana.* Although these taller shrubs are frequently conspicuous and may give the association a particular physiognomy, there is no definite demarkation into an "upper and lower" shrub stratum. The lower shrubs most important are *Daviesia genistifolia, D. brevifolia, Adenanthos terminalis, Lhotzkya glaberrima, Phyllota pleurandroides, Pultenaea viscidula, Logania ovata, Spyridium* sp., *Petrophila multisecta, Isopogon ceratophyllus, Tetratheca halmaturina, T. ericifolia, Hibbertia stricta, H. sericea, H. fasciculata, Lepidosperma carphoides, Lepidosperma* sp., *Gompholobium minus* and *Leucopogon concurvis.*

Other plants present, though usually of less abundance, are *Melaleuca gibbosa, Caustis pentandra, Platylobium obtusangulum, Spyridium thymifolium, Conospermum patens, Leptospermum myrsinoides, Hibbertia stricta* var. *glabriuscula, Boronia filifolia, Pimelia octophylla, Pimelia* sp., *Choretrum spicatum, Adenanthos sericea, Pultenaea trinervis* and *Dillwynia floribunda.* This association, with minor floristic differences (principally the absence of species endemic to Kangaroo Island), is the same as that described by Adamson and Osborn on Fleurieu Peninsula (1).

As has been mentioned earlier, there is a good deal of admixture of gravel soils with grey siliceous sand in parts of the plateau region. As can be seen from reference to Table 1, the phosphoric acid and copper levels are somewhat lower in the siliceous types but nitrogen and pH are of the same order. These grey soils carry an almost identical association—there are, however, changes in the frequency of species, and the greater importance of *Leptospermum myrsinoides* (tea-tree), *Adenanthos sericea* and *Platylobium obtusangulum* is noticeable. Some new species like *Hypolaena fastigiata, Epacris impressa* and *Grevillea quinquenervis* may be present, while *Pultenaea viscidula, Logania ovata* and *Daviesia genistifolia* are rarely, if ever, important.

Loudonia Behrii is very widespread on the island, particularly following fire, or some other severe setback to an association, like clearing.

2 *E. Baxteri—E. diversifolia—E. cosmophylla* edaphic complex.

E. diversifolia —E. cosmophylla association.

Where the rainfall is too low (probably below 21") for *E. Baxteri* (stringybark) dry sclerophyll forest, it gives place to a sclerophyll scrub dominated by *Eucalyptus diversifolia* (white mallee) and *E. cosmophylla* (swamp or cup gum). Many, indeed most, of the associated undershrubs remain and the transition with gradually decreasing rainfall is very gradual, the *E. Baxteri* first becoming very stunted and sometimes mallee-like in habit before disappearing altogether. The profile characteristics of the soil remain apparently the same, there still being much admixture of ironstone gravel. The fertility levels of the soils, as shown in Table I, are of the same order.

The most important and consistently associated plants are *Xanthorrhoea Tateana* (yacca), *Melaleuca uncinata* (broombush), *Casuarina striata, Banksia marginata, Hakea rostrata, Daviesia genistifolia, D. brevifolia, Lhotzkya glaberrima, Calythrix tetragona, Adenanthos terminalis, Tetratheca ericifolia, Melaleuca gibbosa, Petrophila multisecta, Lepidosperma concavum, Hibbertia* spp., *Spyridium* spp. (principally *S. spathulatum*), *Leucopogon concurvis* and *Isopogon ceratophyllus*.

The grasses *Stipa semibarbata* and *Danthonia setacea* are usually present very sparingly, but in the first year following fire may become locally prominent.

Eucalyptus leptophylla (narrowleaf mallee) occasionally occurs as a co-dominant, but the edaphic variation of which it is indicative is not yet fully understood. *E. fasciculosa* (pink gum) also occurs occasionally but is usually confined to slopes where there is a tendency for the older sedimentaries to break through.

Eucalyptus remota association.

On the very shallow soils over dense laterite which occur in north-west Hundred of Newland, and which become more extensive further west, is a sclerophyllous scrub association dominated by the restricted mallee, *E. remota* (bastard mallee). Edaphic conditions, owing to the shallowness of the soil and the apparent denseness of the laterite, must be too severe for stringybark. The rainfall is probably between 23-26 inches.

The sclerophyllous undershrubs are largely those common throughout the sclerophyll association; most prominent are *Hakea rostrata, Banksia marginata, B. ornata, Adenanthos terminalis, Petrophila multisecta, Phyllota pleurandroides, Grevillea quinquenervis* and *Hibbertia* spp., *Tetratheca* spp., *Leucopogon* spp., etc. *Pultenaea canaliculata* var. *latifolia* and *P. viscidula* are of somewhat irregular occurrence. The association is often given a marked physiognomy by the prevalence of *Banksia ornata*.

Eucalyptus Baxteri—E. diversifolia association.

On the grey and grey-white siliceous sands which overlie "conglomerate ironstone" in the Mount Stockdale—Mount Taylor region, Hundred of Newland, is a very open association dominated by dwarfed *E. Baxteri, E. diversifolia* and *E. cosmophylla*. These soils are the poorest sampled on the Island (see Table I), and the association is so open and the dominants frequently so depauperate that it becomes heathlike. Phosphates (P_2O_5) are as low as 0·002-0·003%. It is interesting to note that *E. Baxteri* is enabled to grow further south, on this soil type, which allows it to exploit a lower rainfall, than on the brown lateritic gravel soils. There is further evidence for this on the island. On the spur that extends from the Middle River Range towards Stokes Bay, and lies within a rain shadow of the Range, *E. Baxteri* is associated with *E. diversifolia* on the grey and grey-white siliceous sands but does not grow on the adjacent ironstone (lateritic) gravel soils.

This demonstrates clearly that the edapho-climatic range of a species may vary considerably. The distribution of an association depends entirely on the potential edapho-climatic limits of its individual species and the variability of soil and climate. The *E. Baxteri—E. diversifolia* association has very definite sclerophyll affinities and many plants of the plateau sclerophyll communities occur here. The chief associated plants are *Petrophila multisecta, Xanthorrhoea Tateana, Hakea rostrata, Banksia ornata, B. marginata, Leptospermum myrsinoides, Lhotzkya glaberrima, Hypolaena fastigiata, Caustis pentandra, Casuarina Muelleriana, Adenanthos sericea, Calythrix tetragona, Dampiera lanceolata, Lepidosperma carphoides, Lepidosperma* sp., *Platylobium obtusangulum* and *Grevillea quinquenervis*. This association appears to have definite affinities with the *E. Baxteri* heathlands of Hundreds of Laffer and Willalooka, South-East, South Australia (Taylor (3)).

3 *E. cneorifolia—Melaleuca uncinata* edaphic complex.

E. cneorifolia—M. uncinata association.

Solonetzic soils occur widely in the Hundred of MacGillivray and south of the lower Cygnet River, Hundred of Menzies. They are associated with an assemblage of plants dominated by stunted *E. cneorifolia* and *M. uncinata*. There are two main variations within the association—(*a*) low-lying solonetz soils south of Cygnet River, between the river and the plateau, and (*b*) elevated solonetz soils of the Birchmore Lagoon—MacGillivray area, very frequently admixed with a little ironstone gravel.

(*a*) The associated plants are *Thryptomene ericaea, Lhotzkya glaberrima, Hakea ulicina, Dodonaea hexandra, Adenanthos terminalis, Grevillea ilicifolia, Petrophila multisecta, Spyridium* sp., *Melaleuca gibbosa, Brachyloma ericoides, Calythrix tetragona* and *Casuarina striata*. Stunted *E. rugosa* occurs very sparingly.

(*b*) In the MacGillivray area there is considerable complexity and in places much lateritic gravelly soil with *E. diversifolia* and *E. cosmophylla* occurring sparingly. The solonetz soils are not as clear-cut as in (*a*) and there is consequently a greater number of sclerophyll types associated. The principal species occurring in addition to the dominants (*E. cneorifolia* is less stunted here) are *Thryptomene ericaea, Lhotzkya glaberrima, Dodonaea Baueri, Casuarina striata, Xanthorrhoea Tateana, Hakea rostrata, H. rugosa, Leucopogon rufus, Grevillea ilicifolia, Adenanthos terminalis, Calythrix tetragona* and *Lasiopetalum Baueri*.

E. cosmophylla—M. uncinata association.

On the slope from the plateau level to the coast adjacent to the Stokes Bay—Dashwood Bay region older sedimentaries, sandstones and shales are exposed, and the soil cover is fairly thin. Here an association occurs which is given a particular facies by the dominance of dwarfed *E. cosmophylla* and *M. uncinata*. The associated plants are sclerophyllous undershrubs and shrubs, *Casuarina striata, Xanthorrhoea Tateana, Adenanthos, Petrophila*, etc.). *E. fasciculosa* is sparingly present and proceeding back from the coast the association merges gradually into the *E. Baxteri—E. obliqua* on the plateau proper.

4 *E. cneorifolia—E. rugosa* edaphic complex.

Over a great portion of the Hundred of Menzies developed over glacial clays and limestones are soils with well-structured clays and apparently solonetzic. They all appear to have free lime in the subsoil. Although most of this area has been cleared for agricultural development, there is sufficient vegetation remaining along roads to define the association. The soils have not been fully investigated and no analyses have been made on the soil samples collected.

This edaphic complex is a typical mallee one dominated by two tall mallees, *E. cneorifolia* and *E. rugosa* (black mallee), both of which frequently grow to 25 feet high.

The principal associated plants are *Dodonaea Baueri, Melaleuca acuminata, Acacia armata, Choretrum glomeratum, Dodonaea* sp., *Thryptomene ericaea, Acacia acinacea, Acacia* sp., *Prostanthera spinosa, Eremophila glabra, Goodenia varia, Helichrysum retusum, Calythrix tetragona, Senecio odoratus*, and *Melaleuca gibbosa*. The chief grasses are species of *Stipa* and *Danthonia*.

On the old dune limestone that occurs in the North Cape and Bay of Shoals region this association is replaced by a very mixed mallee association which has closer affinities with the *E. diversifolia—E. rugosa* association of the consolidated dunes.

5 *E. rugosa—E. diversifolia* edaphic complex.

This complex occurs on the consolidated and unconsolidated dunes of the southern portions of the Hundreds of Newland, Seddon and MacGillivray and on consolidated dunes elsewhere.

E. diversifolia—E. rugosa association.

The dominant mallee on consolidated dunes is *E. diversifolia*, but *E. rugosa* is frequently present. *E. oleosa ?* is also found very sparingly. Associated with the mallees are a large number of sclerophyllous shrubs and undershrubs, principal of which are *Grevillea ilicifolia, Lhotzkya glaberrima, Spyridium halmaturinum* (var.), *S. spathulatum, Hakea ulicina, H. vittata, Templetonia retusa, Beyeria Leschenaultii, Lasiopetalum Schulzenii, Pultenaea acerosa, P. canaliculata, Goodenia* sp. (near *G. varia*), *Dampiera lanceolata, Leucopogon costatus, Acacia myrtifolia, Olearia ciliata* var. *squamifolia, Stylidium Tepperianum, Microcybe pauciflora, B. marginata, Petrophila multisecta, Daviesia genistifolia, Calythrix tetragona, Xanthorrhoea Tateana* (rarely), *Prostanthera aspalathoides* and *Choretrum glomeratum.*

The principal grasses are *Danthonia setacea* and *Stipa* sp. (probably *S. eremophila*).

In the Bay of Shoals—North Cape region *Prostanthera aspalathoides, Eremophila glabra, Dodonaea Baueri* and *Melaleuca pubescens* are prominent. *M. pubescens* is also very important on the Woakwine Range, a consolidated dune range in the lower South-East of South Australia.

E. rugosa association.

This association has only been investigated at two places, but on the unconsolidated dunes, where examined, there is a community dominated by *E. rugosa,* while *E. diversifolia* and *E. oleosa* (?) also occur, though much less prominently. There is not the wealth of associated species as on the consolidated dunes, and as one approaches nearer the coast the mallees become very dwarfed and much sparser and there are increases in the number of purely coastal species.

The major species recorded were *Dodonaea humilis, Melaleuca pubescens, Acacia ligulata, Lasiopetalum discolor, Spyridium phylicoides, Choretrum glomeratum, Microcybe pauciflora, Gahnia deusta* and *Scaevola crassifolia.*

6 *Eucalyptus cladocalyx* (sugar gum) edaphic complex.

E. cladocalyx is prominent both on alluvial soils along creeks and on some of the soils derived from the old sedimentaries, as on the Middle River Range and near Stokes Bay. The association along creeks is very variable owing to both varying fertility and water relationships.

E. cladocalyx association.

The fertility levels of the red-brown and brown soils associated with the sugar gum are noticeably higher than of the lateritic gravel type of the plateau. Here *E. cladocalyx* reaches its highest development in a savannah woodland, which may at times be almost closed. Undershrubs and shrubs are rare and grasses are scattered with only a rare tendency to form a continuous ground cover.

Acacia pycnantha, A. obliqua and *A. armata* are of frequent and usual occurrence. Other prominent species include *Olearia teretifolia, Pultenaea daphnoides* and the low sclerophyllous undershrubs *Hibbertia stricta, H. acicularis*

Fig. 1 *Eucalyptus obliqua* association—1 mile east of Archway Lagoon, Hundred of Gosse

Fig. 2 *Eucalyptus cneorifolia*—*E. rugosa* association, Hundred of Menzies

Fig. 1 *Eucalyptus cosmophylla—E. diversifolia* association

Fig. 2 *Eucalyptus cneorifolia—Melaleuca uncinata* association, Hundred of MacGillivray

Fig. 1 *Eucalyptus [illegible]* association, Hundred of Newland

Fig. 2 *Eucalyptus remota* association, Hundred of Gosse

Fig. 1 *Eucalyptus cladocalyx* association—Middle River Range, Hundred of Duncan

Fig. 2 *Eucalyptus diversifolia—E. rugosa* association on consolidated dune limestone

var. *sessiliflora, Astroloma conostephioides* and *Acrotriche depressa. Stipa eremophila* and *Danthonia setacea* are the most frequent grasses.

In many places, as an expression of varying and probably intermediate edaphic conditions, certain conspicuous members of the sclerophyll communities may be present; the most noticeable of these are *Xanthorrhoea Tateana* (yacca), *Casuarina striata* (bulloak), *Melaleuca gibbosa, Grevillea ilicifolia, Leptospermum myrsinoides* and *Lepidosperma concavum.*

Vegetation of the Salt Swamp.

In Hundred of Menzies there is a limited amount of salt swamp and tidal salt marsh unfit for agriculture. The ecology of this area has not been studied closely. The saltwater tea-tree (*Melaleuca halmaturorum*) is of common occurrence, together with samphires, principally *Arthrocnemum halocnemoides* var. *pergranulatum* and the matlike *Wilsonia rotundifolia.*

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BATHERS' ITCH (SCHISTOSOME DERMATITIS) IN THE MURRAY SWAMPS, SOUTH AUSTRALIA

By T. HARVEY JOHNSTON, University of Adelaide

Summary

In 1937 was described *Cercaria jaenschi* from the pond snail, *Amerianna pyramidata*,[1] from Tailem Bend (Johnston and Cleland, 1937).

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[Read 11 September 1941]

In 1937 was described *Cercaria jaenschi* from the pond snail, *Amerianna pyramidata,*[1] from Tailem Bend (Johnston and Cleland, 1937).

It was shown to belong to Miller's (1923; 1926) Group C. of brevifurcate, apharyngeate distome cercariae and to be closely related to *C. douthitti* Cort (1915) from North America. This group, together with Group A (which includes the human schistosomes), Group B (*Schistosomum spindale*), Group D (*C. ocellata, C. elvae*) and certain others, all belong to the Schistosomatidae. Faust, in 1920, published his criteria for the differentiation of schistosome larvae. *C. douthitti* was re-studied by Miller (1924) and has since been shown by Price (1929; 1931) to be the larva of *Schistosomatium douthitti,* which occurs in small North American rodents. Penver (1939) has carried on further experimental work with the species. The life history of a related bloodfluke, *S. pathlocopticum* was traced by Tanabe (1923), who obtained the adult stage by experimental infection of mice. In view of the fact that *C. douthitti* was reported by Cort (1928 *b*) to be a causative agent of bathers' itch in Michigan, U.S.A., it was suggested by Johnston and Cleland (1937) that a similar dermatitis might occur in South Australia.

C. jaenschi has been found in *Amerianna pyramidata* on many occasions between October and May, 1937 to 1941, since its description was published. An additional host is *A. pectorosa* from Robe. We have attempted, without success, to infect rats and pigeons.

In 1939 was published an account of another South Australian schistosome cercaria, *C. parocellata* from *Limnaea lessoni* from Swan Reach (Johnston and Simpson 1939). It was shown to belong to Miller's Group D, and to be closely related to *C. ocellata* from Europe and *C. elvae* from U.S.A. Attempts to infect a duck were unsuccessful. *C. ocellata* has been shown by Brumpt (1931; 1936) to be the larva of *Trichobilharzia ocellata,* and closely related to it is the cercaria of *Bilharziella polonica,* both of these schistosomes occurring in ducks. *C. parocellata* is probably the larva of a *Trichobilharzia.* A species of that genus has been found on a few occasions in the intestinal veins of the black swan, *Chenopis atrata,* in the same swamp at Tailem Bend as the cercaria, and will probably prove to be the adult stage of *T. parocellata. C. parocellata* has been recognised only twice since originally described, having been collected from *Limnaea lessoni* at Tailem Bend in December 1940 and February 1941. It should be stated that the host species has been relatively uncommon in the locality during the past few years, since the Murray Barrage has affected the level (and perhaps the chemical composition) of the water in the river and swamps. Attempts to infect a duck, pigeons and rats have not succeeded.

As a result of enquiries made since the publication of the account of *C. jaenschi,* it has been ascertained that bathers' itch occurs at times during summer and autumn in the swampy areas adjacent to the Murray River at Tailem

(1) Cotton and Godfrey (Gastropoda of South and Central Australia, 1938, 36) indicated that *Amerianna* Strand 1928 is the correct name for the freshwater gastropod genus *Ameria* nom praeocc. The terms *Bulinus, Bullinus, Physa* and *Isidora* have all been applied to this group of snails in Australia.

Bend and at Mannum. Mr. G. Jaensch and several members of his family have from time to time reported to us that they have been subjected to an irritating itching while wading or bathing in the swamp at Tailem Bend, but not when bathing in the main river. The itch was at first regarded as due to attacks by aquatic insects and was recognised as distinct from the effects of bites by the local leeches such as *Limnobdella australis*. The condition was more common at times when the "bubble snail," *Limnaea lessoni*, had been blown close to the shore by winds which had caused the snails to accumulate in certain parts of the swamp. On one occasion Mr. Jaensch, who was then collecting *L. lessoni* for our work, had a large number of them, together with some *Amerianna* spp., in an open tank near his home, awaiting our arrival. We observed that his forearms showed the typical small rounded reddish lesions and pustules just like those figured by Brumpt (1936, fig. 362 *bis*) as occurring in France as a result of invasion by *C. ocellata*; and by Cort (1928 *a*) as caused by *C. elvae* in Michigan. Attempts by the author and members of his staff to infect their arms in the same tank were unsuccessful, and subsequent attempts, using *C. parocellata* from snails brought back to Adelaide, were also ineffective. The result of cercarial attack has been stated by American observers to depend on the number of larvae penetrating at the time, as well as on the individual susceptibility of the person attacked.

Mr. B. C. Cotton, Conchologist, South Australian Museum, reported that he and his brother had experienced a pronounced attack in February 1930, while wading in order to collect mussels (*Hyridella australis*) in a small billabong adjacent to the Murray River at Mannum. An intense itching had developed, then followed red lesions like those caused by biting insects, the urticaria increased, scratching led to some bleeding, and methylated spirits were applied to the affected parts (from the waist to the feet) in the hope of relieving the irritation. The sufferers had been unable to sleep during the night, but the condition began to subside next day and disappeared the following day. Mr. Cotton stated that he had had similar (though less marked) symptoms while collecting molluscs in the swamps at Tailem Bend. Mr. L. Ellis, of Tailem Bend, informed us of prickling sensation, followed by pronounced itching, experienced by him while wading during duck-shooting in the local swamp.

The symptoms seen or described were similar to those reported by Cort (1928; 1936), Matheson (1930), Taylor and Baylis (1930), Vogel (1930) and Brumpt (1936). Since the three cercariae especially responsible, as had been proved experimentally by these authors, in North America and Europe were *C. elvae*, *C. stagnicola* and *C. ocellata*, we have little doubt that *C. parocellata* which is very closely related to them, is the main agent in the Murray swamps. It has been mentioned that Brumpt (1931; 1936) proved that *C. ocellata* reached maturity (as a *Trichobilharzia*) in European ducks. Mathias (1930) succeeded in infecting fowls as well as ducks with it. We regard the *Trichobilharzia* occurring in the local black swans as likely to be the adult stage, though an attempt to infect *Limnaea* has not yet succeeded. *C. jaenschi* is probably able to cause schistosome dermatitis in view of its close similarity to *C. douthitti*, which is a minor causative cercaria in U.S.A.. Since *Schistosomatium douthitti* has been found experimentally and naturally infecting small North American rodents (H. Price 1929; 1931—Penner 1938; 1939), it seems likely that the adult stage of *C. jaenschi* will be found in the Australian water rat, *Hydromys leucogaster*, which occurs in the swamps and is the only aquatic rodent in the area. It should be mentioned that E. Price (1929) described *Paraschistosomatium anhingae* from a darter, *Anhinga anhinga*, from Texas, and stated that the genus was closest to *Schistosomatium*. *Anhinga novaehollandiae* occurs in the Murray swamps.

The first to investigate schistosome dermatitis seems to have been Cort (1928 *a*, *b*), who proved that *C. elvae* Miller (1923; 1926; 1927) was an important causative agent in Michigan. He described the condition and stated that the larva entered through the hair follicles. He referred to a similar dermatitis occurring in Japanese rice fields and known as "Kabure," which was regarded by some investigators (Narabayashi 1916; Matsuura 1909) as caused by invading cercariae of *Schistosoma japonicum*, but other workers (Miyagawa 1913; Faust and Meleny 1924) did not accept that view. Fülleborn (1932) regarded it as due to invasion by non-human schistosomes. Cort considered the severity of bathers' itch to be due, at least in part, to reactions of an abnormal host.

Cort (1928 *b*) proved that *C. douthitti* could, under experimental conditions, produce lesions similar to those caused by *C. elvae*. He had already indicated that *C. douthitti* could utilise snails belonging to the genera *Limnaea* and *Physa* (Cort 1918). Christenson and Greene (1928) found *C. elvae* to be responsible for bathers' itch in Minnesota.

Szidat, in 1930, recorded the occurrence of a dermatitis in East Prussia and suggested that the agent might be the cercaria of *Bilharziella polonica*, but he subsequently informed Cort (1936) that that larva did not penetrate human skin, this statement being supported by the experience of Brumpt (1936).

Dermatitis was reported in 1930 as occurring in a small artificial lake at Cardiff, England, by Matheson (1930) who regarded the organism as *C. elvae*, and by Taylor and Baylis 1930 who identified the cercaria as *C. ocellata*. Vogel (1930) reported many cases in north-western Germany and proved by means of sections that *C. ocellata* had penetrated the skin in experimental infections. Brumpt (1931 *a, b*) reported the latter cercaria to be the causative agent in France, and traced its life history. Wesenberg-Lund (1934) referred to earlier records of dermatitis in Europe and North America and reported an outbreak in Denmark in 1931, most probably due to *C. ocellata* which was known to occur in the same area.

McLeod (1934) recorded dermatitis as common in parts of Manitoba, Canada, where over 50% of bathers were at times affected. The agents were stated to be *C. elvae*, *C. wardlei* and *C. bajkovi*. La Rue (1935) discussed the ecology of the condition in Michigan.

In 1936 Cort and his associates began to publish a series of studies on schistosome dermatitis. In the first contribution Cort (1936 *a*) gave a review of the literature. He pointed out that penetration of the human skin by cercariae of the three human schistosomes seldom produced a significant dermatitis. At least five non-human schistosome cercarie had been shown experimentally to be able to produce dermatitis—*C. ocellata*, *C. douthitti*, *C. elvae*, *C. physellae* and *C. stagnicolae*. The cercariae reported by him in 1928 as *C. elvae* were stated to have been probably *C. physellae* and *C. stagnicolae*. Of the five species mentioned by Cort, all but *C. douthitti* were very similar in structure and had the same flame cell pattern and number of penetration glands, and possessed fin folds on the tail furcae. He went on to state that it seemed possible that the penetration of the human skin and the production of a dermatitis would be found to be a characteristic of all cercariae belonging to that group, and that any new species found with the same general morphology should be placed under suspicion. He remarked on the great variation in susceptibility of individuals to invasion. The character of the skin lesions suggested that the invading cercariae were definitely walled off by the host reaction (a defensive mechanism) and did not reach the deeper tissues or blood stream. The available evidence suggested that the severity of the dermatitis was a manifestation of the natural immunity of man to a non-specific species of parasite, this view being supported by the fact that no comparable dermatitis was ordinarily produced by the cercariae of any human schistosome when they penetrated the skin of man, their natural host.

Watarai (1936) discussed the reaction caused by the cercariae of *S. japonicum* when applied to the skin of animals. Culbertson and Talbot (1935; 1936), as well as Tubangui and Masilungan (1936), had drawn attention to an antagonistic property of normal sera, the cercaricidal action. The production of a histolytic ferment by certain furcocercariae, permitting their penetration of tissues, was studied by Davis (1936 *a, b*), and Hunter and Hunter (1937) showed that such a ferment occurred in the cercaria of *Cryptocotyle*.

Talbot (1936) carried out life history studies on three of the cercariae mentioned by Cort (1936 *a*), *C. elvae*, *C. stagnicolae* and *C. physellae*, the last two being described by Talbot as new. Attempts to infect ducks, gulls, pigeons and rats with each of the three kinds of cercariae were unsuccessful. Cort and Talbot (1936) then gave an account of their observations on the behaviour during their free life of the three species just referred to, as well as *C. douthitti*. Swales (1936) reported *C. elvae*, *C.* sp. (determined by Talbot as *C. stagnicolae*) as causing dermatitis in Manitoba, and considered that McLeod (1934) was in error regarding *C. wardlei* and *C. bajkovi* as agents, these latter being strigeid larvae. Further information concerning the distribution of schistosome dermatitis in Canada and U.S.A. was given by Cort (1936 *b*), who reported that a similar condition occurred in Iowa, North Dakota, Illinois, Texas, Florida and Washington. Cort also mentioned that Miller had informed him that *C. tuckerensis*, described by Miller (1927) as a member of the *elvae* group, occurring commonly in *Planorbis* in the State of Washington, was able to produce dermatitis experimentally.

Brumpt (1936) gave a very brief account of several schistosome larvae known to be capable of causing human dermatitis, and included *C. wardlei* and *C. bajkovi* because of McLeod's statements (1934). In the account of *C. elvae* Brumpt was in error in stating that a pharynx occurred in that species, thus constituting a difference between it and *C. ocellata*.

McLeod (1936) published further notes on cercarial dermatitis in Manitoba, stating that the condition was common in many parts of Canada, from Quebec to the Rocky Mountains. He described two new species of *Microbilharzia* from ducks (*Nyroca*), but their life history was unknown. Next year he gave an account of two more schistosomes from water birds, *Pseudobilharziella querquedulae* from a teal (*Querquedula*) and *Ornithobilharzia lari* from a gull. Cercariae causing dermatitis were abundant in the same locality as also were their known molluscan hosts, *Limnaea* and *Stagnicola*, and it was suggested that *P. querquedulae* might be the adult of one of the local dermatitis-producing cercariae (McLeod 1937).

Cort, McMullen and Brackett, in 1937, published their ecological studies on the cercariae occurring in the common beach snail, *Stagnicola emarginata*, in Michigan, this snail being the vector for *C. stagnicolae* which is responsible for most of the swimmers' itch in that State. Buckley (1938) reported that the cercaria of *Schistosoma spindalis* of cattle caused a dermatitis known as Sawah itch in workers in Malayan rice fields. Edwards and Brackett (1938) referred to swimmers' itch in Wisconsin as a schistosome dermatitis, and in 1939 Brackett indicated methods for control. Cort (1939) gave a brief survey of the condition as a public health problem in U.S.A., and stated that of the five known causative agents, *C. douthitti* was the only one whose life history was known. McMullen, Rezin and Allison (1939), in discussing the distribution and epidemiology of the dermatitis in Michigan mentioned that *C. physellae* was the chief agent there.

Brackett (1940 *a*) described two new schistosome cercariae, *C. gyrauli* and *C. elongata*, from Wisconsin. The former was stated to be closely related to *C. elvae*, *C. physellae*, *C. stagnicolae* and *C. ocellata*; and *C. elongata* to be near

C. douthitti. He reported that one, perhaps both, of these cercariae were able to produce dermatitis. Brackett (1940 *b*) discussed the prevalence of bathers' itch in Wisconsin. Cort (1940), in an address on helminth diseases, referred to swimmers' itch in Michigan, and stated that the State Board of Health had organised a special unit of research workers to study the problem with a view to formulating control measures against the dermatitis that had become so common on certain beaches as to constitute a real menace to the tourist business which was the second most important industry of that State.

Brackett (1940 *c*), who was one of the members of the team referred to by Cort, paid special attention to the behaviour of the cercariae concerned and reported that a rapid rise in temperature along the bathing beaches caused an increased emission of cercariae from infected snails. The cercariae were all positively attracted towards light, and thus reached the surface layers of the water even from snails living in deeper water. Some of the cercariae were found to be able to swim a metre in three minutes, and to cover a distance of at least 10 metres. He also referred to *C. tuckerensis* as a known agent of dermatitis but its habits were different from the others since it crawled along the floor and was perhaps not affected by light.

Cort, McMullen, Olivier and Brackett (1940 *a*) discussed particularly the relation of *C. physellae* and *C. stagnicolae* to their respective host species, to their environment, and to the seasonal incidence of dermatitis on the shores of Lake Michigan. These same authors (1940 *b*) published detailed information regarding the seasonal incidence of *C. stagnicolae* in relation to the life cycle of its snail host, and discussed the epidemiology of the dermatitis caused by that species of cercaria which was commonly concentrated in shallow warm water. The species apparently penetrated when water containing them dried in the human skin—hence the resulting dermatitis was usually worse in children who played in shallow water and in adults who entered and left the water repeatedly. The great increase in prevalence of swimmers' itch was probably due to the increase in the use of the beaches for bathing purposes rather than to any increase in infection of the snails by schistosome cercariae.

Brackett (1940 *d*) dealt with the life cycle of the snails concerned in Wisconsin and studied the relation of young and adult molluscs to the occurrence of swimmers' itch. The cercaria of *Schistosomatium pathlocopticum* was not known to be able to cause dermatitis, and though *S. douthitti* larvae could do so, Brackett thought the latter species was not of importance in connection with the outbreaks, but that the cercariae of avian schistosomes were responsible for most of the dermatitis amongst bathers in the Great Lakes region. He brought forward reasons for suggesting that *Pseudobilharziella querquedulae* McLeod (1937) from ducks might be the adult of *C. physellae*, while *C. gyrauli* or *C. elongata* might belong to an undescribed schistosome from a grebe. The natural host for the adult of *C. elvae* was unknown, but was probably a gull; the adult stage (as yet undescribed) had been obtained experimentally in pigeons.

McLeod (1940) published his further studies on cercarial dermatitis in Manitoba. He drew attention to the differences in human resistance to invasion by schistosome cercariae. The latter could be distributed amongst four groups, according to their reaction: (*a*) those which did not respond positively to the presence of man in water; (*b*) those responding positively but unable to penetrate the human skin; (*c*) those which responded and penetrated the skin, but owing to lack of balance between the host and parasite did not enter deeply, the result being a localised skin reaction; and (*d*) those which responded positively, penetrated the skin, and eventually reached the portal vein and its branches to reach sexual maturity, this group commonly causing no skin reaction. To group (*d*) belong the human schistosomes, while those causing dermatitis are in group (*c*). In addition to the cercariae already mentioned as causative agents, McLeod added *C. pseudo-ocellata* Szidat 1933 and *C. dermolestes*, a new species which he described from *Stagnicola*. The latter belonged to the *elvae* group. He reported that his *C. bajkovi* should be suppressed, since it was based on a confusion of two species; and *C. wardlei* was a strigeid larva and did not produce dermatitis. He described two new species of *Ornithobilharzia* (from ducks and gulls respectively.

Consideration of the observations and investigations in America and Europe leads one to expect that, in addition to *C. parocellata*, several other closely related species are likely to be found in Australia capable of causing dermatitis. The chief transmitters elsewhere are pond snails belonging to the Limnaeidae (*Limnaea, Stagnicola*), but Physidae (*Physa, Physella*) and Planorbidae (*Planorbis*, etc.) are also concerned. The commonest Australian pond snails are Physidae. In the great Murray watershed *Limnaea* and *Planorbis* are also present, but are much less frequently met with than are species of *Amerianna* and related genera of Physidae. For the present, all pond snails must be considered suspect. Detailed systematic examination of such molluscs for the presence of schistosome or any other kind of cercariae has not been carried out anywhere in the Commonwealth except in the one region in South Australia, where our investigations have led to the incrimination of two (probably three) species —*Limnaea lessoni, Amerianna pyramidata* and apparently also *A. pectorosa*. By far the great majority of furcocercariae occurring in our pond snails have proved to belong to the Strigeata whose larvae are not known to be able to penetrate human skin.

In U.S.A. and Canada dermatitis is especially prevalent in the region of the Great Lakes and the associated rivers. In these areas there are many large centres of population, the inhabitants using the beaches of the lakes as tourist and bathing resorts because of the remoteness of ocean beaches. In Australia conditions are not quite similar. Our population is located mainly in the coastal region and there are relatively few large centres associated with our huge Murray drainage system, and the main towns along the Murray, Darling and other tributaries in New South Wales and Victoria are generally far apart. Except for Lakes Alexandrina, Albert and Victoria there are no extensive freshwater lakes except such as have resulted from the water conservation schemes associated more particularly with the Murray waters, *e.g.*, at Barmera. We may then expect to hear occasionally of dermatitis as a result of bathing or wading in lakes, billabongs and swamps, provided these are rather shallow, with plentiful plant life suitable as food for pond snails, especially if *Limnaea* be present.

If the various coastal lakes or lagoons of Eastern Australia be sufficiently fresh to permit pond snails to flourish in them, dermatitis may be expected there, too, since Physidae and *Planorbis* are common in the eastern coastal streams and pools, though *Limnaea lessoni* apparently does not occur in them.

Areas of freshwater which afford a suitable habitat for native ducks and black swans, as well as associated birds (terns, gulls, pelicans, etc.) should be regarded as possible regions for dermatitis, if used by human beings for bathing or wading (unless suitably protected). Anseriform and lariform birds are probably the main hosts for the adult stages of the dermatitis-producing cercariae issuing from the appropriate pond snails. E. Price (1929), in his valuable synopsis of the Schistosomatidae, indicated that five species of bloodflukes, distributed amongst four genera, were known from ducks, and four species (belonging to three genera) from terns and gulls. To Price's list from ducks and gulls must be added those described by McLeod. Only one species of native bloodfluke has been described from Australia, *Austrobilharzia terrigalensis* S. J. Johnston, from the common gull, *Larus novaehollandiae,* at Terrigal, New South Wales. This schistosome has been met with several times in the same host species on the Adelaide beaches, but not, as yet, in gulls from the swamps and rivers.

We have not yet found *Limnaea lessoni* in the main stream of the Murray which is too deep for the favoured food plants, but the snail occurs in the shallow, slowly moving or still swamps and bywaters where plenty of suitable food is available for pond snails as well as for bird life. Such waters, because of their shallowness, become very warm under the influence of the bright Australian sun in summer and autumn. Such conditions of increased water temperature and intensity are known to cause a rapid increase in the rate of development of cercariae and their emission from infected snails, as well as in the activity of such cercariae while free-swimming. The effect of a suitable wind in wafting shorewards *Limnaea lessoni* which, if detached from the water weeds, readily floats (hence the popular local name of "bubble snail" for it), is an important factor in the occurrence of dermatitis.

Cherry (1917), in his article relating to human schistosomiasis, mentioned finding eyeless apharyngeate fork-tailed cercariae in *Bulinus ? tenuistriatus* near Melbourne. Bradley (1926) described *Cercaria greeri* from *Bulinus brazieri* near Cooma, New South Wales, but was unable to give a satisfactory account of its glands. He believed that a pharynx was absent. In the same paper Bradley described a new Xiphidiocercaria, *C. pellucida,* found commonly in *Limnaea brazieri* and less frequently in *Bulinus brazieri.* It was stated to belong to the *Polyadena* group and to be near *C. brevicaeca* Cort. It is probably the larva of a Plagiorchid, Since the specific name had been used previously by Faust (1917) for a trioculate monostome cercaria from Montana, U.S.A., Bradley's form is now renamed **C. bradleyi** nom. nov., and *Limnaea brazieri* is considered as its type host. In a later paper (1933), Bradley referred again to his *C. pellucida* and *C. greeri,* calling the latter a schistosome larva. His figures (1926) indicate *C. greeri* to be a longifurcate cercaria with well-developed subequal suckers and apparently with small gland cells in preacetabular position. All known schistosome cercariae belong to the brevifurcate group. The presence of a pharynx is sometimes detected only with difficulty and may have been overlooked by Bradley. *C. greeri* seems to be a strigeid larva. The only strigeids known to be devoid of a pharynx are species of *Apharyngostrigea,* a genus which occurs in herons in Australia and elsewhere. If a pharynx be present and the glands be situated in front of the acetabulum, then the cercaria may belong to a species of *Cotylurus.* Ross and Mackay, in 1929, mentioned finding *C. greeri* and *C. pellucida* in *Limnaea brazieri* in New South Wales.

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Summary

1. The occurrence of bathers' itch in the swamps of the Lower Murray at Tailem Bend and Mannum, South Australia, is reported.

2 A review of the recorded occurrences of, and observations on, schistosome dermatitis and of its relation to pond snails in other parts of the world is given.

3 The probable relation of *Cercaria jaenschi* from *Amerianna pyramidata* and *C. parocellata* from *Limnaea lessoni* to the South Australian occurrences is discussed.

4 It is suggested that these latter cercariae are the larval stages of schistosomes occurring in birds (probably ducks and black swans) frequenting the swamps.

5 *Amerianna pectorosa* is recorded as an additional snail host for *Cercaria jaenschi.*

6 The presence of the bloodfluke, *Austrobilharzia terrigalensis,* in gulls (*Larus novaehollandiae*), in St. Vincent Gulf is recorded.

7 *Cercaria bradleyi* nom. nov., is proposed for *C. pellucida* Bradley 1926 (nec Faust 1917), probably a Plagiorchid larva, from *Limnaea brazieri* in New South Wales.

8 *Cercaria greeri* Bradley appears to belong to the Strigeata instead of the schistosomes.

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LIFE HISTORY OF THE TREMATODE, PETASIGER AUSTRALIS N. SP.

By T. HARVEY JOHNSTON and L. MADELINE ANGEL, University of Adelaide

Summary

Petasiger australis n. sp. is a minute echinostome occurring in the grebes, *Podiceps ruficollis novaehollandiae* Stephens and *P. poliocephalus* Jardine and the swamps at Tailem Bend, South Australia. For assistance in collecting this material we are indebted to Messrs. G. and F, Jaensch and L. Ellis, of Tailem Bend. Our investigation has been assisted by the Commonwealth Research Grant to the University. Type material deposited in the South Australian Museum.

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By T. Harvey Johnston and L. Madeline Angel, University of Adelaide

[Read 11 September 1941]

Petasiger australis n. sp. is a minute echinostome occurring in the grebes, *Podiceps ruficollis novaehollandiae* Stephens and *P. poliocephalus* Jardine and Selby, in the swamps at Tailem Bend, South Australia. For assistance in collecting this material we are indebted to Messrs. G. and F. Jaensch and L. Ellis, of Tailem Bend. Our investigation has been assisted by the Commonwealth Research Grant to the University. Type material deposited in the South Australian Museum.

The largest parasite measures about ·7 mm. long, with its maximum breadth (·28 mm.) at the midacetabular level. Other dimensions are: width at sex pore, ·2 mm.; at level of ovary, ·26; across testicular zone, ·2-·25; at narrowest part of neck, ·12; across head collar, ·17. The anterior part of the body (except the head) is rather flattened and minutely spiny, with spinules arranged in closely-set rows. The posterior region is much thicker and devoid of spines. The reniform head bears 19 spines, 11 of them evenly spaced in a single unbroken series, and two pairs in each ventral angle, arranged more or less transversely to the long axis of the worm. One of each pair is slightly longer than the other, lengths ·054 and ·047 mm. respectively, while the remainder are about ·025 mm. long. The oral sucker is almost terminal and ·045 mm. broad by ·05 long. The acetabulum lies mainly in the hind-body, its anterior border being just in front of the midlength of the worm; it measures ·17 mm. broad by ·16 mm. long, the sucker ratio being about 1:3·7; sex pore near end of first third of body.

The prepharynx is about ·02 mm. long, the pharynx ·04 mm., the oesophagus about ·1 mm. and extending almost to the genital pore. The crura at first diverge widely to skirt the border of the cirrus sac, metraterm and acetabulum, terminating a short distance behind the level of the posterior testis.

The anterior testis is ·11 by ·07 mm. and obliquely placed on one side of the worm; the posterior testis is ·12 by ·08 mm., and the two glands are in contact along part of their inner surfaces. Both testes and ovary are in the posterior third of the body length. The large cirrus sac, ·13 mm. in length by ·11, occupies the region between the crura and the anterior border of the acetabulum on the same side of the body as the ovary and posterior testis. A considerable part of the sac is occupied by deeply-staining prostate cells, but a large seminal vesicle lies in its posterior portion.

The spherical ovary, ·06 mm. in diameter, lies dorsally between the posterior testis and the acetabulum. The shell gland is nearly median, beside and partly above the anterior testis. The uterus has two or three short convolutions. The metraterm lies on the opposite side of the acetabulum from the cirrus sac. The eggs are large (·085-·09 by ·05-·06 mm.) and few (one to seven, usually about four). Yolk glands obscure the intestinal crura and extend from just behind the level of the sex pore almost to the end of the worm, the opposite vitelline fields joining in a narrow zone behind the testes. They lie above and below the crura, as well as laterally from them. The transverse yolk duct is just in front of the posterior testis and above the anterior testis.

The smallest worm measured ·48 mm. long; the longest which had not yet become egg-bearing was ·57 mm. The smallest parasites containing each a single egg were ·59 and ·61 mm. long. Most specimens were ·66 mm. long.

Petasiger australis differs from *P. exaeretus* (Dietz, 1909; Davies, 1934) and *P. variospinosus* Odhner 1911 from *Phalacrocorax carbo* in the number of collar spines (27 in each) and position of the testes. Several species, all with 19 collar spines, are known from grebes. The nearest known relative of *P. australis* is *P. nitidus* Linton 1928, redescribed by Beaver (1939), from *Colymbus auritus* from Massachusetts, but the two differ in the dimensions of the body, organs and collar spines and in the sucker ratio. Yamaguti (1933) described *P. lobatus* from *Podiceps ruficollis japonicus*, but that species differs from the Australian in the sucker ratio and especially in the form and arrangement of the testes. The account of *P. novemdecim* Lutz 1928 from a Venezuelan *Phalacrocorax* is not available to us. *P. pungens* (Linstow), from *Colymbus nigricans* in Central Europe, differs (judging from the summary account given by Lühe 1909) in general form, length of oesophageal region and the arrangement of the testes.

We have studied a large-tailed species of echinostome cercaria which agrees in general structure and reactions with that described by Beaver (1939) as being the larva of *Petasiger nitidus*, which, as already mentioned, is a 19-spined form from a North American grebe. Our cercaria obviously belongs to a species of *Petasiger*, closely related to *P. nitidus*. All known species possessing 19 spines have been taken from grebes, a group to which *Podiceps* spp. belong. We have not recognised *Petasiger* amongst the trematodes found in any other birds so far examined by us. The adult worms and the cercariae were found at the same time and in the same swamp. In view of these facts we have little doubt that they belong to the same species, though our attempt to infect a canary with metacercarial cysts in the hope of obtaining adult stages proved unsuccessful. Until actual proof has been established, we deem it advisable to describe the larval stages (redia, cercaria and metacercaria) under a distinctive name, *Cercaria gigantura* n. sp.

Cercaria gigantura n. sp.

Of 2,500 *Amerianna pyramidata* collected in February 1941 from the Murray swamps at Tailem Bend, 10 were found to be infected with a new type of echinostome cercaria. In the following March one of 424 of the snails was infected, in April none of 148, in May none of 64, and in June one of 27. Thus from April 1937 (when routine examination of the swamps was commenced) to June 1941, this cercaria has been found on only three occasions. We have found only 12 out of 3,163 *A. pyramidata* infected, *i.e.*, under ·4% during the summer and autumn of 1941. The distinctive feature of the cercaria is the relatively huge tail, which makes the swimming action clumsy. The tail does not appear to propel the body by the figure of eight movement characteristic of most echinostome cercariae, but lashes the water with a snake-like movement. The animal frequently hangs vertically with tail straight and body downwards, in which position it sinks gradually, though the resting period is not as a rule longer than six seconds. The cercariae emerge from the snail over-night (probably in the early morning) and up till midday, and have been observed to live for at least 30 hours. Although eye-spots are not discernible, the cercariae exhibit positive phototropism.

Probably because of the thickness of the tail, the cercaria does not perform sucker-to-sucker creeping movements under the compression of a coverslip. A pressure which will flatten the tail and keep it almost still, will allow a fair range of movement of the body, while sufficient pressure to enable the body to be studied in detail results in the loss of the tail. With only slight compression the animal oscillates about one axis, the tip of the tail describing almost 180°, while the body has a more limited range, probably a swimming movement limited to one plane.

Redia

The pale orange rediae are closely packed within the liver of the snail, where the individuals are clearly visible to the naked eye by reason of the black intestine. They vary in length from 0·8 to 1·4 mm., while the diameter is from 150 to 200 μ.

Each redia generally contains five or six cercariae. The birth pore was not seen, but a short distance behind the anterior end the collar shows as a definite protuberance. The foot processes are prominent, and behind them is a narrow terminal part, with somewhat the appearance of a tail. In this region there are generally a number of fairly large germ balls, and it seems probable that the nearly

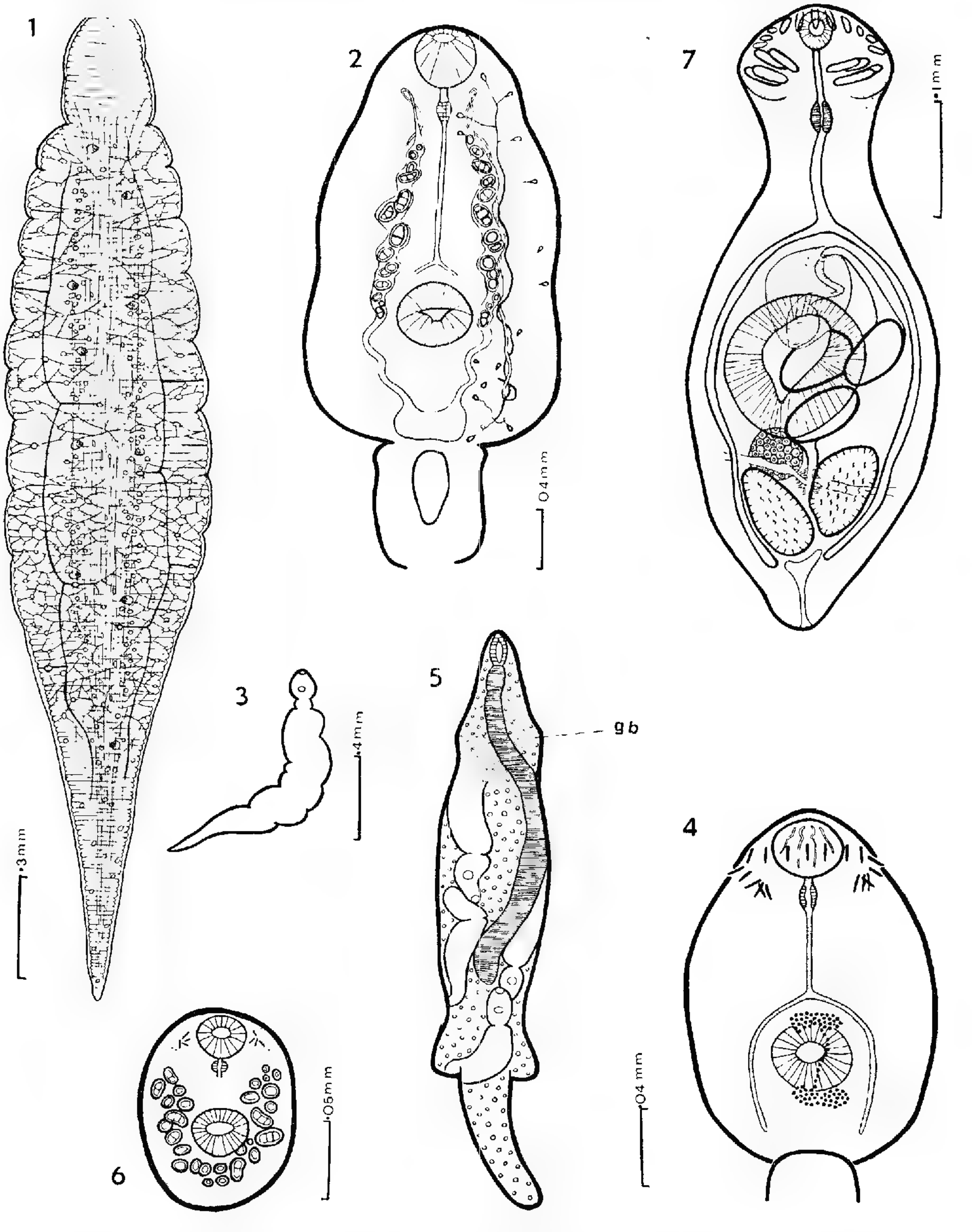

Fig. 1-6, *Cercaria gigantura:* 1, tail; 2, excretory system from living cercaria; 3, 4, formalinised cercariae (in fig. 4 arangement and size of spines probably not precisely accurate—errors due to difficulty of determination, compression of cercaria, etc.); 5, redia; 6, cyst. Fig. 7, *Petasiger australis:* ventral view. Vitellaria not indicated. Fig. 1, 5, to same scale. g.b., germ balls.

mature cercariae do not remain in this region but migrate anteriorly, which would explain the smaller diameter of the part. The gut varies from half to seven-eighths (commonly three-quarters) the length of the redia.

Cercaria

For measurements, the cercariae were killed by the addition of an equal volume of boiling 10% formalin to the water containing them. This standard method resulted in the cercariae being fixed in different positions, from one of maximum contraction to one of great extension. In the former case the body measured 105 by 100 μ, while the most extended specimen was 267 by 70 μ. Actual range in ten specimens measured 105 to 267 μ long by 50 to 100 μ wide.

Between the body and the tail proper is a relatively short neck, the diameter of which is less than that of the body. Most of the central part of the neck is occupied by an extension of the excretory bladder. The neck region is coloured by the same orange pigment as is present in the cystogenous cells of the body; it varies from 50 to 167 μ long by 17 to 54 μ wide. The rest of the tail, the measurements of which are necessarily only approximate because of the distorted positions in which it is fixed, varies from 434 to 584 μ long by 134 to 200 μ at the widest point. There is a definite apical region in the tail, which narrows suddenly, the tip so formed (which is very obvious in the resting position) ranging, in formalinised specimens, from 83 to 192 μ by 33 to 42 μ.

The tail has a transparent, glassy appearance, although at the margin, which is notched at intervals, the cuticle has a greenish tinge. The central third is occupied by longitudinal muscle fibres which appear to have their origin at the junction of the tail proper with the neck, and taper off towards the tip. Abundant myoblasts are associated with these fibres. A number of fine radial muscle fibres, arising from just beneath the cuticle, insert in the central longitudinal strand. In addition to the longitudinal and radial muscles, there is a somewhat complex system of fibres. Each unit of this system forms a reticulum which has its mid-point at one of the marginal notches and ends on either side about midway between notches, while centrally the muscle strands attach to the longitudinal fibres. About half-way down the tail this system forms a more or less continuous reticulum (fig. 1). Laterally to the main longitudinal muscles on either side is a very fine thread which continues throughout the length of the tail nearly to the tip, and is connected occasionally with the margin as well as with the central muscle strands.

The entire body is beset on both dorsal and ventral surfaces with parallel rows of spines. There are many cystogenous cells which are filled with long rod-like crystalline bodies of a bright orange colour. These cystogenous cells, which are arranged in a series of bands running longitudinally from the post-pharyngeal region to the posterior end of the body, are even more resistant to the passage of light than is ordinarily the case in echinostomes, and details of anatomy are consequently difficult to determine. No gland cells can be seen, even with intra-vitam staining, but what appear to be four very fine ducts are present in the region of the oral sucker. The collar region is more distinct than in other echinostome cercariae we have examined. The spines are arranged in a single row, uninterrupted dorsally; the total number is 19, of which four on each side form a corner group. There is no obvious differentiation in the size of the spines, the length of each being about 13 μ.

The acetabulum is slightly larger than the oral sucker, the diameter in formalinised specimens ranging from 28 μ across the transverse diameter by 21 μ lengthways to 38 by 30 μ for the acetabulum, and from 21 to 30 μ for the round oral sucker. The acetabulum is situated slightly behind the mid-line of the body, the ratio of length of the body in advance of the acetabulum to that part including the latter varying from 5:4 to 3:2.

The alimentary system is not obvious; there is a short prepharynx, and the oesophagus and intestinal crura are very narrow and filled with finely granular material. The crura extend almost to the posterior end of the body.

The excretory system conforms to the plan of the typical echinostome. The pre-acetabular part of the main excretory tubes is very prominent; each contains 12-14 large round or oval excretory bodies with doubly refractive margins. In some cases two or three granules, though maintaining their individuality, are enclosed in a common refractive envelope. In addition, there may be 4-6 smaller single granules. The anterior part of each main tube does not form a distinct triangle, as is usually the case in echinostomes, but each tube forms a small loop as it turns posteriorly. The posterior collecting tube is short and unites with the anterior tube at the side of the excretory bladder. Examination of the cercaria in equal parts of horse serum and water enabled us to see a number of flame cells which were invisible by other means. Even with this help it was not possible to demonstrate the exact connections of all the flame cells, but we are satisfied that they are arranged in groups of three, and we think that there are five or six groups on each side of the body, making a total of 30-36 flame cells. There is an extension of the bladder in the "neck" of the tail, but we could see no excretory tube in the tail itself. The excretory pore probably opens on the dorsal surface at the junction of the body with the tail.

The genital anlage, which stains deeply with haematoxylin and other permanent stains, is represented by two masses of tissue, anterior and posterior respectively to the acetabulum and connected by a narrow string of cells.

Cyst and Metacercaria

The cercaria was found experimentally to encyst in the following Australian native fish, *Retropinna semoni*, *Philypnodon grandiceps*, *Nannoperca australis*, young *Tandanus tandanus;* and in the aquarium fish, *Phalloceros caudo-maculatus*, *Oryzias latipes*, *Carassius auratus* and *Gambusia affinis*. Of a large number of fish from the River Murray swamps which have been examined, none were found to be naturally infected with cysts of *Cercaria gigantura*. However, these cysts were found in *Nannoperca australis* from the River Finnis (collected in March 1941). In all cases the cysts were limited to the wall of the oesophagus and the pharyngeal region. Negative results followed attempts to infect tadpoles, *Lymnodynastes* spp.; the shrimp, *Paratya australiensis;* a triclad; and the molluscs, *Planorbis isingi*, *Limnaea lessoni* and *Corbiculina angasi*. A few of the host snails (*Amerianna pyramidata* and *A. pectorosa*) contained a number of cysts in the liver. Those snails which were examined in the summer contained no cysts, and we suggest that the occurrence just mentioned may not be a normal event, but was probably due to the lateness of the season, coupled with the fact that the snails had been isolated daily for some considerable time in small tubes, when the cercariae must encyst in the snail from which they had emerged, or perish.

The small, oval, rather flat cysts are remarkably uniform in size, being about 125 by 75 μ. They have thick walls through which the pale orange colour and the large dark excretory granules of the contained metacercaria show clearly.

In general features, the metacercaria shows no advance on the cercarial stage. Orange pigment is still present in the body, and cannot, therefore, be associated only with the cystogenous cells in the cercaria; it appears to be mainly in the hind end, and relatively scarce anterior to the acetabulum. The metacercaria could not be expressed from the cyst sufficiently intact to enable us to study it in the living state, and hence we have obtained no information regarding the excretory system. The collar spines are more definite than in the cercaria.

Cercaria gigantura resembles *C. Petasigeri-nitidi* Beaver 1939 very closely. If it should prove (as we anticipate) to be the cercaria of *Petasiger australis* it will be evident that here is a type of echinostome life-history in which the structure of the cercaria, apart from the collar spination, is an indication of the genus of the adult, the number of spines being a specific or group character.

Other characters in which the two cercariae are in general agreement are the following: length of life; resting and swimming action; positive phototropism; size; collar spination; relative sizes of oral sucker and acetabulum. They differ, however, in the following features: *C. Petasigeri-nitidi* colourless, *C. gigantura* orange-yellow; prepharynx long in former, short in latter; three pairs of gland cells present in former, not visible in latter; 20 to 25 excretory granules in *C. Petasigeri-nitidi*, 12 to 14 in *C. gigantura*; dorsal collar spines 5 to 6 μ in former, 13 μ in latter. They also differ in the shape of the bladder and in the flame cell formula. In *C. Petasigeri-nitidi* the longitudinal bands of the tail musculature are poorly developed and circulo-diagonal bands well developed, while in *C. gigantura* the longitudinal muscle is well developed, and there is no circulo-diagonal muscle; and there is no dorso-ventral flattening of the tail as in *C. Petasigeri-nitidi.*

The two rediae agree in most features; that of *C. gigantura* is probably smaller and the collar is not divided into four distinct folds. We confirm Beaver's observation that great masses of cercariae consistently were found free in the tissues, from which Beaver concluded that the cercariae apparently require a period of maturing in the snail's tissues, after emerging from the rediae.

For the cysts, Beaver states that, exclusive of host tissues, they vary round 85 by 68 μ; this makes the ratio of length to breadth 5:4, but his figure shows a ratio of 5:3, which corresponds with the ratio given by our measurements for *C. gigantura* (125 by 75 μ). As with *C. gigantura*, the cyst of *C. Petasigeri-nitidi* is slightly flattened.

Beaver mentioned four other described species of large-tailed echinostome cercariae, all of which closely resemble *C. Petasigeri-nitidi* . We have examined the accounts of these cercariae—*C. magnacauda* O'Roke 1917,[1] *C. caudadena* Faust 1921, *C. cita* Miller 1925 (not described till 1929) and *C. oscillatoria* Brown 1931—and find that *C. gigantura* differs from each of them. Since Beaver has listed the features separating them from *C. Petasigeri-nitidi*, in many of which they differ also from *C. gigantura*, we do not propose to distinguish between them specifically. *C. cita* appears to resemble *C. gigantura* most closely, but the description of the former does not include either the number of collar spines or the flame cell formula, and Miller did not find the cyst. In addition to this, *C. cita* is described as having gland cells from the acetabulum to the pharynx, and this in itself we regard as sufficient to separate it from *C. gigantura*, in which it was not possible for us to identify any gland cells.

Szidat (1937) described *C. gigantocerca*, which he regarded as belonging to the Psilostomidae, near *Sphaeridiotrema*; the body of this cercaria, as figured, was very similar to that of an echinostome cercaria, but lacked collar and spines. The tail was huge, and though the figure is lacking in microscopic detail the relative sizes of the tail and body in *C. gigantura* and *C. gigantocerca* Szidat appear to be comparable, while the absolute sizes are very similar. The close resemblance of these two forms is further evidence of the relationship between the Echinostomidae and the Psilostomidae.

In describing *C. oscillatoria*, Brown stated that he found cysts in the tissues of the cercarial host snail, and that they appeared to be the encysted stage of

(1) O'Roke described *C. magnacauda* as a megalurous cercaria, but Miller who examined a slide of *C. magnacauda* (in 1929) lent him by O'Roke, identified it as an echinostome.

C. oscillatoria. Beaver (1939) thought that Brown probably observed another species of echinostome—evidently on the grounds that he (Beaver) did not expect this type of cercaria to encyst in a snail. However, we have indicated that *C. gigantura* will encyst in the snail host. The main point of difference is that Brown's cyst was spherical, while the cysts of *C. gigantura* and *C. Petasigeri-nitidi* are of the same oval, partly flattened, type. However, Brown stated that the compound nature of the calcareous concretions in the main collecting tubules was suggestive of *C. oscillatoria,* and we are inclined to agree that the cyst was the encysted form of *C. oscillatoria.*

The occurrence of these cercariae, which have been definitely identified as echinostome larvae, obviously calls for some modification of the accepted classification scheme for echinostome cercariae. Brumpt (1936), following Luhë's classification (Luhë 1909), which Brumpt says has been adopted by most authors, lists echinostome cercariae under Leptocercariae, with tail narrower than the body. In cercariae of the *magnacauda* group the tail is greater in length, breadth and thickness than the body, and these cercariae must be regarded as an aberrant type which develops into a typical echinostome cyst and adult. Sewell (1922) proposed three sub-groups for the echinostome cercariae, but this separation appears to us to be no longer satisfactory in view of the large number of echinostome cercariae which have been described since then.

In an effort to obtain the adult of *C. gigantura* experimentally, a canary and two pigeons were fed with cysts of the cercaria over a number of days, but on dissection of the birds some fortnight later no trematodes were found.

Summary

1 *Petasiger australis* n. sp. is described (from hosts *Podiceps ruficollis novaehollandiae* and *P. poliocephalus*) from South Australia.

2 A large-tailed echinostome cercaria, *C. gigantura,* is recorded (from *Amerianna pyramidata*) from the same locality, and is considered to be the larval form of *Petasiger australis.*

3 The redia, cercaria, cyst and metacercaria of *C. gigantura* are described, and their intermediate hosts recorded.

4 *C. gigantura* is compared with other known large-tailed echinostome cercariae.

5 The relationship of the Psilostomidae with the Echinostomidae is further shown by comparison of *C. gigantocerca* Szidat and *C. gigantura.*

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THE RED-LEGGED EARTH-MITE (ACARINA, PENTHALEIDAE) OF AUSTRALIA

By H. WOMERSLEY, F.R.E.S., A.L.S., South Australian Museum

Summary

Family PENTHALEIDAE Oudemans 1931

This small family of mites is of considerable economic importance to Australian agriculture, for it includes at least two species which are major pests of pasture and fodder in this country. It includes four genera, all of which are represented here by at least one species in each.

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[Read 11 September 1941]

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The earth-mites are small soft-bodied and soft-skinned animals of a black colour, with or without red dorsal patches, and with bright red legs and mouth-parts. They are phytophagous in habit, many living in moss, but those of economic importance occur in immense numbers in pastures and vegetable gardens, where they become a serious nuisance.

The four genera may be separated by the following key:

1. Cuticle strongly reticulated, punctured or rugose. Body not globose
   Gen. *Stereotydeus* Berl. and Leonardi 1901
   incl. *Tectopenthalodes* Tragdh. 1907
   Cuticle smooth or at most faintly hexagonally patterned in punctured lines. Body more or less globular. 2
2. Anus dorsal. Cuticle smooth. Gen. *Penthaleus* Koch 1835
   = *Notophallus* Canest. 1886
   Anus ventral. Cuticle sometimes hexagonally patterned. Gen. *Penthalodes* Murray 1877
   = *Penthaleus* Koch 1835 (in part)
   Anus terminal. Cuticle smooth. Gen. *Halotydeus* Berl. 1903
   = *Penthaleus* Koch 1835 (in part)

Genus Penthaleus Koch 1835 (in part)

In Panzer, Deutschl. Crust., Hft. I, tab. 12, 1835.
= *Notophallus*, Canest., Atti Ist., Veneto., (6), **4**, 697, 704, 1886.

Penthaleus major (Duges 1934)

Tetranychus major Duges 1834, in Ann. Sci. Nat., (2) **2**, Zool., 53.
For further synonymy see Womersley 1935, Bull. Ent. Res., **26**, (2), 163.

This is an introduced species, abundant in many agricultural areas in Australia, where it is an important pest on pasture and fodder crops. It also occurs in certain areas in South Africa. Its separation from the following species is discussed hereunder.

Penthaleus minor (Canestrini 1886) Fig. A-C

Notophallus minor Canest. 1886 Acarof. ital., **211**, tav. 18, fig. 16; Berl. 1892, A.M.S. ital. rept., fasc. 61, No. 5.

I have known of the occurrence of this second European species in Australia for some time but have not hitherto recorded it. It is rather smaller than the preceding and can be distinguished as follows:

1. Movable finger of chelicerae slender and stylet-like for its whole length, and with a right-angled base; basal portion of fixed finger broadly membraneous. Apical segment of palp as long as penultimate. *P. major* (Duges 1834)
2. Movable finger of chelicerae without right-angled base; basal half uniformly wide and wider than apical half. Apical segment of palp shorter than penultimate.
   P. minor (Canest. 1886)

Localities—South Australia: Morialta Gorge, Adelaide, September 1934 (H. W.). Western Australia: Katanning, June 1940 (K. R. N.).

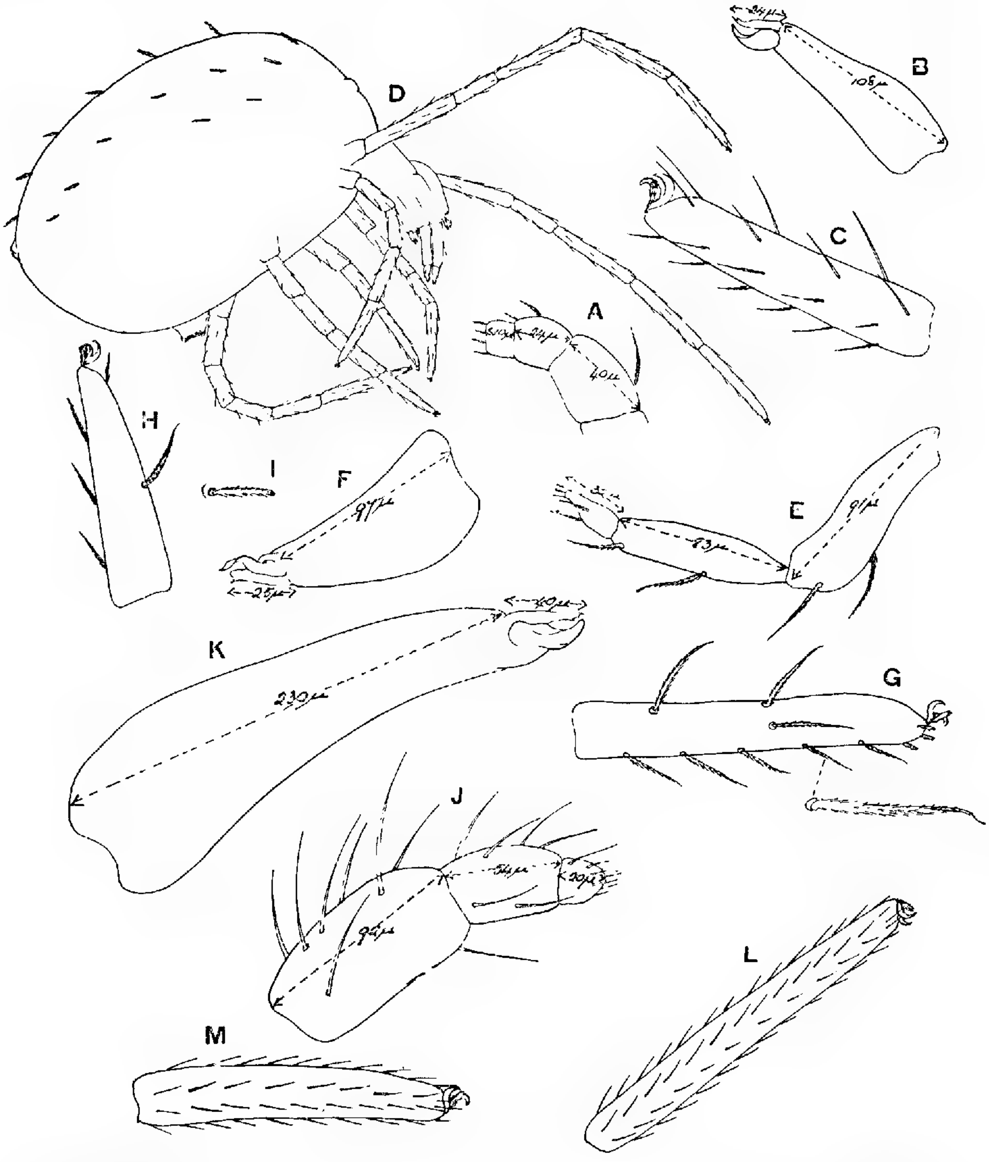
Genus Halotydeus Berlese 1891

Berlese, A., A.M.S. ital, rept., fasc. 60, No. 9.

Halotydeus destructor (Jack 1908)

Jack, R. W. 1908 Cape of Good Hope Agric. Jour., No. 31.
Tucker, R. W. E. 1925 Entom. Mem., No. 3, Dept. Agric., S. Africa.
Womersley, H. 1933 Trans. Roy. Soc. S. Aust., **57,** 108

A common and well-known pest on subterranean clover and vegetables in most cultivated areas in Australia, as well as in South Africa.



A-C *Penthaleus minor* Canest., A palp, B mandible, C tarsus IV; D-I, *Halotydeus egregius* Berl., D entire, E palp, F mandible, G tarsus I, H tarsus IV, I dorsal seta; J-M **Penthalodes australicus** sp. n., J palp, K Mandible, L tarsus I, M tarsus IV.

Halotydeus egregius Berlese 1891 Fig. D-I

Penthaleus egregius Berlese, A., A.M.S. ital. rept., fasc. 60, Nos. 1 and 3.

In fasc. 60, No. 3, Berlese (*loc. cit.*) does not figure or refer to the position of the anus, but this is clearly shown as terminal in fig. 5 of fasc. 60, No. 1, so that there is no doubt but that this species should be placed in this genus. The differences between this and *H. destructor* are to be found in the mandibles, palpi, and setae of the legs and body, as figured.

I am indebted to Mr. K. R. Norris, of the Division of Economic Entomology, C. S. & I. R., for the following colour description of the living mites:

"Legs red, basal two segments pale. Mouth parts red. Body black, shining, but may have pale blotches ventrally near the genital aperture. The lips of the genital aperture and a small patch surrounding the uropore vary in colour from red to whitish. In one specimen a pale pinkish streak extended about half-way along the dorsum from the uropore, whilst ventrally it continued to connect the uropore and genital aperture."

The species has been taken by Mr. Norris in the following localities in Western Australia: Hovea, September 1935, 1936; Pemberton, November 1936; Katanning, in winters of 1939, 1940 and 1941; Narrogin, July 1937; Cranbrook, 1937; Kalgan River, July 1937; Donnybrook, November 1937, April 1938.

Genus PENTHALODES Murray 1877

Murray, A. 1877 Econ. Aptera.

This genus differs from the others in the ventral position of the anus as given in the key. In 1931 Oudemans made a separate family, the Penthalodidae, for it, and this was recognised by Sig Thor (Das Tierreich 1933) who separated it, in a key, on the basis of the hexagonal patterning of the cuticle. Vitzthum (Handbucher Zoologie 1931) did not recognise the Penthalodidae but retained *Penthalodes* in the Penthaleidae.

The cuticular patterning of the genotype of *Penthalodes* (*P. ovatus* Koch) is, however, very different from that of members of the genus *Stereotydeus*, also placed in the Penthaleidae by Vitzthum (*loc. cit.*). The description in this paper of a new species of *Penthalodes* which lacks any cuticular patterning whatever, further suggests the untenability of the family Penthalodidae.

Penthalodes australicus n. sp. Fig. J-M

Description—Large species. Colour black with red mouth-parts and legs. Length 2·25 mm., width 1·36 mm. Legs I 2·89 mm., II 1·445 mm., III 1·645 mm., IV 2·125 mm. Dorsal and leg setae very numerous and mainly simple; on dorsum 64 μ long. Mandible 270 μ long, as figured. Palpi as figured, ultimate segment less than half the length of penultimate. Tarsi I and IV as figured. Genital opening with the usual two pairs of discs. Anus ventral.

Locality—Type specimens from moss, Summers' Park, Acheron Way, Victoria, Jan. 1937 (H. W.); West Tanjil, Victoria, July 1941 (R. T. M. P.).

Genus STEREOTYDEUS Berlese and Leonardi 1901

Berlese and Leonardi 1901 Zool. Anz., **25**

Womersley, H. Proc. Linn. Soc. N.S.W., **60**, 79-82

This genus and the three Australian species have been previously discussed by the writer (*loc. cit.*). It was then placed in the Penthalodidae but, as noted above, this family is not satisfactorily separated from the Penthaleidae.

The Australian species may be distinguished by the following key:

1. Segment IV of palp longer than III. Dorsum with an areolation of pitted hexagonal markings. Median lobe of epirostral plate narrower than lateral lobes. — *S. areolatus* Womersley 1935
   Segment IV of palp equal to or shorter than III. — 2
2. Dorsal surface strongly rugose. Legs 5-segmented. — *S. occidentale* Womersley 1935
   Dorsal surface more finely rugose. Legs 6-segmented. — *S. australicus* Sig Thor 1934

THE WILPENA POUND FORMATION AND UNDERLYING PROTEROZOIC SEDIMENTS

By D. MAWSON, D.Sc., F.R.S.

Summary

This contribution is a further investigation into the nature and thickness of the sediments immediately underlying the fossiliferous Cambrian strata of South Australia. Details of the record in two new areas are given.

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[Read 11 September 1941]

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The Succession at Wilpena Pound

The land form so splendidly illustrated by Wilpena Pound is determined by the existence in that locality of a very thick, arenaceous, basin-shaped, sedimentary formation. The tectonic structure of the Flinders Range is primarily that of a folded system of extremely thick sediments of Proterozoic and Cambrian age. There are represented some remarkable examples of domes and anti-domes.

Wilpena Pound is the most notable example of the anti-domes. It is one of the remnants left after long continued sub-aerial erosion of the fold system. The basin of the anti-dome now stands in high relief, ringed all around by a towering battlemented scarp. The sediments which are horizontally disposed under the centre of the basin are quaquaversally dipping inwards around its entire margin. Proceeding outwards in all directions from the Pound, the underlying strata are presented in descending order of age. The locality is therefore ideal for detailed study of the sedimentary formations involved, and has been made the locus of this further study of the late-Proterozoic sediments of South Australia.

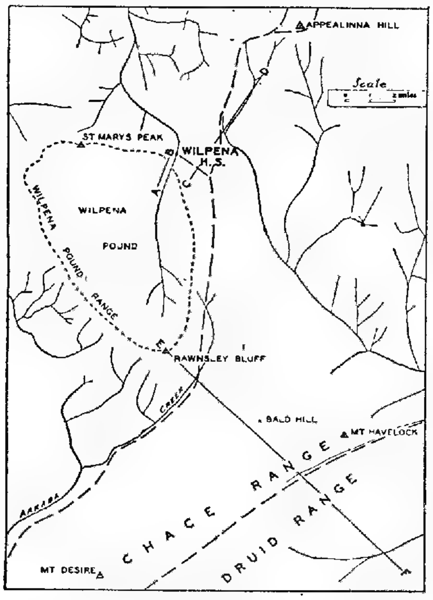

Fig. 1

Map of the vicinity of Wilpena Pound, indicating the location of lines of section.

Preliminary field reconnaissance ascertained that the sequence of beds is comparatively little disturbed in the region between the Pound and Appealinna Hill, which latter is a prominent feature figuring in the structure of the next dome succeeding to the north-north-east (fig. 1). This dome we refer to as the Oraparinna Dome, since it is mainly comprised within the area of Oraparinna sheep station.

Herewith in tabular form, are details of the strata encountered along this line of section from a point 17,548 feet stratigraphically below the topmost beds of the Pound Formation. It will be observed (fig. 1) that the section has been measured in two divisions; namely, the Pound Formation along the line A—B and the underlying beds along the line C—D. Fig. 2 graphically represents the strata encountered. The field work was conducted with the assistance of advanced students of geology at the University, amongst whom W. B. Dallwitz and R. C. Sprigg were most helpful.

The formations are numbered from below upwards, and the succession illustrated begins above the fluvio-glacial shales and greywackes of the waning Proterozoic ice age.

Details of Section North-East from the Pound

1	114 ft.	of flaggy, silty shale. Dip 23°, strike N. 30° W.
2	18 ft.	Calcareous sandstone.
3	284 ft.	of flaggy siltstone. Dip 23°.
4	48 ft.	Sandstone, slightly calcareous. Dip 22°, strike N. 30° W.
5	105 ft.	Sandy limestone passing upwards into mottled cryptozoonic limestone.
6	58 ft.	of soft shales with thin calcareous bands.
7	225 ft.	Sandy limestone with some bands of argillaceous limestone and of calcareous shale. Near the base of this section curious markings appear on the weathered face of the sandy limestone. Dip 23°.
8	50 ft.	of shale.
9	20 ft.	of sandy limestone.
10	151 ft.	Grey fissile shale. Dip 25°.
11	125 ft.	Calcareous sandstone with some grey fissile shale bands near the base. Towards the upper limit the proportion of sand gradually diminishes until the upper 8 ft. is of the nature of a sandy limestone. Dip 26°.
12	17 ft.	of sandstone. Dip 27°.
13	45 ft.	of calcareous shale.
14	440 ft.	Shale, only slightly calcareous. Dip 28°.
15	100 ft.	(a) Grey, calcareous shale. Thickness, 60 ft. (b) Argillaceous limestone with impurities showing as traceries on the weathered surface. Thickness, 10 ft. (c) Grey, calcareous shale. Thickness, 30 ft.
16	240 ft.	of grey shale. Dip 30°, strike N. 35° W.
17	12 ft.	of sandy limestone. Dip 32°.
18	140 ft.	Grey shale. Dip 34°.
19	3 ft.	of grey limestone with cryptozoonic traceries.
20	620 ft.	Reddish shale, showing a transition at the base from grey below to red above.
21	684 ft.	Soft, grey shale, showing a transition at the base from red colour to grey above. Dip 34°, strike N. 41° W.
22	108 ft.	of hard shale. Dip 35°.
23	318 ft.	Hieroglyphic limestone bands in a hard, calcareous shale formation.
24	216 ft.	of calcareous beds. Dip 38°.
25	228 ft.	(a) Even-grained, buff-coloured sandstone strongly cemented. Thickness, 50 ft. (b) Hard, reddish sandstone, gritty in places. Dip 40°, strike N. 40° W. Thickness, 178 ft.
26	3,195 ft.	(a) Reddish to chocolate-coloured shale. Dip 43°, strike N. 43°W. Thickness, 2,670 ft. (b) Sandy, chocolate shale. Dip 42°, strike N. 75° W. Thickness, 525 ft.
27	893 ft.	(a) Grey shale somewhat buckled. The dip of undulations in these beds ranges between 35° and 48° with an average of 45°. The strike ranges from 70° to 82° W. of N. Thickness, 586 ft. (b) Shale with some interbedded sandstone flags which make their appearance in the upper section. Dip 54°, strike N. 68° W. Thickness, 307 ft.

28 598 ft. (a) Flaggy sandstone with interbedded sandy shale. Dip 54°. Thickness, 318 ft.

(b) Sandstone with some shale bands. Thickness, 187 ft.

(c) Strong quartzite with some intersecting veins of micaceous haematite. Dip 52° strike N. 68° W. Thickness, 51 ft.

(d) Hard sandstone. Clay gall impressions appear at the base of this section. Dip 45°, strike N. 68° W. Thickness, 42 ft.

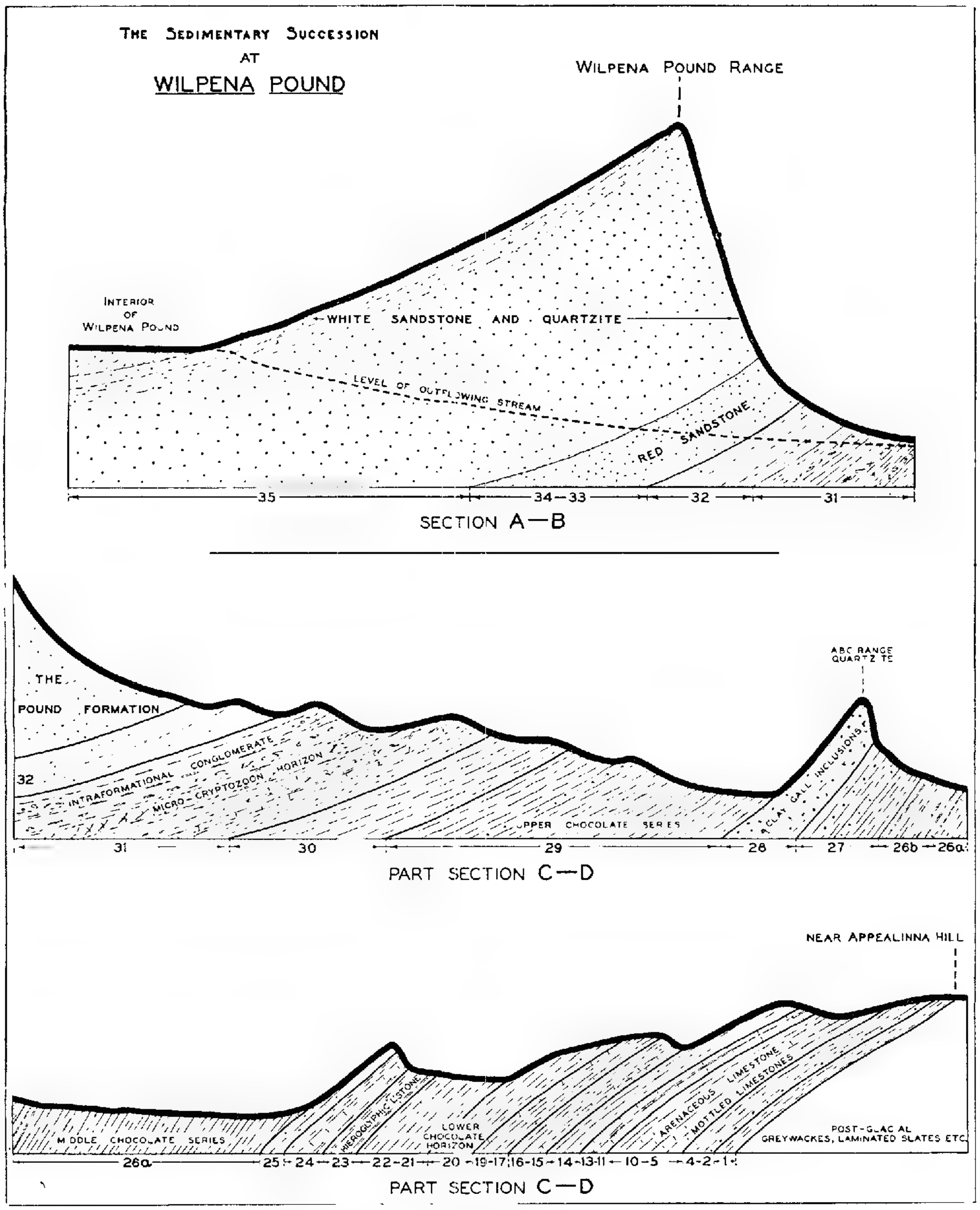

Fig. 2
Cross section of the Wilpena Pound Range and underlying sediments.

29 2,277 ft. (a) Soft, chocolate shale. Dip 38°. Thickness, 1,290 ft.
(b) Somewhat sandy, chocolate shale. Thickness, 274 ft.
(c) Thin-bedded, moderately indurated chocolate shale. Dip 36°. Thickness, 713 ft.

30 700 ft. Shale, non-calcareous below to moderately calcareous above. Dip 36°.

31 1,090 ft. (a) Flaggy, calcareous shale in which the calcareous element increases above. Dip 31°. Thickness, 150 ft.
(b) Thinly laminated, calcareous shales and argillaceous limestone with "micro-cryptozoon" structure and bands of intraformational conglomerate. Near the upper limit some reddish, sandy shale appears. Average dip 25°, strike N. 50° W. Thickness, 940 ft.

32 430 ft. Reddish, sandy flags with a little shale, the latter becoming increasingly calcareous below. Dip 20° strike N. 40° W.

33 325 ft. Soft, red flaggy sandstone. Dip 30°, strike 52°.

34 1,225 ft. Red sandstone. Dip 27°.

35 2,556 ft. (a) White sandstone. Dip 25°, strike N. 46° W. Thickness, 2,213 ft.
(b) White sandstone. Dip 20°, strike N. 50° W. Thickness, 80 ft.
(c) White quartzite. Dip 18°. Thickness, 106 ft.
(d) White sandstone. Dip 17°, strike N. 50° W. Thickness, 157 ft.

17,548 ft. Total thickness.

Below this thick pile of sediments are several thousands of feet of post-glacial slates, fluvio-glacial sands and slates as well as the tillite (Sturtian in age) itself. Some details of these will be published at a later date.

The Succession at the Druid Range

The broader tectonic features of the country to the south-east of Wilpena Pound are displayed in fig. 3, which is a cross-section along the line E—F recorded on the map (fig. 1). Notable faulting in the area has been observed only where the beds approach verticality. There is good reason to believe that a fault extends

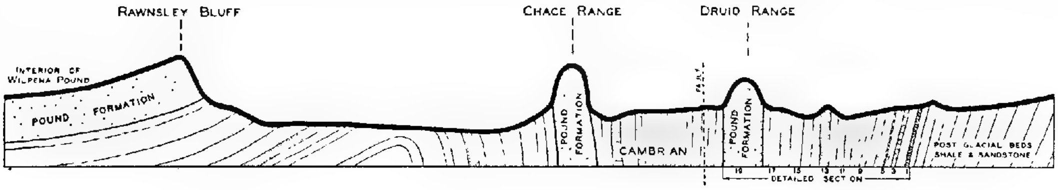

Fig. 3

along and nearly parallel to the north face of the Druid Range. This has probably truncated the Cambrian beds and may have reduced the apparent thickness of the quartzite formation of the Druid Range. Evidence of faulting is best seen at the eastern end of the Chace Range where it cuts in to join the Druid Range. Clear evidence of such a line of fault was observed on one of our field excursions by R. C. Sprigg when viewing the area from the summit of the Chace Range near Mount Havelock.

Both the Chace Range and the Druid Range are constituted of the Pound Formation which originally arched over from Wilpena Pound, then dived down almost vertically as the Chace Range. The Pound Formation is again met nearby to the south as the Druid Range which extends approximately parallel to the Chace Range over a length of more than 16 miles. The road from Hawker to Martin's Well runs along the valley between these two great walls. Where tra-

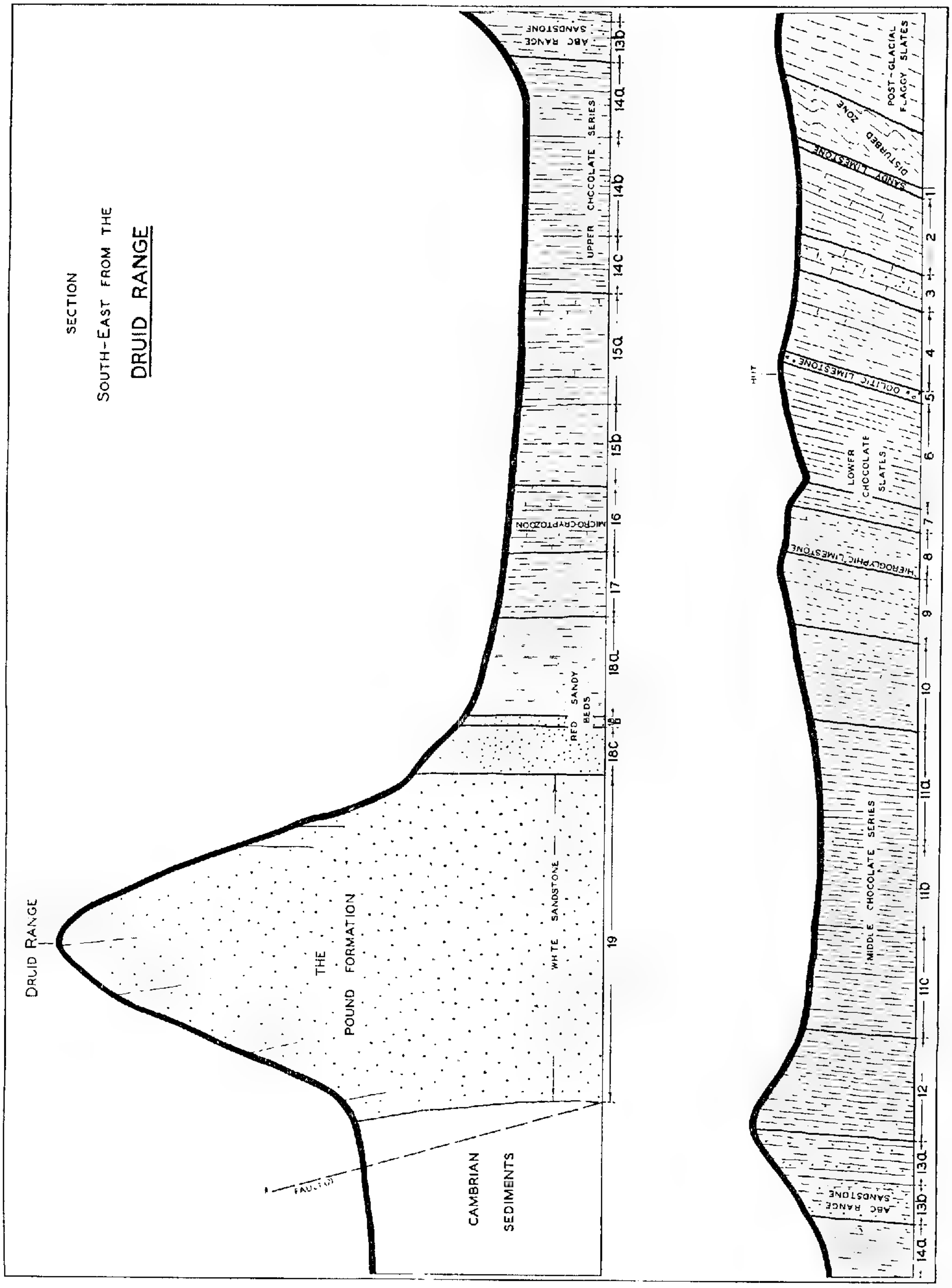

Fig. 4 Section across the Druid Range and underlying sediments.

versed by the line of section (fig. 1) this valley has a width between the quartzite walls of 2,500 yards, but narrows towards the east-north-east and widens in the opposite direction. It is occupied by steeply dipping Cambrian limestones and shales. Massive, grey Archaeocyathinae limestone which flanks the Chace Range passes upwards into a soft, dark-coloured slate which occupies the central portion of the valley. Close to the eastern end, where the Chace Range closes in on the Druid Range, the Cambrian formation is almost entirely eliminated.

Strike faulting has played a part in the parallel arrangement of these two outcrops of the Pound Formation. How much the repetition is also due to the original folding of the beds is yet uncertain. It is possible that the soft beds immediately on the south side of the Range are affected by strike faulting, but as the outcrops are considerably hidden over a wide belt the existence of such was not established. The general regularity of the outcrops in that locality actually suggests the absence of faulting.

The country to the south-south east from the more easterly extension of the Druid Range is but little disturbed, and is thus a region where the order of succession of the beds is well exhibited and faulting is at a minimum. In that direction a good section can be obtained, extending from the Pound Formation of the Druid Range downwards to the Proterozoic glacial beds.

The succession along the line of section E—F, through a thickness of 15,741 feet of strata stratigraphically below the top of the Pound Formation is detailed herewith (fig. 4). The still lower glacial and post-glacial tillite, fluvio-glacial beds, greywackes and slates will be dealt with in another publication. In the field work prosecuted in this area some four years ago, my chief student assistant was L. W. Parkin.

Details of Section South-East of the Druid Range

1 85 ft. Massive sandy limestone.

2 585 ft. (a) Flaggy, calcareous argillite. Thickness, 345 ft.

(b) Resistant flaggy argillite, only slightly calcareous. Thickness, 20 ft.

(c) Flaggy argillite, somewhat calcareous. Thickness, 220 ft.

3 270 ft. A strongly developed grey compact limestone. Much of it is oolitic and some is arenaceous. One zone has a poorly developed coarse cryptozoonic marking. Dip 72°, to N.; strike S. 70° W.

4 695 ft. (a) Poor exposures, but underlying rock appears to be a calcareous argillite. Thickness, 230 ft.

(b) Grey flags somewhat calcareous. Dip 75° N. Thickness, 465 ft.

5 6 ft. Oolitic grey limestone.

6 870 ft. Slates.

7 180 ft. Hard, flaggy slate, chocolate to grey in colour. Dip 80° N.

8 250 ft. (a) Shales and soft sandstone with interbedded limestone. One band is 5 feet thick and chocolate-coloured. Thickness, 190 ft.

(b) Calcareous bands alternating with slate and soft sandstone. Strike S. 65° W. Some of the limestone exhibits a poorly developed hieroglyphic structure. Thickness, 60 ft.

9 570 ft. (a) Red slate and soft red sandstone. Thickness 125 ft.

(b) Soft, very fine-grained, reddish sandstone. Thickness, 45 ft.

(c) Soft, slaty argillite of a general reddish colour. Thickness, 400 ft.

10 680 ft. (a) Resistant grey slates. Thickness, 360 ft.
(b) Grey slate; somewhat calcareous with a couple of minor bands (2 ft. wide) of arenaceous limestone. Thickness, 210 ft.
(c) Grey slate, weathering to small chips. Thickness, 110 ft.

11 2,550 ft. (a) Hard, chocolate-coloured slate. Thickness, 850 ft.
(b) Reddish flaggy slates and siltstones. Dip 86° to N.; strike S. 54° W. Thickness, 830 ft.
(c) Dark reddish siltstone with some argillaceous element, particularly near the base. Current bedding is well illustrated at certain horizons, also concentrations by currents of iron sand are to be observed. Strike S. 61° W. Thickness, 870 ft.

12 780 ft. of hard mudstone slate, in places arenaceous, colour grey. These beds are standing vertically.

13 580 ft. (a) Flaggy slate with some bands of hard sandstone. Strike S. 65° W. Thickness, 340 ft.
(b) Flaggy sandstone with interbedded bands of somewhat argillaceous sandstone. Thickness, 240 ft.

14 1,690 ft. (a) Red shales weathering to chips at the surface. Thickness, 540 ft.
(b) Grey shales standing almost vertical. Thickness, 750 ft.
(c) Chocolate shales. Thickness, 400 ft.

15 1,480 ft. (a) Calcareous shales with several thin bands of flaggy, argillaceous limestone. Strike S. 63° W. Thickness, 880 ft.
(b) Soft beds, apparently argillites; an alluviated valley bottom. Thickness, 600 ft.

16 450 ft. of flaggy, argillaceous limestone, calcareous shale and occasional belts of more massive and purer limestone. "Micro-cryptozoon" structure appears in this section.

17 480 ft. Yellowish to grey shales weathering to chips. Most of the outcrops obscured by alluviation.

18 1,070 ft. (a) Outcrop almost entirely obscured by alluviation. Some red sandy shale outcrops in one place. Soft beds probably red sandy shale and flags. Thickness, 660 ft.
(b) Red sandstone with some interbedded red shale. Thickness 75, ft.
(c) Sandstone and argillaceous sandstone. Dip 89° to S., strike S. 65° W. Thickness, 335 ft.

19 2,470 ft. (a) Hard quartzite forming a precipitous face. Thickness, 400 ft.
(b) Hard quartzite forming rugged knobs. Dip 90°, strike 64° S. Thickness, 180 ft.
(c) Quartzite slope on south side of the summit of the Druid Range. Dip 89°, strike S. 70° W. Thickness, 710 ft.
(d) Quartzite of slopes on north side of the summit of the Range. Thickness, 380 ft.
(e) Quartzite of the steep northern face. Dip 80°. Thickness, 370 ft.
(f) Hard quartzite of the steep face. Dip 75° S. Thickness, 280 ft.
(g) Flaggy sandstone along the foot of the north face of the Druid Range. Dip 75° S., strike S. 70° W. Thickness, 150 ft.

15,741 ft. Total thickness.

In the upward succession beyond this horizon there is a further considerable thickness of softer, arenaceous and argillaceous beds before arriving at the Cambrian Archaeocyathinae limestone.

Items (18) and (19) of the above section are evidently equivalents of the main body of the great Wilpena Pound Formation. Here, however, the sandstone of the red section of the Pound Formation is poorly represented, but there is a corresponding increase in argillites. It thus appears that the depositions of this horizon, in the area where the Druid Range beds were accumulated, were more argillaceous than their equivalents further to the west nearer to the old Cambrian shore line.

The general accordance of the sedimentary record at the two localities dealt with above is obvious and well shown in the following summarized statement.

	Pound	Druid
The arenaceous Pound Formation - -	4,106	3,740
Thickness between the top of the ABC Quartzite and the base of the red arenaceous stage of the Pound Formation -	4,387	4,100
Thickness of sediments between the thick oolitic limestone and the top of the ABC Quartzite - - - -	7,003	7,061
	15,496	14,901

Comparison with Data from Other Localities

In earlier publications there are recorded measurements from other areas in the Flinders Range (see references 1 to 4) of the same range of sediments as detailed in the foregoing section at Wilpena Pound and the Druid Range. Considering the broader stages in this sedimentary series, we can now make some general comparisons.

The Pound Formation is always presented as two divisions; an upper hard white sandstone of more uniform thickness and a minor, lower red division which fluctuates considerably in thickness from locality to locality. The red section, in some areas, is less arenaceous and correspondingly more argillaceous. In view of its variability this lower red portion of the Pound Formation and the underlying beds as far down as the calcareous horizon with "Micro-cryptozoon" need further investigation.

Where it is well represented the thickness of the upper, white division is of the order of 2,500 feet. Actually it is given as 2,556 feet at Wilpena Pound, 2,470 feet at the Druid Range, and 2,640 feet at Brachina Creek. At the Ten-Mile Creek on Oraparinna (Mawson 4) and at Parachilna Gorge (Mawson 1), the apparent thickness is greatly reduced by faulting and overlap.

The red section of the Pound Formation is also of considerable thickness, namely, 1,550 feet at the Pound, 1,270 feet at the Druid Range, and 1,010 feet at Parachilna. At Brachina Creek a fault truncates this red, arenaceous formation.

Next in descending order are passage beds bridging the gap between the red, arenaceous beds above and the calcareous formation below. A mean thickness of about 350 feet is indicated here.

The "micro-cryptozoon" limestone formation and underlying grey shales as far down as the junction of the upper chocolate shales occupies a thickness of 1,790 feet at the Pound, 1,930 feet at the Druid Range, 1,215 feet at Brachina Creek, and 1,457 feet at the Ten-Mile Creek. A greatly reduced thickness is recorded at Parachilna Gorge, probably a result of faulting.

The upper chocolate shales are 2,277 feet thick at the Pound, 1,690 feet at Druid Range, 2,195 feet at Brachina Creek, and 1,287 feet at Parachilna Gorge.

The ABC Sandstone (considering only the upper entirely arenaceous portion) is 270 feet at the Pound, 240 feet at Druid Range, 390 feet at Brachina Creek, and 178 feet at Parachilna Gorge.

From the base of the hard, upper section of the ABC Sandstone to the upper limit of the hieroglyphic limestone horizon amounts to 4,860 feet at the Pound, 4,820 feet at Druid Range and 3,582 feet at Brachina Creek.

From the upper limit of the hieroglyphic limestone horizon to the top of the first thick oolitic limestone formation below the lower chocolate shale horizon is 1,873 feet at the Pound, 2,001 feet at Druid Range, 1,953 feet at Brachina Creek and 2,628 feet east of Mount Caernarvon.

From the top of the above oolitic limestone to the top of the first thick arenaceous limestone above the post-glacial slates is 1,483 feet at the Pound, 1,710 feet at Brachina Creek and 1,610 feet at the Mount Caernarvon section.

I had hoped to have been able to compare the thickness of these sediments of the central Flinders Range with that of the same formations in areas mapped by R. W. Segnit (5). However, this is not possible, for it is apparent that in the preparation of his maps he has failed to recognise the great thickness and diversity of the sediments involved and has accepted rocks of superficially similar lithological characters as identical horizons, whereas in actuality they may be far removed in the stratigraphical sequence. This misconception has introduced awkward problems necessitating the assumption of hypothetical (actually non-existent) faults introduced to explain apparent anomalies.

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3 Mawson, D. 1939 Reports A.N.Z.A.A.S., **24**
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MIDDLE PROTEROZOIC SEDIMENTS IN THE NEIGHBOURHOOD OF COPLEY

By D. MAWSON, D.Sc., F.R.S.

Summary

The late Pre-Cambrian sequence in the central region of the Flinders Range has been dealt with recently (Mawson 6). Below the beds there described comes a thick series of sediments deposited during a severe glacial period (Sturtian) and its prolonged waning phases. An account of this section is in preparation.

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By D. Mawson, D.Sc., F.R.S.

Plates XVIII and XIX

[Read 11 September 1941]

The late Pre-Cambrian sequence in the central region of the Flinders Range has been dealt with recently (Mawson 6). Below the beds there described comes a thick series of sediments deposited during a severe glacial period (Sturtian) and its prolonged waning phases. An account of this section is in preparation.

At a still lower horizon, underlying the tillite and fluvio-glacial beds, is another thick series of sediments distinguished by the inclusion therein of a remarkable development of dolomite, some horizons of which, in certain areas of the State, exhibit in their outcrops progressive enrichment in magnesium even to the stage of pure magnesite.

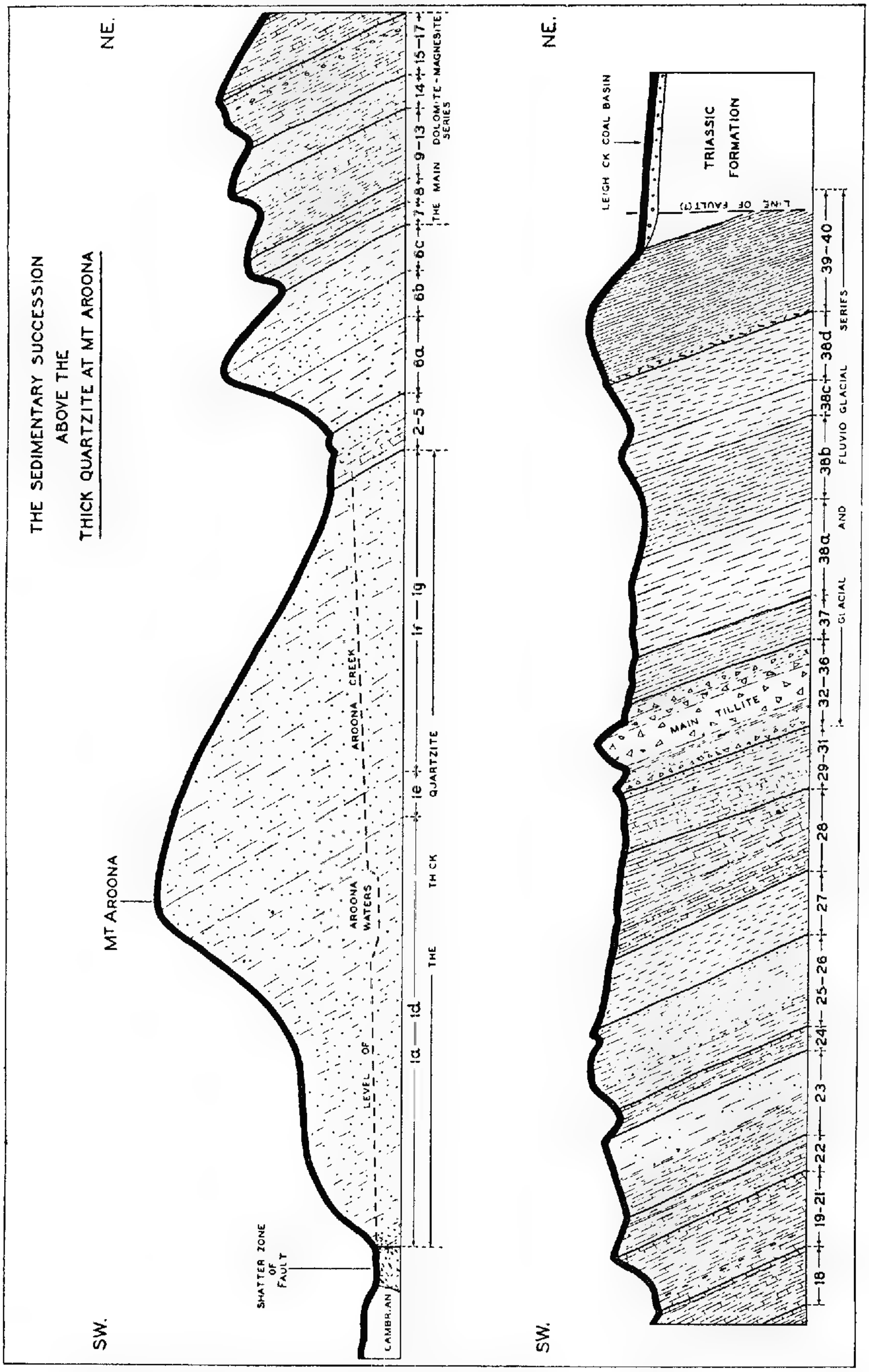
This dolomite-rich section of the South Australian Proterozoic record is part of the Adelaide Series, the general sequence of which for the Adelaide area was worked out by Howchin many years ago (Howchin 2). The range of sediments now under discussion corresponds in Howchin's succession with the Thick Quartzite and the beds overlying it up to the advent of the ice age.

It is a matter of note that Howchin had not recognised the presence of dolomite in this range of sediments, but he stressed the occurrence of an horizon referred to as the "Blue Metal Limestone." This was shown by Barnes and Kleeman (1) to be dolomite. The latter authors also indicated the existence of repeated bands of dolomite among the shales of this section in the area near Adelaide, which they examined.

Segnit (7), in geological maps of various areas of the State, has encountered portions of this series of beds, which he has referred to as the Middle Pre-Cambrian. He indicates the occurrence therein of dolomitic limestones, some characterised by chert nodules. While we yet have no exact basis for fixing the age of this series of beds, I am of the opinion that it cannot be regarded as older than Middle Proterozoic, since we have in South Australia at least one still older division (Mawson 4) of the Proterozoic.

One of the least disturbed exposures of this division of the South Australian Proterozoic butts against the western margin of the Triassic basin at Copley. This latter locality is some 222 miles in an air-line north of Adelaide and 20 miles east of Lake Torrens. There the beds which strike in a north-west to south-east direction extend unbroken for miles. Attention has already been drawn to this occurrence (5). Since then, on account of the growing importance of the magnesite deposits included therein, Segnit (8) has visited the field and reported upon the distribution of that mineral in the area. His report makes reference to several earlier inspections by other members of the Mines Department staff. Details are now submitted of the sedimentary succession determined on a line of section across the strike of the country extending for about $3\frac{1}{4}$ miles in length. The section commences at a major strike-fault which abruptly terminates the eastward extension of the Mount Scott Cambrian basin at a point about 1,000 yards to the south-west of Aroona Waters. From there the direction of traverse extends north-easterly until the margin of the Triassic basin is reached.

As already mentioned, the beds outcrop with amazing regularity over a length of many miles and are singularly free from notable faulting. There is therefore offered a splendid opportunity for making a detailed study of the beds.



The lowest formation in the sequence exposed to view is the quartzite of the Mount Aroona ridge. All beds below this horizon are cut off by the great strike-fault, which is defined by a wide shatter zone. Segnit (7), dealing with the Cambrian and Pre-Cambrian sediments of this neighbourhood, indicates the existence of this strike-fault. His map, which is principally of the region to the south-west of the fault, also includes most of the Mount Aroona quartzite. The latter he has assumed, on superficial lithological grounds, to be a repetition of the Pound Formation (Segnit's D7 horizon) well represented locally in the Mount Scott Range. We, however, have not been able to establish this correspondence; on the contrary, some of the leading characteristics of the Pound Formation are unrepresented in the psamites of the Mount Aroona belt. However, they do have in common the fact that both are extremely massive formations. That at Mount Aroona is the thickest arenaceous horizon of which we have any record in the South Australian region. It therefore well deserves the title which Howchin conferred upon its greatly attenuated equivalent of the neighbourhood of Adelaide, namely, the Thick Quartzite (or Mount Lofty Quartzite).

Resistance to weathering and the great thickness of the Mount Aroona quartzite have resulted in the line of outcrop standing out boldly. It extends on the same line of strike for some miles to the south-east and can be clearly traced with the eye, receding in the distance to the north-west as far as Termination Hill, a distance of 21 miles.

In the detailed account of the beds submitted below, the strata are dealt with in rising order from the base upwards. The sequence of strata along this line of section extends through some 16,000 feet of beds from the base of the Thick Quartzite below upwards through a thick formation in which dolomite and magnesite figure prominently; then on through sediments of the ice age (Sturtian) to a stage in the post-glacial ribbon slates over 3,600 feet above the base of the tillite before it is abruptly terminated against the Triassic basin.

A matter of some importance has been the establishing of the degree of dolomitization and of magnesitization represented in the various carbonate horizons. This has been done by a partial analysis of samples from selected beds. The finely powdered rock was subjected to a prolonged leach with hot concentrated hydrochloric acid. The undissolved residue was recorded as "insoluble." Magnesium and calcium were determined in the solution and calculated as carbonate. These chemical tests were executed for me by J. H. Shepherd.

Details of a Cross-Section through Aroona Waters

1 5,217 ft. (a) Quartzite which shows evidence of having been disturbed and cracked by severe shock, though finally reconsolidated. Thickness, 50 ft.

(b) Hard quartzite. The quartz grains in this and indeed the whole of this quartzite formation are more or less angular and commonly exhibit shadowy extinction. Thickness, 990 ft.

(c) Quartzite. Dip of 54° to the north-east. Thickness, 730 ft.

(d) Quartzite with some slightly argillaceous bands. 1,112 ft.

(e) Quartzite forming the high wall immediately above Aroona Waters. Dip 60°, strike N. 50° W. Thickness, 265 ft.

(f) Quartzite. Thickness, 520 ft.

(g) Felspathic quartzite passing upwards into felspathic sandstone. Dip 61°, strike N. 50° W. Thickness, 1,550 ft.

2 50 ft. Outcrop obscured; evidently a soft formation, in all probability calcareous argillite.

3 41 ft. (a) Very fine-grained, red marble containing 44·8% $CaCO_3$, 39·8% $MgCO_3$ and 13·75% insoluble residue. 1 foot only.

(b) Buff-coloured dolomite, found to contain 47·7% $CaCO_3$, 40·3% $MgCO_3$ and 12·3% insoluble residue. Thickness, 40 ft.

4 110 ft. (a) A medium, grey micaceous siltstone conveniently referred to as greywacke. Strong hydrochloric acid took into solution 1·79% CaO and 4·51% MgO, leaving 82·45% insoluble residue. Thickness, 65 ft.

(b) Outcrop obscured. Thickness, 45 ft.

5 140 ft. Sandstone; for the most part soft and reddish but with some thin beds of coarser white felspathic sandstone.

6 1,185 ft. (a) Silty and sandy calcareous shales. A buff-coloured specimen was found to contain 95·5% insoluble residue, and traces only of Ca and Mg carbonates. Thickness, 540 ft.

(b) Sandstone below and sandy laminated beds above. Thickness, 300 ft.

(c) Laminated sandy beds passing upwards through sandy shales to a narrow bar of quartzite at the top. Thickness, 345 ft.

7 180 ft. of shale, partly calcareous.

8 190 ft. Marly and dolomitic shale, with some narrow seams and patches of magnesite. Evidence of secondary silicification in places.

9 2 ft. of magnesite as a solid rock stratum. Dip 63°.

10 45 ft. Soft, marly shale.

11 5 ft. A wall-like outcrop of dolomite seamed with ferruginous and siliceous traceries.

12 390 ft. (a) Soft, marly shale and some dolomite; outcrop mostly hidden beneath surface debris in which are magnesite nodules and fragments of chert. Grey dolomite ($CaCO_3$ 54·5%, $MgCO_3$ 43·0%, and insoluble 2·5%) outcrops at the base of this section. Among the fragments shoaded down the sloping surface of the ground are pieces of edgewise intraformational conglomerate. Thickness, 210 ft.

(b) Mainly soft, thinly laminated, argillaceous, dolomitic shale shedding blocks of magnesite over the outcrop. The base of this section is a stratum of dolomite with marked silicification of its upper margin. Thickness, 180 ft.

13 10 ft. The underlying rock is completely hidden by soft, springy surface debris. The nature of the underlying bed is uncertain, but may conceivably be gypsum.

14 271 ft. (a) Sandy marl passing upwards into very fine-grained calcareous sandstone. At the base is a cellular metasomatized belt. Thickness, 50 ft.

(b) A highly metasomatized zone. Ferruginous below and chertified above. Nature of the original rock obscured by debris. Thickness, 25 ft.

(c) A bed of magnesite. Thickness, 2 ft.

(d) Soft marls and flaggy dolomite with one thin band of magnesite and terminating above in a further bed of magnesite 18 inches thick. Thickness, 78 ft.

(e) Soft marl and thin, flaggy dolomite. Outcrop much obscured by alluvium carrying shoaded chert nodules. Dip 64°. Thickness, 116 ft.

15 12 ft. A bed of massive, argillaceous dolomite. Contains about 27% $CaCO_3$, 25% $MgCO_3$, and 48% insoluble residue.

16 358 ft. (a) Laminated, dark grey dolomite with chert nodules. The dolomite gave on analysis 53·5% $CaCO_3$, 42·5% $MgCO_3$, and 3·88% insoluble residue. Thickness, 32 ft.
(b) A bed of light grey, pisolitic magnesite of the following composition: nil % $CaCO_3$, 97·25% $MgCO_3$, and 2·75% insoluble residue. Thickness, 3 ft.
(c) Shaley, dolomitic marl with thin seams of magnesite. 88 ft.
(d) A bed of greyish white, pisolitic magnesite of the following composition: 54·14% $CaCO_3$, 42·72% $MgCO_3$, and 3·82% insoluble residue. Associated with this horizon are pockets of white powdery magnesite. Thickness, 4 ft.
(e) Grey, dolomitic, shaley marl. Thickness, 83 ft.
(f) A massive bed of grey crystalline dolomite. Thickness, 4 ft.
(g) Shaley marl with thin bands of dolomite and semi-magnesite. Chert appears at intervals as nodules and irregular bands. Outcrop partly obscured by alluvium. Thickness, 144 ft.

17 9 ft. (a) Medium-dark-grey dolomite of the following composition: 54·1% $CaCO_3$, 43·1% $MgCO_3$ and 3·06% insoluble matter. Dip 65° to the north-east, strike N. 45° W. This bed forms the crest line of a ridge. Thickness, 7 ft.
(b) Grey, crystalline magnesite of low grade. Thickness, 2 ft.

18 408 ft. (a) Flaggy, grey dolomite with argillaceous bands. 46 ft.
(b) A bed of medium grey, low grade magnesite. Thickness, 2 ft.
(c) Flaggy, dolomitic marl with thin seams of magnesite. Thickness, 179 ft.
(d) A belt of thin, platy magnesite. Thickness, 3 ft.
(e) Shaley marl from which shoaded magnesite nodules are shed. Thickness, 32 ft.
(f) A solid bed of magnesite. Dip 65°. Thickness, 2 ft.
(g) Soft, marly shales with occasional thin seams of magnesite. Thickness, 95 ft.
(h) Dolomitic, silty shale with wavy bedding planes. 45 ft.
(i) A bed of nodular magnesite. Thickness, 4 ft.

19 387 ft. (a) Flaggy, argillaceous dolomite. Thickness, 61 ft.
(b) Dense, dark grey dolomitic, silty flags. Thickness, 8 ft.
(c) Dark grey, flaggy dolomite. Amongst the lower portion of this section are some bands of dark dolomitic magnesite and of nodular magnesite. A specimen of dark grey rock with subconchoidal fracture was found to contain only a trace of CaO, 2·8% MgO, and 84·5% of insoluble residue. 317 ft.
(d) A band of hard, laminated, medium grey, crystalline magnesitic dolomite. Thickness, 1 foot only.

20 109 ft. of calcareous shales becoming less calcareous in later depositions.

21 65 ft. Dolomite interbedded with flaggy, laminated, siltstone shale. Also a thin bed of sandstone is included here. The dolomite is considerably affected by silicification.

22 285 ft. (a) Somewhat calcareous shales distributed through which are ten minor bands of dolomite. Thickness, 120 ft.
(b) A strongly developed bed of dolomite. Thickness, 2 ft.
(c) Argillite, somewhat calcareous, with four thin bands of dolomite. Thickness, 115 ft.
(d) A bed of pinkish grey dolomite containing 45·0% $CaCO_3$ and 33·7% $MgCO_3$. Thickness, 3 ft.

(e) Grey, argillaceous shale with a thin seam of argillaceous dolomite at the upper limit. Thickness, 45 ft.

23 608 ft. (a) Grey, arenaceous shale distributed through which are a few bands of sandstone from 8 inches to 12 inches thick. Thickness, 230 ft.

(b) Greywacke siltstone of a remarkably uniform character. The rock is structureless, there being no visible laminations. Thickness, 370 ft.

(c) A hard, grey, siliceous siltstone with fine laminations disturbed by currents during deposition. Thickness, 8 ft.

24 183 ft. (a) Calcareous, argillaceous shale. Thickness, 80 ft.

(b) A bed of argillaceous dolomite containing 29·8% $CaCO_3$, and 30·8% $MgCO_3$. Thickness, 3 ft.

(c) Shaley argillite with occasional arenaceous bands, one of which is of calcareous sandstone. Thickness, 90 ft.

(d) A belt of hard argillaceous, yellow dolomite containing 28·3% $CaCO_3$ and 28·6% $MgCO_3$. Dip 65°, strike N. 47° W. Thickness, 10 ft.

25 640 ft. (a) Argillaceous shale. Thickness, 245 ft.

(b) Greywacke shale, slightly calcareous and distinctly laminated. Thickness, 315 ft.

(c) Argillaceous to sandy greywacke, laminated. 80 ft.

26 15 ft. of laminated, light-coloured, sandstone defining the crest of a ridge.

27 420 ft. of hard, dense, greywacke siltstone. On examination this was found to contain no more than a trace of soluble CaO and only 3·2% of soluble MgO. The insoluble residue amounted to 80·4%.

28 620 ft. (a) Argillaceous shale alternating with bands of a buff-coloured dolomite. Thickness, 215 ft.

(b) Alternations about every 40 feet of hard, grey, calcareous shale and buff-coloured, argillaceous dolomite. Dip 65°, strike N. 45° W. Thickness, 315 ft.

(c) A soft, glaucous-grey-coloured mudstone with some bands of buff-coloured, impure, ferruginous dolomite. Dip 70°. 90 ft.

29 235 ft. (a) A bed of dolomite. Thickness, 3 ft.

(b) Grey shale. Thickness, 34 ft.

(c) A bed of dolomite. Thickness, 6 ft.

(d) Grey, silty shale. Thickness, 56 ft.

(e) Buff-coloured argillaceous dolomite containing 40·9% $CaCO_3$, 29·1% $MgCO_3$ and 17·0% insoluble residue. 6 ft.

(f) Grey siltstone. Thickness, 50 ft.

(g) Laminated shale and siltstone. These are calcareous and apparently dolomitic in part. Dip 71°, strike N. 50° W. Thickness, 80 ft.

30 115 ft. of laminated and slightly calcareous shale. Thin partings of intraformational conglomerate appear in this section; the thickest observed band of which was 6 inches across. This latter was found to contain about 85% $CaCO_3$, 1% $MgCO_3$, and 14·28% of insoluble matter.

31 140 ft. (a) Calcareous sandstone. Thickness, 3ft.

(b) Soft, argillaceous shale. Thickness, 21 ft.

(c) Fine-grained, calcareous sandstone. Thickness, 6 ft.

(d) Mainly laminated shale, a little calcareous in places and with cherty bands and patches. Near the upper limit are some thin beds of sandstone alternating with shale. This section ends at its upper limit in a 2-ft. thick stratum of sandstone Dip 65°, strike N. 45° W. Thickness, 110 ft.

32 50 ft. of grey tillite. This has a characteristic rock-flour base and is studded with erratics, many of them exhibiting glacial striae. Some of the erratics appear to be fragments of the underlying formation, one piece being chert. Other erratics noted were several types of quartzite, coarse siliceous conglomerate and one porphyry.

33 70 ft. of fluvio-glacial sandstone.

34 27 ft. of fluvio-glacial ribbon slate with some embedded grit and pebbles.

35 347 ft. of tillite with some fluvio-glacial shale bands. This tillite is light-coloured and somewhat more sandy than the more typical Proterozoic tillite of South Australia. Also, it weathers more readily than usual.

36 118 ft. Very coarse-grained fluvio-glacial, arkosic sandstone. 10 ft.
(b) Fluvio-glacial shale with gravel bands and erratics. 7 ft.
(c) White fluvio-glacial felspathic sandstone. Thickness 30 ft.
(d) Fluvio-glacial shale with erratics. Thickness, 33 ft.
(e) Coarse fluvio-glacial, arkosic sandstone. Thickness, 8 ft.
(f) Fluvio-glacial, ribbon shale with occasional erratics of quartz-porphyry, etc. Thickness, 30 ft.

37 300 ft. (a) Laminated and in part varved fluvio-glacial shale distributed through which are occasional strata of 3 to 6 inches in thickness of highly calcareous argillite. Dip 68°, strike N. 50° W. Thickness, 140 ft.
(b) Laminated shale with occasional thin, flaggy bands of impure limestone. One of these, about 2 inches in thickness, was found to contain 46% $CaCO_3$, 30% $MgCO_3$, and 20% insoluble residue. Thickness, 160 ft.
(c) A harder and slightly lighter-coloured phase of the laminated shale. Thickness, 235 ft.
(d) A softer phase of the laminated shale, with several thin bands of calcareous, intraformational breccia coming in near the upper limit. Dip 67° to the N.E., strike N. 45° W. 471 ft.

38 1,946 ft. (a) Laminated shales. Thickness, 690 ft.
(b) A somewhat softer and darker-coloured phase of the laminated shales. Dip, 69°, strike N. 50° W. 550 ft.

39 29 ft. (a) A more arenaceous phase of laminated shale. 27 ft.
(b) Intraformational breccia, somewhat calcareous. 2 ft.

40 800 ft. of laminated shale.

16,132 ft. Total Thickness.

Reference should be made to the fact that the lower horizons of the tillite carry as erratics fragments of chert, siltstone and dolomite resembling such rocks of the underlying series. This, therefore, appears to be further evidence that in the Sturtian Ice Age, the whole land surface was submerged under an ice-sheet.

On examining the details of strata listed above, it is to be observed that an outstanding feature of the series of beds underlying the tillite is its richness in dolomite. A rough analysis of the data secured when making the above traverse indicates that there was observed an aggregate thickness of about 50 feet of magnesite and 650 feet of dolomite, with the probability that an additional 250 feet of

Fig. 1
A general view of the outcrop of the central portion of the Thick Quartzite in the vicinity of Aroona Waters. View looking north, taken from Aroona Creek just below Aroona Waters.

Fig. 2
The cliff face, several hundred feet in height, overlooking Aroona Waters. This is the central section of the Thick Quartzite.

Fig. 1

View at a point E. 10° N. from Mt. Aroona, looking north-east across the strike of the dolomitic series. Outcropping on the scrubby hill-slope in the distance are to be seen items 13 to 17 of the cross-section.

Fig. 2

Magnesite outcrops in flat country located about 2½ miles east-south-east of Mt. Parry, near Myrtle Springs Head Station. In the area between the white linear magnesite outcrop visible on the right and the distant figure there are three other parallel magnesite beds.

more or less argillaceous dolomite is represented in the areas where outcrops were obscured. This indicates a total thickness of dolomite and magnesite approaching 1,000 feet.

Until it has been mined to some depth there is no knowing to what extent the magnesite of the outcrops traversed persists in depth. The progressive enrichment in magnesium of some dolomite outcrops undergoing slow subaerial weathering in arid localities is well known. It is therefore to be expected that the magnesite outcrops will, for the most part at least, change over in depth to dolomite. There are, however, features in certain of the outcrops suggestive that the magnesitization of the dolomite is not entirely a present-day development from weathering.

R. C. Sprigg assisted me in the above traverse and, more recently, he was chiefly responsible with other students in running a second traverse across the same beds at a point 10 miles distant, further to the north-west, along the strike. This second line of section was carried through Myrtle Springs Head Station. In that locality the upward succession of the beds continues to a higher horizon in the Proterozoic before being obscured by later formations. There, also, I was able to get further details of the glacial sediments which, together with the overlying beds, will be considered in a later publication.

A comparison of the two cross-sections respectively at Aroona Waters and at Myrtle Springs demonstrates the general regularity of the beds. The thickness of the Thick Quartzite at Aroona Waters was determined as 5,217 feet, but at Myrtle Springs only 4,600 feet. The difference in thickness can be accounted for by the fact that its base in both cases is affected by the line of faulting to which reference has been made. On its western side, at Myrtle Springs, the quartzite disappears beneath the plain, so that the absolute basement is not seen. Stated in round figures, the thickness of that notable formation may be taken as about 5,000 feet.

The extensive series of marly argillites, sandstone and dolomites with magnesite which occupies the gap between the Thick Quartzite and the Tillite is shown as a total of 7,858 feet in the Aroona Waters section, and 7,701 feet in the Myrtle Springs section. Comparing the detail of strata in these two sections, it is found to vary somewhat, but the main theme is the same. The multiplicity and abundance of the intercalations of dolomite and dolomitic limestone, and a certain regularity in the occurrence of chert nodules in association with some of these horizons, is a constant characteristic. A notable feature near the upper limit where the Tillite is approached is the existence of a marked recurrent alternation of arenaceous beds with argillaceous and dolomitic bands.

This same series of dolomitic and magnesitic beds underlies the Tillite in the neighbourhood of Mount Warren Hastings (see Mawson 3). There, beds of this series are thrown down in relation to beds further east by a great north to south fault which breaks the sequence in the vicinity of the Ammonia Cave Hill. This fault was not recognised when I submitted the section on page 190 of that contribution.

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AN UNRECORDED METHOD OF MANUFACTURING WOODEN IMPLEMENTS BY SIMPLE STONE TOOLS

By C. P. MOUNTFORD, Hon. Assistant in Ethnology, South Australian Museum

Summary

This paper describes a method of making wooden implements by unworked stone tools. The observations were made at Aparina Springs in the Musgrave Ranges of South Australia by the writer during the 1940 Adelaide University Expedition.

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Plate XX

[Read 9 October 1941]

This paper describes a method of making wooden implements by unworked stone tools. The observations were made at Aparina Springs in the Musgrave Ranges of South Australia by the writer during the 1940 Adelaide University Expedition.

The particular implement manufactured was a wooden spear-thrower, such as is in common use over a wide area in Central Australia (text fig. 1, A, B). The aborigines who carried out the work were members of the Pitjendadjara or Pitjendara Tribe, whose country centred around the Mann Ranges of South Australia (text fig. 1, L).

This tribe has, perhaps, the simplest and most primitive material culture in Australia, their only possessions being a spear, spear-thrower, digging stick, wooden dishes, grinding stones, a simple bobbin for the manufacture of fur string, and several articles of personal adornment. An adze stone is used on the end of the spear-thrower, but there are indications that this is the most modern tool possessed by these people. All the sacred engraved sticks[1] seen by the writer have been obtained by barter from the tribes to the north. Adornment, except for septum pegs, hair string and occasional pubic ornaments, is confined to body painting.

Method of Manufacture

This can be divided into two main and several subsidiary stages.

A *Cutting the rough Slabs from the living Tree*

1 *Selection of the required Tools*—The tools employed were natural stones of various shapes collected from the adjacent hillsides; those having some form of cutting edge were tried out, and the unsuitable ones discarded. Several were broken in an endeavour to obtain a good cutting edge, but all these were rejected as ineffective. The one most suitable in weight and cutting edge (text fig. 2, A, B, C) was used for about 90% of the time. It was composed of epidotic gneiss, and weighed seven pounds.

2 *Making the preliminary Cut*—The operator chose a mulga tree (*Acacia aneura*) about eight inches in diameter, and at about three feet six inches from the ground made an acute angled cut (text fig. 1, E). The tool was held mostly by two hands, occasionally only one. In general, there were only two directions of striking, the grasp being unchanged; one in which the blows were delivered in a downward direction with the point of the tool, to remove the wood from the arms of the triangle (pl. xx, C, and text fig. 1, E); the other, with blows delivered at right angles to the axis of the tree, to cut the wood away at the apex of the triangle (pl. xx, D, and text fig. 1, F). In the former the grip was as shown in pl. xx, C, but in the latter, although the method of holding was not changed, the left hand was depressed, the right raised, and the stone turned on its side (pl. xx, D).

The task of making the preliminary cut in the tree was slow and laborious and lasted for over an hour. Several older men took turns in wielding the "axe,"

[1] These are equivalent to the *tjurunga* of the Aranda.

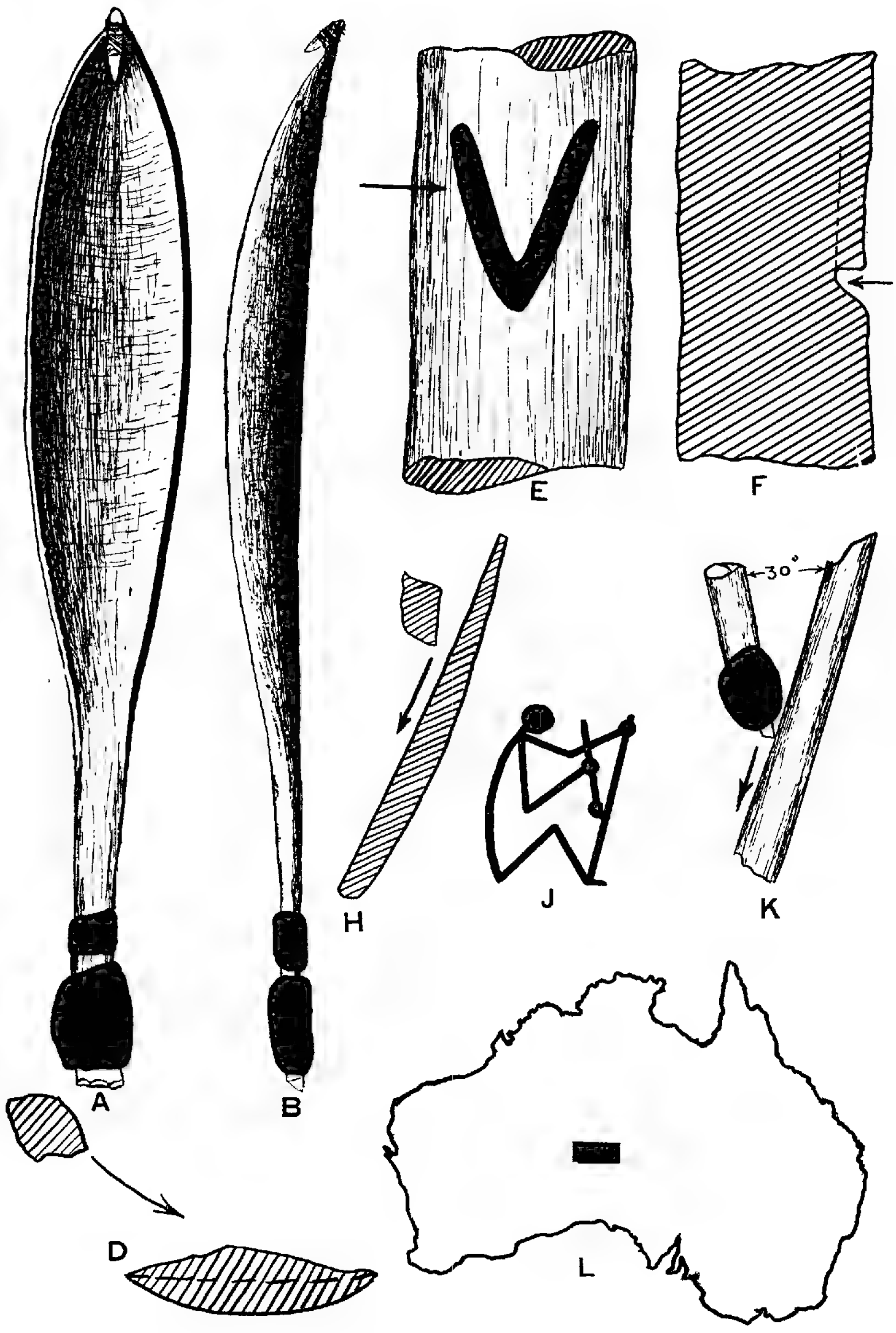

Fig. 1
Details of wooden spear-thrower and methods of manufacture.

but soon became exhausted, the bulk of the work being carried out by a young aborigine (pl. xx, A, C).

3 *Splitting off the Slab*—When the cut was about one and a half inches deep one of the older aborigines, taking a large stone, struck the tree with considerable force, at right angles to its axis and near the upper part of the cut (see arrow, text fig. 1, E), until a small vertical crack appeared. He then made two crude wedges from dead sticks lying nearby, and inserted one on the left hand side of the split and drove it in until the other wedge could be inserted in the right side. They were then alternately driven home until a rough slab of wood was removed (in this case the crack had conveniently tapered upward). The wood was then stripped of its bark and roughly chopped into shape by using the long edge of the cutting stone (text fig. 2, O, P), before being taken into camp. All

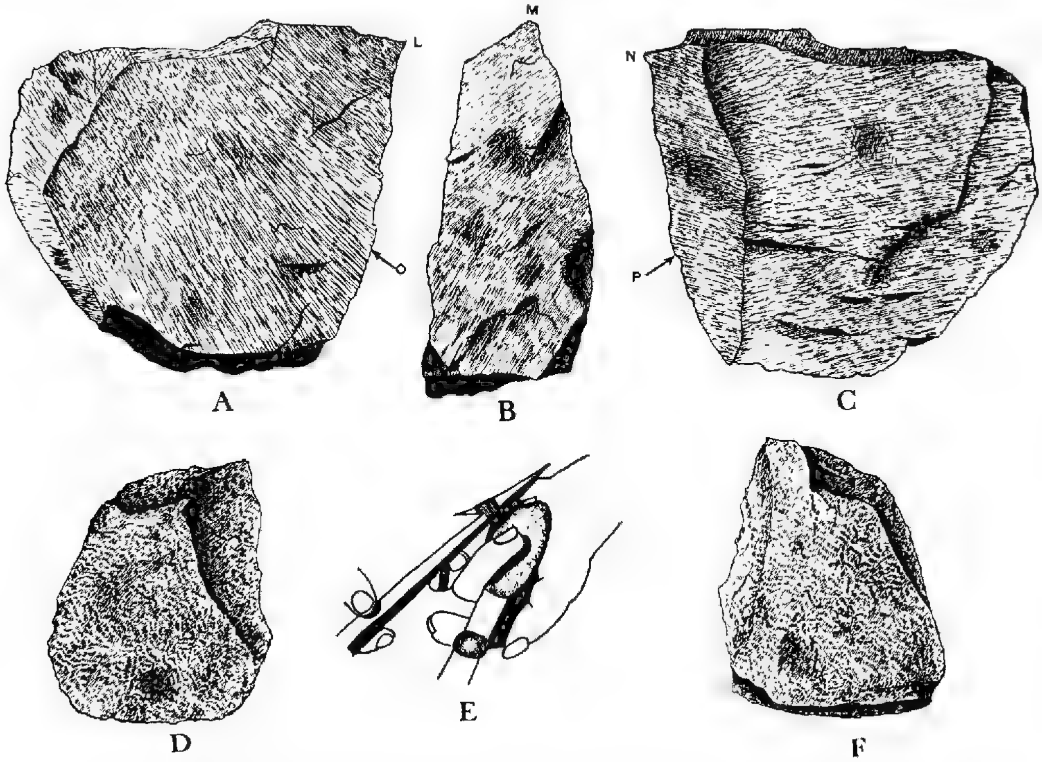

Fig. 2

A, C, D, F, side elevation; B, end elevation of unflaked stone, used in the manufacture of a wooden spear-thrower; E, method of sharpening adze stone.

stones used in these series of operations were left behind by the aborigines. The point utilised for cutting is indicated at L, M, N, text fig. 2.

B *Shaping and finishing the Implement*

1 *Removal of the Heart-wood*—In this case unflaked but much smaller stones were used. When no longer serviceable, they were discarded for new ones. Several were broken in halves to obtain a better cutting edge, but rejected after a short trial. D, F, text fig. 2, illustrates the tool most used, although it was one of perhaps ten stones employed during the process. It consisted of a highly siliceous gneiss and weighed three pounds.

The rough wooden slab was first laid flat on the ground, and a series of blows delivered across the grain of the wood (pl. xx, B), and in the direction of the arrow (text fig. 1, D), until the upper side of the new spear-thrower was slightly concave. When this stage was reached this method of striking was abandoned, because of the liability of breaking the outer edges.

The crude spear-thrower was then held in a more or less vertical position, with the end resting against the heel of the operator, and the cutting carried out in the direction of the grain (pl. xx, A; text fig. 1, J. H.), until the dense dark-coloured heart-wood was removed and the implement roughly the shape of a finished spear-thrower.

2 *Smoothing and shaping with the Adze Stone of a Spear-thrower*—In smoothing and shaping, the end of the implement, supported by the left hand, was held against the heel, using the latter as an anvil. The right hand operated a cutting adze stone, mounted in the end of another spear-thrower. The latter was held at an angle of about 30° (text fig. 1, J. K), and the pressure applied on the downward

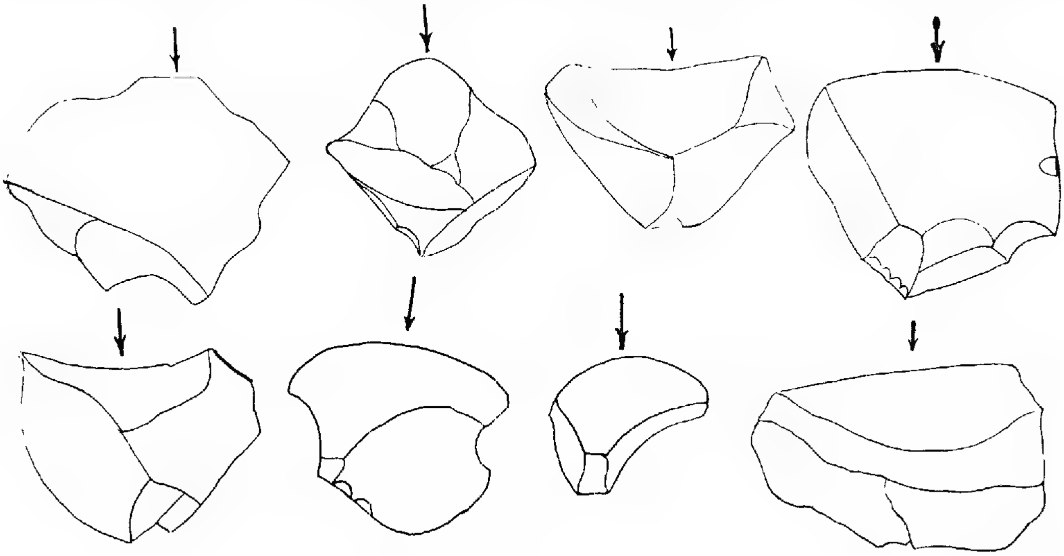

Fig. 3

Rough flakes of stone suitable for use as adze stones of spear-thrower. Scale, full size.

stroke. It acted generally as a plane or scraper, although chopping blows were occasionally used. In planing, shavings several inches long were often removed. This was continued, on both convex and concave sides, until the new implement was about three-sixteenths of an inch thick and crescentic in section (text fig 1, A, B).

Several times during this operation the adze stone was retouched or given a new cutting edge, by holding the spear-thrower in the right hand, with its adze stone resting against the palm, and tapping its flat face with the wooden blade of a spear until miniature flakes were broken off (text fig. 2, E).

3 *Fitting the Adze Stone to the new Spear-thrower*—A lump of spinifex gum was warmed by the fire until one end became softened, then made into pellets, which were stuck on the handle of the new spear-thrower until a mass of gum about two inches long, one inch wide, and about half an inch in thickness, was formed. This was then held over the fire until soft enough for a flake of fine grain stone to be pressed into it. The gum was then moulded around the adze stone with wetted fingers, until only about one-eighth to three-sixteenths of an inch of the stone projected.

No special shape of adze stone was preferred, any flake of a suitable size and with a cutting edge being used. To test this an aborigine was requested to break a number of flakes from a small boulder of white chert. Some 30 flakes in all were handed to six men, with a request to pick out only those suitable for mounting. Eight flakes were selected of varying shapes and sizes, the only similarity being the existence of a sharp cutting edge (text fig. 3). Whilst travelling with the Pitjendadjara aborigines the author often saw a man pick a natural flake from the ground and store it in his hair for future use. The adze stone on the new spear-thrower described above was taken from the operator's head-dress.

4 *Fitting the Throwing Peg*—The throwing peg is about one and a quarter inches long, a quarter-inch thick, and, when in use, fits into a corresponding cavity in the end of the spear. One end was rounded, and the other cut to an angle of 30° to the axis. The operator attached a softened pellet of spinifex gum to the end of the spear-thrower and embedded the wooden peg in it. The surplus gum was then scraped away, and the peg securely bound to the implement by a lashing of kangaroo or emu tendons.(2) Considerable care was taken to be sure that the axis of the throwing peg coincided with the central line of the spear-thrower. The implement was then rubbed all over with powdered red ochre, and the operations were complete. The time occupied in its manufacture was from three to four hours. A cinefilm, showing all stages of manufacture, is stored in the records of the Board for Anthropological Research of the Adelaide University.

C *Description of Spear-thrower*

The wooden spear-thrower of the Pitjendadjara tribe is by far the most important tool in their culture. It has four main uses: (*a*) as a spear-thrower; (*b*) as a cutting tool; (*c*) as a small dish, the hollow body forming an excellent receptacle; and (*d*) as a firemaking tool in which the edge of the spear-thrower is rubbed rapidly across a cleft stick until the powdered wood-dust ignites.

This type, with its adze stone, has a wide distribution in Central Australia and is probably the most modern implement possessed by the Pitjendadjara.

Discussion

This paper records one of the most primitive examples of the use of stone tools, a remarkable instance of a survival of man's early realisation of the use of stone.

Although the stage of lithoclastic culture reached by the Pitjendadjara is not clear,(3) it is evident, from observation and information obtained, that before the introduction of the mounted stone adze these people could have made satisfactory spear-throwers, spears and carrying dishes with unworked stones similar to those figured.

Further, as such discarded untrimmed stones would bear no recognisable trace of having been used by man, it would be possible for a people with a similar material culture to that of the Pitjendadjara to become extinct, yet leave no trace behind.

Acknowledgment

The author is indebted to Mr. L. E. Sheard for his companionship and help; to Miss A. Harvey for her assistance in the production of the drawing; and to Mr. H. V. V. Noone for his criticism and help in the preparation of this paper.

(2) The leg-tendons of emus, kangaroos and wallabies are dried, stored in the hair, and when required softened by chewing.

(3) In the collection of artifacts, made by N. B. Tindale and by Harry Balfour in the Musgrave Ranges, are a number of *pirris* and crescent-shaped microliths. It is not clear, however, whether these are a part of the culture, or have reached this area by trade routes.

Photographs, C. P. Mountford

Stages in the manufacture of a wooden spear-thrower with unflaked stones.

THE LIFE HISTORY OF ECHINOSTOMA REVOLUTUM IN SOUTH AUSTRALIA

By T. HARVEY JOHNSTON and L. MADELINE ANGEL, University of Adelaide

Summary

In December 1940 eight specimens of *Amerianna pyramidata* collected from the Murray swamps at Tailem Bend were found to be infected with a 37-spined echinostome cercaria, the anatomy of which suggested *Cercaria Echinstomirevoluti* as described by Beaver (1937). These cercariae were found by experiment to encyst in molluscs and tadpoles, and the cysts were then fed to two pigeons. Subsequently adult echinostomes were recovered from one pigeon, and young stages from the other. These were identified as *Echinostoma revolutum* (Froëlich).

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Although *E. revolutum* has been reported from North Queensland, the cercaria and cyst stages, as such, at any rate, have not previously been recorded from Australia. Johnston and Cleland (1937) considered it very probable that *Cercaria catellae* Bradley 1926 was the larval form of *E. revolutum*. Bradley thought that *C. catellae* was the larval stage of an echinostome, though he had not observed collar spines and, indeed, did not seem to expect them in the cercariae of echinostomes, although he had noted their presence in cysts. Bradley mentioned that it was quite possible that he had included two or more related species of cercaria under the name of *C. catellae*. He had found *C. catellae* in *Bulinus brazieri* and *Limnaea brazieri*, and in the same snails were large numbers of cysts measuring from 130 to 160 μ in diameter. These cysts appeared to be identical with those which Bradley occasionally observed *C. catellae* forming on the slide. He made no mention of the number of spines present in the metacercariae, and the description of the cercaria itself is obviously too generalised to permit definite identification. The most that can be said is that, as far as measurements are concerned, the cercaria and cyst could be the larval forms of *Echinostoma revolutum*. It should be mentioned that in six months' examination of *Cercaria Echinostomi-revoluti*, we have never observed the cercaria encysting on the slide; but it is probable that Bradley did not use such great compression as we find necessary to examine the cercaria.

We have found *C. Echinostomi-revoluti* in the Murray swamps from December 1940 to May 1941, in both *Amerianna pyramidata* and *A. pectorosa*. It was present in eight of 520 of these snails collected in December, eight of 861 in January, three of 2,470 in February, one of 424 in March, one of 142 in April, three of 64 in May, and nil in 25 in June. Cercariae collected from six *A. pectorosa* from Flinders Chase, Kangaroo Island, in February 1940, have now been identified as *C. Echinostomi-revoluti*. In April and August 1939, two snails (*Amerianna* sp.) from the Murray swamps yielded spherical echinostome cysts of the same size as those of *Echinostoma revolutum*, and with 37 spines and approximately the same number of excretory granules. They are probably cysts of *C. Echinostomi-revoluti*.

Since April 1937, when these investigations were commenced, we have examined ten different kinds of echinostome cercariae from the River Murray, and of these only two have been 37-spined forms, *C. Echinostomi-revoluti*, and another (as yet not described) which is quite distinct on account of the much greater size of the cercaria and cyst.

Redia

The liver of the infected snail is coloured bright orange by the rediae which are closely packed throughout. The most common size is about 900 by 200 μ, but there are many much larger, some measuring as much as 2·7 mm. by 184 μ. In the very small rediae no orange colouring is present. In some specimens the collar is prominent as a broad band at whose junction with the body the birth pore may be seen. The gut is short, in most cases extending little further than the posterior border of the collar; its walls are composed of large flat cells. Foot processes are present, and may be quite prominent. Flame cells were not seen.

CERCARIA

The cercariae emerge from the host before noon, and have a free life of less than 24 hours. The size of the body in formalinised specimens (284 to 350 μ long by 92 to 109 μ wide) agrees with the measurements given by Beaver (323 by 95 μ), but the length of the tail is appreciably less in our specimens (284 to 384 μ long by 38 μ at the widest point) than in Beaver's (450 μ long). The actual sizes of the suckers in our specimens (oral 37 μ across by 44 μ long, acetabulum 48 μ in diameter) are less than the sizes given by Beaver (oral 41 by 46 μ, acetabulum 58 μ), but the ratio of breadth of suckers (approximately 3:4) corresponds fairly closely. The acetabulum is situated well behind the middle of the body.

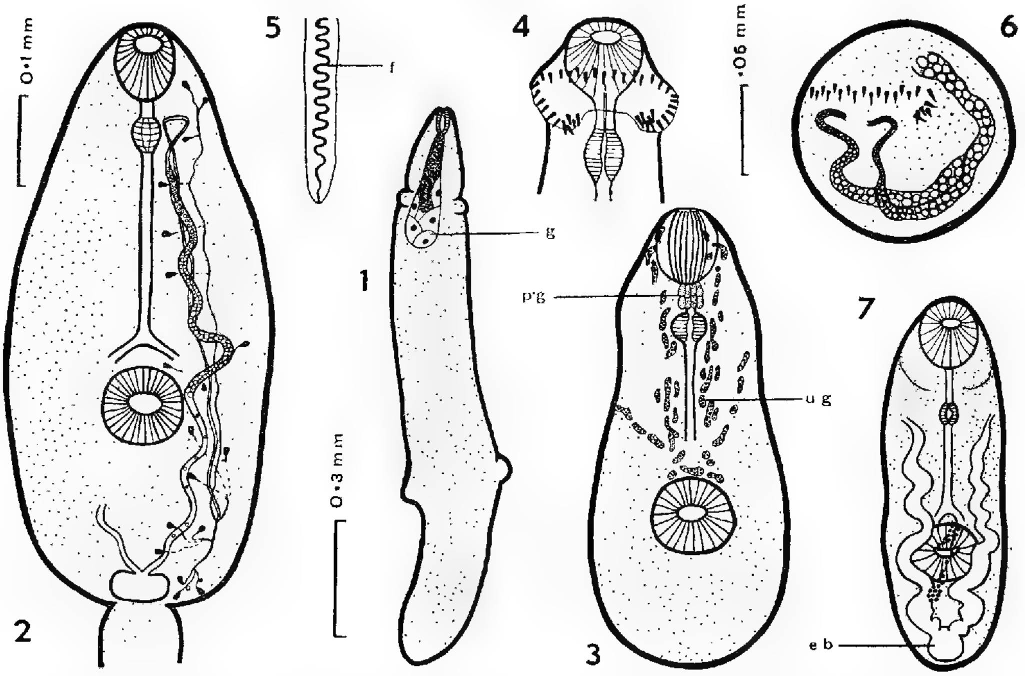

Fig. 1, redia; 2, 3, cercaria; 4, head end of cercaria; 5, fin-fold of tail, seen in specimen immobilized with neutral red; 6, cyst; 7, metacercaria. Fig. 2 and 7 to same scale; fig. 4 and 6; 3 and 5 sketches. eb, excretory bladder; f, fin-fold; g, gut; pg, ? penetration glands; ug, unicellular glands. In fig. 4 and 6 shape and size of spines not necessarily exactly accurate, due to difficulty of determination; in fig. 4 the arrangement is accurate.

The collar spination agrees with Beaver's description, namely, a group of five corner spines followed by six lateral spines in a single row, and fifteen dorsal spines arranged in two alternating rows. Cuticular spination is not obvious. Beaver's method of examining fixed specimens cleared in glycerine to which a small amount of methylene blue has been added fails to show any spination, though Beaver describes it as being then distinctly evident. Staining with picric acid shows a roughening over both dorsal and ventral surfaces, giving the appearance of very fine sand rather than that of spination.

The cystogenous cells, present throughout the body, are finely granular. Opening on the anterior end of the body are eight narrow ducts, which are clearly visible as far back as the posterior border of the oral sucker. It is thought that the gland cells associated with these are arranged in two rows of four each, in the region of the prepharynx. These cells are small and inconspicuous and were seen only in a few favourable specimens; their nuclei were not detected. Staining with some intravitam stains, of which neutral red is the best, shows up a number of apparently unicellular bodies in the anterior half of the body. These rather coarsely granular "cells" extend from the anterior end of the body to the anterior border of the acetabulum in a single chain on either side of the alimentary canal, and in addition there are a few scattered cells (fig. 3). They appear to open on the ventral surface of the body, and, though their function is unknown, it is suggested that they are gland cells of some kind. Beaver has noted twelve ducts associated with the oral sucker, which, he says, are outlets of a group of gland cells situated laterally to the oesophagus. Further, he says that the cells and ducts are arranged in two groups, an anterior one opening on the dorsal lip of the oral sucker, and a more posterior second group whose ducts are more coiled and much smaller. We have been unable to find any gland cells laterally to the oesophagus. We think it unlikely that the structures we have described as unicellular gland cells are the same structures as those referred to by Beaver as the coiled ducts of his posterior group of gland cells. Beaver quotes Brown (1926) and Wesenburg-Lund (1934) as having noted ducts and gland cells for *Cercaria echinata* similar to those he described, but both these authors refer only vaguely to the cells, stating that their structure is obscured by the overlying cystogenous gland cells, and neither of them gives figures of the cells. Moreover, Beaver states that *C. echinata*, "which is generally accepted as the larva of *Echinostomum revolutum*," cannot be distinguished from the cercaria of *Echinoparyphium aconiotum* Dietz as described by Riech (1927) and Dubois (1928), and that it is very different from the cercaria of *Echinostoma revolutum*.

For studying the excretory system, intravitam staining with basic fuchsin in normal saline gave best results for flame cells and ciliary patches, while for the tubes orange G following neutral red was best. We consider that the total number of flame cells is almost certainly 36, the arrangement being: six single flame cells connected with the anterior collecting tubule, and four groups, each of three flame cells, the first group situated to the side of the anterior border of the acetabulum, and the fourth at the posterior end of the body. The junction of anterior and posterior collecting tubules is slightly in advance of the bladder, and at the junction opens the common duct from a group of flame cells; but it is difficult to state whether this group belongs to the anterior or the posterior collecting tubule, and the flame cell formula can be expressed as $2 [(6 + 3) + (3 + 3 + 3)]$ or $2 [(6 + 3 + 3) + (3 + 3)]$. Although 36 is the number of flame cells suggested by Beaver, the arrangement he gives is different from that we have described. He found no flame cells in the "opaque" region between the two suckers, but indicated an extra group of three flame cells in the region posterior to the acetabulum. We could not see any trace of excretory duct in the tail, and observed ciliary patches in the main arms of the bladder only as far as the anterior border of the acetabulum, but we agree with Beaver in finding 40 to 80 excretory granules in the enlarged portion of the excretory trunks. Near the acetabulum there are one to two granules across the diameter of the tube, but anteriorly, as the tube narrows, the granules become smaller, and there are two to three across the diameter.

In stained preparations the genital rudiment was clearly defined. A darkly-staining mass of cells posterior to the acetabulum was connected by a fine string of cells with another mass of cells beneath, and extending to the anterior border of the acetabulum.

In the tail, the only muscles visible are radial; these are regularly spaced throughout the length of the tail, but end a short distance below the tip. They arise somewhere in the central strand, and insert just below the cuticle, with myoblasts more or less evenly distributed. The delicate fin-fold appears, in specimens compressed with a coverslip, to be divided into several parts, lying alternately to right and left of the tail. But in specimens which have been more or less immobilized by strong neutral red, the fin-fold is seen to be attached in the midline of the dorsal surface, and its free border convoluted. It is colourless and apparently structureless, except for a very fine granulation.

Beaver examined the type material of *Cercaria trivolvis* Cort 1914, and reported it to be identical in all features with his own specimens (*i.e.*, *C. Echinostomi-revoluti*). Miller (1936) stated that the many large cystogenous glands of *C. trivolvis* were filled with elongated refractile bodies arranged in bundle-like formation. As stated previously, the cystogenous glands in our species have a fine, granular structure. It is our experience that the structure of the cystogenous glands is a constant character in any one species. Beaver did not mention this character for *C. Echinostomi-revoluti*, but it is possible that *C. trivolvis* (or, at least, the material described by Miller as such) is not a synonym of *C. Echinostomi-revoluti*. However, Miller also noted a row of six swollen openings along the anterior lip of the oral sucker, each of which extended posteriorly as a small fibre-like structure. Each fibre was swollen near the dorsal median side of the oral sucker. He thought that possibly each of these fibres was an undeveloped duct which connected with the penetration glands of the cercaria. Similarly, Beaver stated that in about half of the toto mounts of the adult worms "these larval structures" (*i.e.*, the ducts of the penetration glands) were still noticeable as six minute papilla-like structures along the anterior border of the oral sucker.

Cyst

We found, as Beaver did, that the cercaria encysts in molluscs and tadpoles. Of the former, those subjected to experimental infection and giving positive results were the hosts, *Amerianna pyramidata* and *A. pectorosa* (in which the cysts occurred in the liver), *Planorbis isingi* and *Limnaea lessoni* (in the mantle chamber), and *Corbiculina angasi*. In tadpoles, *Lymnodynastes* sp., it is found in the kidney, though two cysts were also free in the intestine. No encystation occurred in the fish *Phalloceros caudomaculatus*, *Gambusia affinis*, *Oryzias latipes* or a young specimen of the catfish, *Tandanus tandanus*, though Beaver recorded the cyst from the American catfish, *Ameiurus melas*.

The cyst is spherical or sub-spherical, varying in diameter from 117 to 125 μ in the former case, and in the latter from 117 by 100 μ to 121 by 109 μ, and has the typical echinostome appearance. Within the outer cyst wall formed from the host tissues, it is enclosed in a thick glassy wall which is resistant to pressure. Beaver did not mention the size of the cyst, but in accounts given by other workers it seems to be somewhat larger than in our specimens. Tubangui (1932), who found them abundant in the connective tissues and reproductive organs of snails, gave the diameter as 150 to 160 μ. Lutz (1924) found them in the neighbourhood of the heart in *Physa rivalis*, and gave 170 μ for the outside measurement and 150 μ for the inside. Rankin (1939), who found them "in various species of pulmonate snails," does not give the measurements, but from his figure the cyst is 180μ in diameter.

Fielder (1896) described briefly a cyst found by himself in Victoria in *Isidora* (= *Amerianna*) *texturata* and *Limnaea lessoni*. He stated that it had 37 spines, and the scale below his fig. 2 indicates a cyst about 330μ in diamter, which could not be that of *Echinostoma revolutum*, though Johnston and Cleland (1937) had suggested that it might be so. The cyst from *Isidora texturata*, *I. aliciae* and *Limnaea lessoni*, shown in Fielder's fig. 1, is about the same size as that of *Echinostoma revolutum*, but the number of spines present was not mentioned.

Metacercaria

We were rarely able to express the metacercaria undamaged from the cyst but, strangely enough, metacercariae which had encysted in *Planorbis isingi* very often emerged spontaneously from the cysts when the snail was dissected. It is probable that they were unable to form so thick a cyst wall in this host as in others.

The metacercaria does not exhibit any great structural differences from the cercaria. The genital rudiments are perhaps a little larger, but show no further differentiation. The acetabulum is still situated behind the midlength of the body. The spination extends over the whole body surface, but is more pronounced in the region between the acetabulum and the anterior end of the body. The excretory system is similar to that of the cercaria, except that the main arms of the bladder are greatly expanded (fig. 7). Many ciliary patches throughout the main tubes can be seen very clearly.

Adult

On five different occasions, from 18 July to 4 August, two pigeons (*Columba livia*) were fed with *Limnaea lessoni* which had been subjected to infection with cercariae of *C. Echinostomi-revoluti* for periods of three to nine days. The number of cysts in each snail would not have been great, as at this time we had only one snail which was giving off cercariae.

Pigeon "A" was killed on 13 August, and from the rectum were recovered four adult specimens (in which ripe eggs were present) of *E. revolutum*. These measured 11-12 mm. long by 1 mm. wide, with the ovary at midlength of the worm, post-testicular region one-third of the body length, and pre-acetabular region approximately one-sixth body length. The eggs measured from 100 to 108 μ by 67μ (Beaver's measurements from all hosts, 91 to 145 μ by 66 to 83 μ).

Pigeon "B" was killed on 14 August, and from it four younger specimens, without eggs, were found. Measurements of the youngest: 5 mm. long by ·75 mm. broad, post-testicular zone nearly one-third body length, ovary just in front of midlength, pre-acetabular region nearly one-fourth body length, and vitellaria not developed. The others were about 7 mm. long and possessed numerous small yolk follicles.

The adult stage of *E. revolutum* was recorded from North Queensland from *Anas superciliosa* by S. J. Johnston in 1913; from *Anseranas semipalmata*, *Nettopus pulchellus* and *Chenopis atrata* by Nicoll in 1914; and from the domestic duck by Roberts in 1939. We now record it from the following anseriform birds from Tailem Bend, South Australia: *Biziura lobata*, *Spatula rhynchotis*, *Anas superciliosa* and *Chenopis atrata*; as well as from *Biziura lobata* from Sandgate, Queensland, and *Anas superciliosa* from New South Wales. To these hosts should be added *Casarca tadornoides* from Cooma, New South Wales, the record having been made by Johnston and Cleland (1937) on the basis of Bradley's account and figures (1927). Bradley believed the echinostomes from the mountain duck to be the adult stage of his *Cercaria catellae*.

Beaver (1937) considered that the description of *E. acuticauda* Nicoll 1914 from *Carphibis spinicollis* from North Queensland, did not permit the species to be distinguished from *E. revolutum*. Nicoll's form, as indicated by his figure, is much more slender, while the uterus, ovary and testes occupy different positions in relation to the length of the worm from those of *E. revolutum*. The ovary is at the end of the first third of the body, the testes are almost entirely in the anterior half, and the distance between the ovary and the posterior edge of the acetabulum (*i.e.*, the main egg containing region) is less than one-sixth of the total length of the worm. There is also a sharply pointed tip to the tail.

As in previous papers dealing with our studies of the life-cycles of Australian trematodes, we desire to acknowledge our indebtedness to Messrs. G. and F. Jaensch and L. Ellis of Tailem Bend; as well as to the Commonwealth Research Grant to the University of Adelaide, for assistance.

Summary

1 *Cercaria Echinostomi-revoluti* is recorded for the first time from Australia, its known hosts being the pond snails, *Amerianna pyramidata* and *A. pectorosa.*

2 Its possible synonymy with *C. catellae* Bradley is discussed.

3 The cercaria is described, and the account contrasted with Beaver's description (1937).

4 The cyst stage is found in various molluscs and tadpoles. Its size appears to be less than that recorded by workers elsewhere.

5 The adult stage was obtained by feeding cysts to pigeons.

6 Its occurrence in various Australian anseriform birds is recorded.

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NEW SPECIES OF GECKOBIA (ACARINA, PTERYGOSOMIDAE) FROM AUSTRALIA AND NEW ZEALAND

By H. WOMERSLEY, F.R.E.S., A.L.S., South Australian Museum

Summary

The family Pterygosomidae contains a number of genera of mites which are confined to lizards, particularly of the families Geckonidae, Agamidae, Zonuridae and Gerrkosauridae. The general taxonomy and classification of the family has been admirably and fully dealt with by Hirst (A.M.N.H. (8), 19, 136-143, 1917; J. Linn. Soc., (Zool.), 36, 173-200, 1924) and Lawrence (Parasitology, 27, (I), 1-45, 1935; ibid, 28, (I) , 1-39, 1936).

NEW SPECIES OF GECKOBIA (ACARINA, PTERYGOSOMIDAE) FROM AUSTRALIA AND NEW ZEALAND

By H. Womersley, F.R.E.S., A.L.S., South Australian Museum

[Read 9 October 1941]

The family Pterygosomidae contains a number of genera of mites which are confined to lizards, particularly of the families Geckonidae, Agamidae, Zonuridae and Gerrkosauridae. The general taxonomy and classification of the family has been admirably and fully dealt with by Hirst (A.M.N.H. (8), **19**, 136-143, 1917; J. Linn. Soc., (Zool.), **36**, 173-200, 1924) and Lawrence (Parasitology, **27**, (1), 1-45, 1935; *ibid*, **28**, (1), 1-39, 1936).

The genus *Geckobia* is confined to the Geckonidae and as yet is the only one known to occur in Australia or New Zealand. Previously only one species (*G. clelandi* Hirst, *loc. cit.*, 1917, 138, 1924, 175) has been recorded from Australia and none[1] from New Zealand. *G. clelandi* was found on *Gymnodactylus platurus* from Narabeen and Sydney, New South Wales, by Dr. J. B. Cleland.

In some parts of the world, notably South Africa, New Guinea and India, this group of acarina is well represented, much more so than in Australia or New Zealand; but doubtless in the latter countries this is due to lack of collecting. A second species is now described from Australia and two from New Zealand.

The Pterygosomidae occur upon various locations of their hosts, and particular locations appear to be restricted to particular species of mite. They may be found in the folds of skin around the eyes, in the tympanum, between the toes and in the armpits, and also under the scales.

Of the early stages little is known, but Lawrence has described the larvae and nymphs of several South African species. In the present paper the nymph and a subsequent pupal or resting stage in the new Australian species are described and figured.

The genera of the Pterygosomidae may be separated thus:

1 Dorsal scutum present, sometimes divided into two lateral portions. 2
Dorsal scutum entirely wanting. 3

2 Dorsum with few setae, these very long. Body longer than wide.
Gen. *Pimeliaphilus* Trgdh., 1905
Dorsum with numerous setae, these shorter. Body usually wider than long.
Gen. *Geckobia* Megnin, 1878

3 Apex of hypostome much enlarged. Dorsum with few setae. 4
Hypostome subparallel. Dorsum with numerous setae. 5

4 Body longer than wide. Size larger. Skin leathery. Gen. *Ixodiderma* Lawrence, 1935
Body much wider than long. Size smaller. Skin not leathery.
Gen. *Scaphothrix* Lawrence, 1935

5 Body very much wider than long. 6
Body longer than wide. 7

6 Dorsum with a dense anterior patch of setae on each side of mouth parts. Eyes absent.
Gen. *Pterygosoma* Peters, 1849
Dorsum without such patches of setae. Eyes present.
Gen. *Zonurobia* Lawrence, 1935

[1] In 1919 (N.Z. Jour. Sci. and Tech., **2**, 163) A. B. Dove refers to the occurrence of "small red ticks" on species of *Lygosoma*. The microphotographs shown, however, prove that these are not "ticks" but a species of Geckobidae.

7 Setae on dorsum few. Gen. *Hirstiella* Berlese, 1920
Setae on dorsum numerous and somewhat enlarged distally. Gen. *Geckobiella* Banks 1905

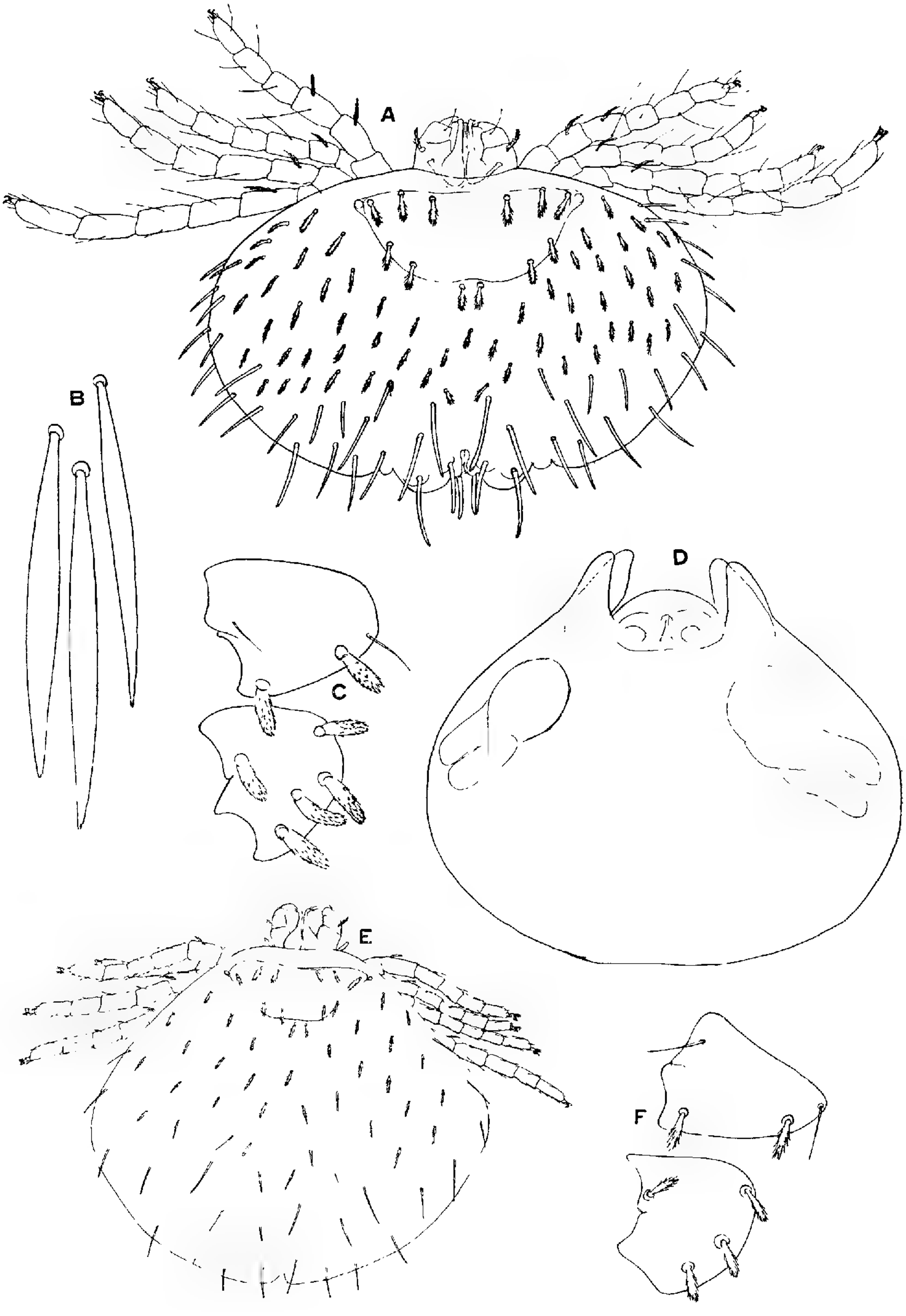

Fig. 1
Geckobia gymnodactyli n. sp.: A, dorsal view; B, posterior ventral setae; C, right coxae; D, pupa; E, nymph from above; F, nymphal coxa.

Genus Geckobia Megnin

Megnin, P. 1878 Bull. Soc. ent. Fr., (5), 8.

Geckobia gymnodactyli n. sp

(Fig. 1, A–F)

Description, Female—Colour in life red. Body rather depressed, wider than long, 425 μ by 310 μ. Gnathosoma basally hidden beneath body, 50 μ long, Scutum wider than long, as figured, 175 μ by 86 μ, posterior margin medially slightly concave, setae 10 in number, rather short, stout and ciliated, 30 μ long, arranged 6 along anterior and 4 along posterior margin; in addition there is a pair of similar setae just off the posterior concavity. Eyes, one on each side at the extreme lateral angles of the scutum. Palpi and mandibles normal for the genus, as figured for *G. haplodactyli;* palpal femur with a thick, ciliated seta. Dorsal setae of two forms as figured; marginal and on posterior fourth simple, thick and rather blunt tipped, to 55 μ; remainder similar to but rather smaller than scutal setae. Ventrally without scales, the first four rows of close-set setae similar to anterior dorsal setae; those on remainder of venter rather close-set and as figured, to 55 μ in length.

Legs without any special protuberances, fairly and uniformly thick, I 135 μ, II 162 μ, III 200 μ, IV 216 μ; second and third segments of I and second of II, III, and IV with a ciliated thick seta; coxa in two conjoined pairs as figured, I and II with two long fine setae, and two thick ciliated setae; III and IV with 5 stout ciliated setae; claws typical of the genus and as figured for *G. haplodactyli.*

Pupa or *Resting Stage:*

This stage was found within the cuticle of the ? protonymph, and the slightest pressure caused the cuticle to split dorsally and the pupa to be extruded. The pupa was as figured, 300 μ wide by 260 μ long, with the processes, in which the future legs would develop, plainly showing. No development of the next stage, however, was evident in any specimen.

? *Protonymph* or *Prepupal Stage:*

Similar in shape and chaetotaxy to the adult. Width 310 μ, length 270 μ. Dorsal setae similar to, but fewer than in adult. Coxae III and IV with only 4 thick ciliated setae as described by Lawrence for the nymph of *G. phyllodactyli.* Scutum 140 μ wide, 75 μ long, its setae 27 μ. Posterior dorsal setae 40 μ. Coxal setae 16 μ

Locality—A number of adult females and nymphs from between the toes of a gecko, probably *Gymnodactylus morio*, from Humbug Scrub, near Adelaide, South Australia, 1 October 1938 (J. S. W.).

Remarks—Differs from the only other known Australian species, *G. clelandi* Hirst, in shape, chaetotaxy, and the longer fourth pair of legs. Comes nearest to *G. malayana* Hirst from the Malay Peninsula, but differs in the entire scutum and the arrangement of setae on the scutum.

Geckobia haplodactyli n. sp

(Fig. 2, A–H)

Description, Female—Colour in life red. Body longer than wide, 1100 μ by 900 μ, not depressed. Gnathosoma well in front of body, 255 μ long. Mandibles and palpi as figured; palpal setae simple. Dorsal scutum short and wide, as figured, 85 μ by 390 μ with numerous thick and blunt apically serrated setae. Eyes at extreme lateral corners of scutum. Dorsal setae numerous but not so numerous as in the following species, to 54 μ long, thick and slightly tapering to blunt point, without serrations. Dorsum medially just behind scutum and posteriorly devoid of setae.

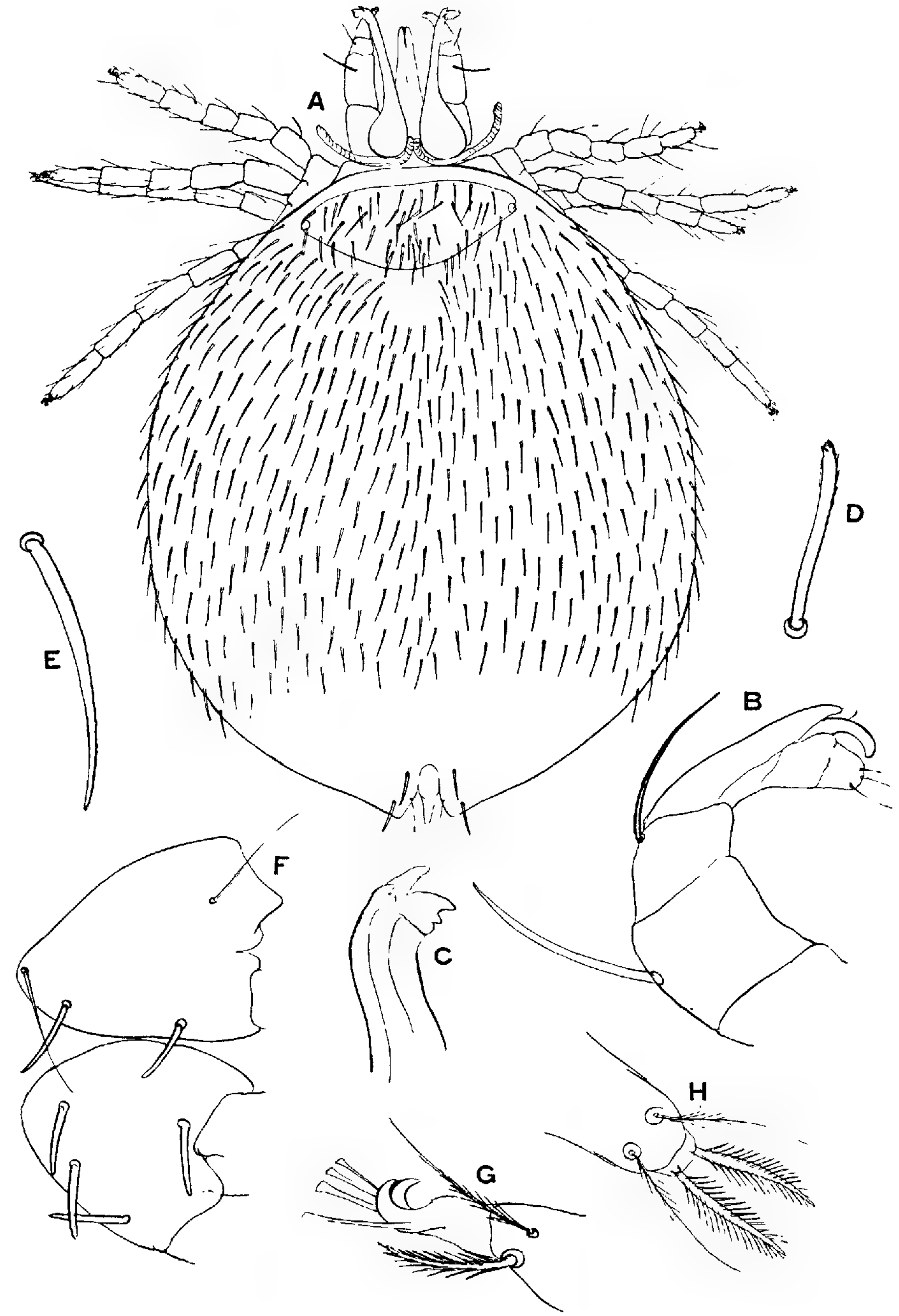

Fig. 2

Geckobia haplodactyli n. sp.: A, dorsal view; B, palp; C, tip of mandible; D, scutal seta; E, dorsal seta; F, right coxae; G, tip of tarsus and claws from side; H, tip of tarsus from above, claws omitted.

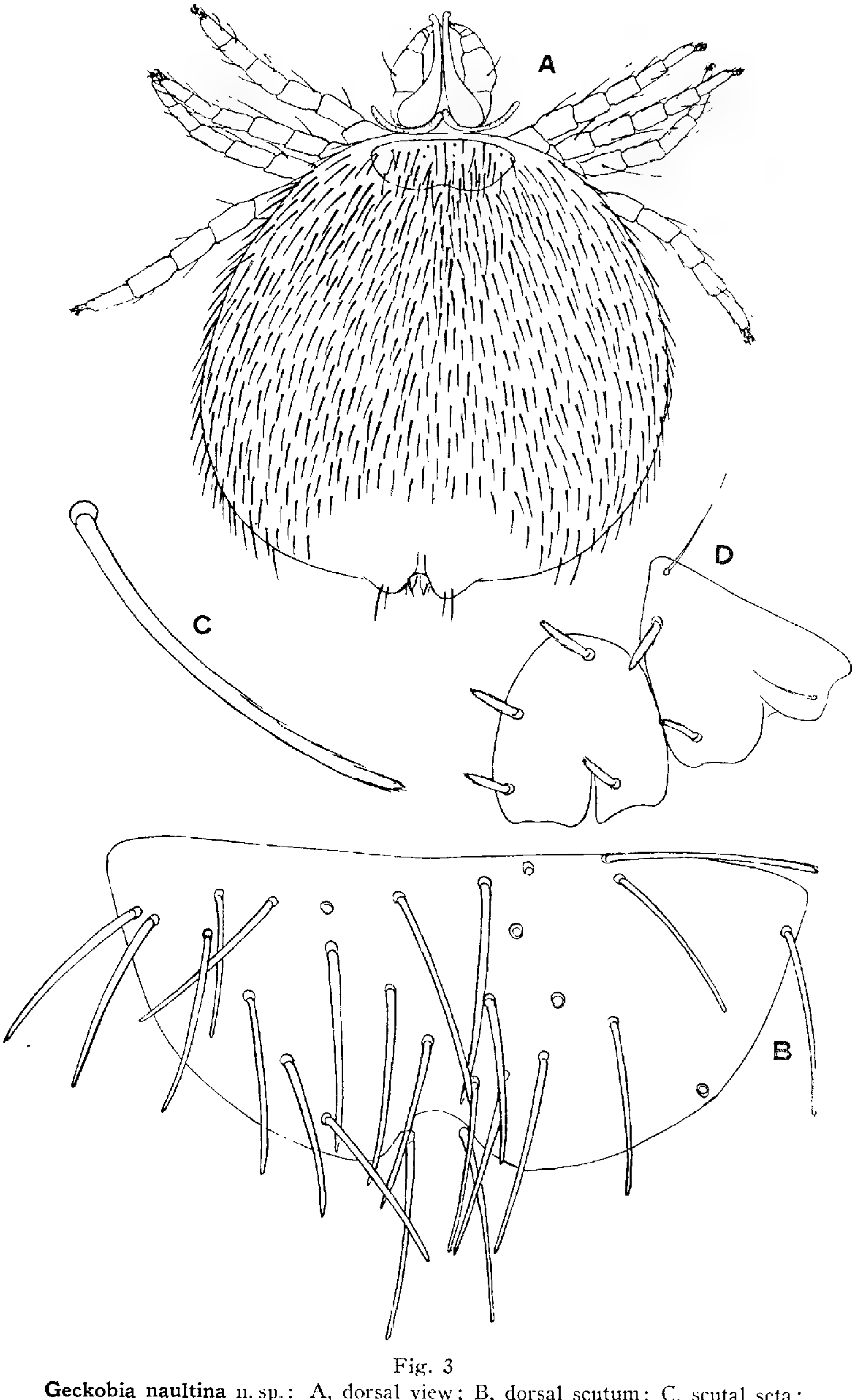

Fig. 3
Geckobia naultina n. sp.: A, dorsal view; B, dorsal scutum; C, scutal seta; D, right coxae.

Legs fairly slender and uniform without any special protuberances, I 380 μ, II 370 μ, III 420 μ, IV 480 μ, no ciliated setae on basal segments; coxae as figured, I and II with two fine and two thick simple setae; III and IV with four thick simple blunt setae. Ventrally without scales and chaetotaxy similar to dorsum.

Locality—From the skin folds of the eyes of *Haplodactylus duvaucellii* from New Zealand. I am greatly indebted to Mr. N. G. Stephenson, of Takapuna, Auckland, New Zealand, for the loan of the gecko from which these specimens were obtained.

Geckobia naultina n. sp.

(Fig. 3, A–D)

Description, Female—Colour in life ? red. Body about as long as wide, 760 μ by 760 μ, not depressed. Dorsal scutum small, as figured, 256 μ wide by 108 μ long, with many long, thick and blunt setae. Eyes ?. Gnathosoma entirely projecting in front of body, 220 μ long. Palpi and mandibles normal, no ciliated seta on palpal femur. Dorsum with very numerous uniform setae which are rather thick and indistinctly serrated in apical half, to 70 μ in length. Legs fairly slender, I 270 μ, II 310 μ, III 335 μ, IV 380 μ, without ciliated stout setae; third segments of I, II, and III with a long setae. Venter without scales, with chaetotaxy similar to dorsum; coxae as figured, I and II with two fine and two stout incrassate serrated setae, 30 μ long, III and IV with four such.

Locality—Several specimens from a gecko, *Naultinus* sp, from Auckland, sent by Mr. N. G. Stephenson.

SOME OBSERVATIONS ON THE EMBRYONIC DEVELOPMENT OF AUSTROICETES CRUCIATA SAUSS. (ACRIDIDAE) IN THE FIELD

By H. VEVERS STEELE [1]

Summary

In South Australia the grasshopper *Austroicetes cruciata* Sauss. has one generation a year. The eggs are laid in November and hatch the following September. In the summer development is inhibited by an embryonic diapause The diapause does not disappear (even slowly) when the eggs are incubated constantly at a temperature above the developmental zero. In this the eggs of *A. cruciata* resemble those of *Circotettix verruculatus* Kirby and differs from those of *M. mexicanus differentialis* Thomas (Carothers 1923) and *M. mexicanus* Sauss. (Parker 1930). This paper is a description of the development of the external form of the embryo of *Austroicetes cruciata* in the field. The internal anatomy was not studied.

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By H. Vevers Steele [1]

[Read 9 October 1941]

Introduction

In South Australia the grasshopper *Austroicetes cruciata* Sauss. has one generation a year. The eggs are laid in November and hatch the following September. In the summer development is inhibited by an embryonic diapause. The diapause does not disappear (even slowly) when the eggs are incubated constantly at a temperature above the developmental zero. In this the eggs of *A. cruciata* resemble those of *Circotettix verruculatus* Kirby and differs from those of *Melanoplus differentialis* Thomas (Carothers 1923) and *M. mexicanus* Sauss. (Parker 1930). This paper is a description of the development of the external form of the embryo of *Austroicetes cruciata* in the field. The internal anatomy was not studied.

Material and Methods

The eggs were collected at Orroroo and Wilmington at intervals during 1939 and 1940, the latter by Mr. L. C. Birch. Usually they were fixed within two or three days of being collected; those collected on 3 February and 3 March 1939 were kept at 25° C. for 10 days before fixing. Staining was chiefly with borax-carmine; for temporary mounts Wheeler's quick method for embryos with Delafield's haematoxylin proved most useful (Wheeler 1893).

Blastokinesis

Blastokinensis may be conveniently described under two headings; anatrepsis and katatrepsis. During anatrepsis the embryo moves tail first towards the anterior pole of the egg; during katatrepsis it moves head first around the posterior pole and then continues towards the anterior pole.

Throughout its development the embryo remains on the surface of the yolk. At the stage shown in fig. I and A the embryo may be beneath or either slightly to the dorsal or slightly to the ventral side of the micropyle cap. [2] From this position it moves over the surface of the yolk tail first towards the anterior pole of the egg (fig. A—K). The tail may become slightly bent or folded during the earlier stages—probably due to the resistance offered by the yolk (fig. Fa). The dorsal surface of the embryo is always next to the yolk. In the majority of cases the embryo is on the ventral side of the egg (fig. A—Fa, G and K); in about 30% it is on the dorsal surface (fig. Fb); in a few it may occupy an intermediate position, lying on the lateral, dorso-lateral, or ventro-lateral surface of the egg (fig. IIa and IIb). The embryo continues to move tail first towards the anterior pole of the egg, until the middle of the embryo lies just posterior to the middle of the egg and the anterior end of the embryo is about one-eighth of the length of the egg away from the micropyle cap. This stage marks the end of anatrepsis (fig. Ha, Hb and K).

During katatrepsis the embryo moves in the opposite direction. The anterior region is strongly flexed backwards, the embryo climbs head first around the posterior boundary of the yolk and moves towards the anterior pole of the egg.

[1] Mrs. H. G. Andrewartha.

[2] In *Melanoplus* the germ band develops directly beneath the chorion at the posterior end of the egg (Slifer, 1932). I was unable to observe the development of the germ band in *Austroicetes*. Eggs collected at Wilmington in November, three days after they were laid, had not yet developed a blastoderm.

When this movement begins there is usually a lot of clear amniotic fluid at the micropyle end of the egg; the posterior boundary of the yolk may be separated from the micropyle cap by about one-fifth the length of the egg (fig. XI—XII).* As the head continues to move forward the abdomen straightens out. The embryo continues to increase in length and to move forward until the head reaches the anterior pole of the egg. Those embryos which have been on the ventral side of the eggs execute a longitudinal "corkscrew" roll which brings the ventral side of the embryo against the ventral side of the egg (fig. XIII—XIV). All the embryos finish up in this position, irrespective of the position they occupied during anatrepsis.

Development of Body Form

The youngest embryo examined was from eggs collected on 3 February 1939, about 0·1 mm. in diameter. It was not possible to distinguish the posterior from the anterior end (fig. I).

Later, constrictions develop which divide the embryo into protocephalic and protocormic regions and divide the protocephalic region into procephalic lobes (fig. II). The protocormic region grows long and ribbon-like and the procephalic lobes expand laterally (fig. III—V). Segmentation sets in at the anterior end and gradually extends to the posterior end. In the protocormic region there are three gnathal, three thoracic and eleven abdominal segments (fig. IV—VII). The embryo increases two- or three-fold in width during the latter part of anatrepsis, but is only about 10% longer at the end of anatrepsis than it was when primitive segmentation was taking place (compare fig. V and X). At the end of anatrepsis the embryo is still comparatively flat but the lateral walls have begun to encircle the yolk. The embryo covers about one-quarter of the transverse circumference of the egg.

During katatrepsis the embryo again increases in length and the side walls grow up to engulf the yolk after the embryo has completed its journey around the posterior boundary of the yolk. The body walls gradually meet and fuse along the mid-dorsal line, beginning at the posterior end of the embryo and finishing at the anterior end of the procephalic lobes (fig. XI—XIII). After yolk engulfment is complete subsequent development consists largely of an increase in the differentiation and complexity of the body parts (fig. XIV—XVI).

The Serosa

The serosa encloses the embryo and yolk from the time it becomes separated from the amnion to the time the embryo begins to revolve around the posterior end of the yolk. Immediately beneath the micropyle cap a group of serosal cells becomes specialised to form the "hydropyle cells" of Slifer (1938) or the "grumulus" of Miller (1940). Towards the end of anatrepsis the serosa is pulled away from the cuticle at the posterior end except where it is attached to the hydropyle cells. As the embryo begins to revolve the head of the embryo breaks through the serosa; the head lobes curve around the strand of serosa which remains attached to the grumulus until eventually it breaks. During katatrepsis the embryo moves through the tear in the serosa (fig. XI). Ultimately the embryonic membranes are engulfed with the yolk as the body walls of the embryo meet in the mid-dorsal line. The last part of the serosa disappears between the head lobes.

The Eyes

A specialised ocular region in the procephalic lobes can be recognised first in the stage shown in fig. IV; it becomes well marked in that shown in fig. VIII. Eye pigment was first observed in the stage shown in fig. IX.

* Numbers in Roman are printed in Arabic in text figure.

The Appendages

The Labrum

The labrum develops as a small swelling between the procephalic lobes early in anatrepsis (fig. III). At first it has a notch in its anterior margin (fig. IV), but subsequently appears as a single median lobe (fig. V). Later a notch develops in the posterior margin (fig. VII). The labrum migrates in a ventro-posterior direction until it covers the mouth (fig. VII). By the end of anatrepsis it is beginning to be differentiated from the clypeus (fig. X), and this differentiation is completed during katatrepsis and later stages (fig. XIV—XVI).

The Antennae

The rudiments of the antennae appear at an early stage as lobular swellings posterior to the opening of the stomadaeum (fig. IV). Their subsequent development can be traced in the figures. By the end of anatrepsis they have migrated to a position anterior to the mouth and have begun to segment.

The Mouthparts

The mandibles, maxillae and labium (second maxillae), arise as paired swellings from the first three segments of the protocormic region. The rudiments of these appendages appear before segmentation has been completed in the rest of the tail. These swellings elongate (fig. VI to VII); they migrate to their final positions around the mouth, and gradually assume the form which they have in the nymph (fig. VIII—XVI). The mandibles become toothed on the posterior margin towards the end of anatrepsis (fig. IX). The maxillae are bilobed (fig. VIII); and a five-segmented maxillary palp can be recognised towards the end of anatrepsis. The appendages of the third protocormic segment migrate forwards and inwards and fuse to form the labium (fig. IX). This bears a three-segmented labial palp. The hypopharynx develops as a small bulge beneath the labium. It can be detected between the bifurcation of the labrum when the embryo is in the stage shown in fig. IX.

The Legs

The legs develop as lateral swellings on the thoracic segments early in anatrepsis (fig. IV). Further development consists largely of an increase in size, migration to the ventro-lateral surface and segmentation. Their development can be followed in fig. V—XVI. Constrictions appear which indicate the boundaries of future segments (fig. VIII): the tibiae become forwardly flexed (fig. X). The length of the hind femora is a useful guide to the development of the embryo in the later stages. At the end of katatrepsis the femora extend to about the fourth abdominal segment. When the embryo is ready to hatch the femora reach to about the end of the abdomen.

The Abdominal Appendages

Ephemeral rudimentary appendages develop on all the abdominal segments. They arise similarly to the gnathal and thoracic appendages as lateral swellings on each segment (fig. V—IX). All but the glandular pleuropodia, which are the appendages of the first abdominal segment and the cerci which are appendages of the eleventh abdominal segment, disappear before anatrepsis is complete (fig. X). The pleuropodia are left attached to the egg cuticle when the nymph hatches.

Development in the Field

The rate of development in the field can be determined by reference to chart and text fig. The fig. I—XVI have all been drawn to the same scale, so that they give a picture of the increase in size as well as the increase in complexity of the embryo. The slowness of development during the summer is striking.

The embryo required 10 weeks to reach stage III. Stage X was reached after 26 weeks. Diapause disappears in the field about mid-June when the embryo has reached stages XI-XIV. Eggs collected on 16 June 1939, hatched in five days at 30° C. In the field low temperatures after May retard development. Nevertheless, the embryo develops from stage X to stage XVI in about 15 weeks—about half the time required to reach stage X. The embryonic diapause in *Aus. cruciata* is strongly developed. Eggs incubated at 25° C. by Mr. L. C. Birch when the embryo was at various stages between I and X developed a little further, but none hatched. Nevertheless, in the field a slow development continues during diapause. This may be associated with the relatively low temperatures at night.

Chart of Developmental Stages in the Field

Date	Town	Stage	Position
(3) 3–2–39	Wilmington	I—III	A—B (4)
15–2–40	Wilmington	II—IV	B—C
(3) 3–3–39	Wilmington	II—V	B—E
11–3–40	Wilmington	III—VI	E
11–3–40	Orroroo	IV—VII	D—F
21–3–39	Wilmington	VII	F
20–4–39	Wilmington	VIII—IX	G
17–4–40	Wilmington	VIII—IX	G
30–4–40	Orroroo	IX	Ha & b
1–5–40	Wilmington	IX	Ha & b
16–5–40	Orroroo	X	Ha & b
16–5–40	Wilmington	X	Ha & b
28–5–40	Orroroo	X—XI	I & as in XI
28–5–40	Wilmington	X—XII	I & as in XII & XIII
16–6–39 } 19–6–40 }	Wilmington	XIV	23 ventral, 1 lateral & 4 ventro-lateral
19–6–40	Orroroo	XIV	3 dorsal, 1 lateral & 8 ventral
18–7–40	Wilmington	XV	23 ventral, 4 latero-ventral & 1 dorsal
18–7–40	Orroroo	XV	13 ventral, 1 latero-ventral
2–9–39	Wilmington	XVI	ventral

References

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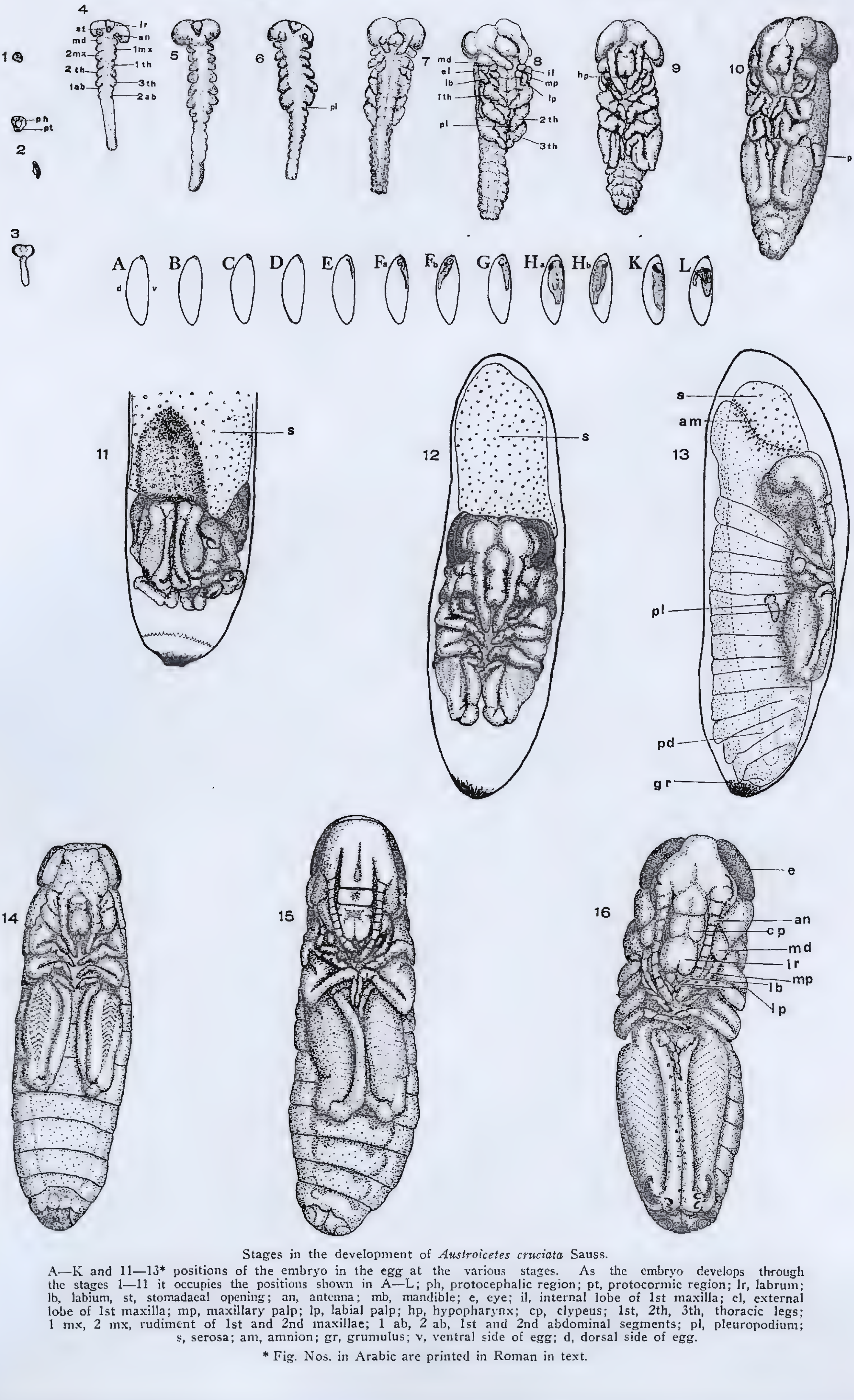
(3) The eggs collected on 3 February 1939 and 3 March 1939 were kept at 25°C for 10 days before they were fixed.

(4) About one-third of the embryos have the "tail" developing on the dorsal surface and about two-thirds on the ventral surface throughout. The two-thirds majority appear to roll over to the ventral surface after blastokinesis, but I was unable to test this on live eggs.



Stages in the development of *Austroicetes cruciata* Sauss.

A—K and 11—13* positions of the embryo in the egg at the various stages. As the embryo develops through the stages 1—11 it occupies the positions shown in A—L; ph, protocephalic region; pt, protocormic region; lr, labrum; lb, labium, st, stomadaeal opening; an, antenna; mb, mandible; e, eye; il, internal lobe of 1st maxilla; el, external lobe of 1st maxilla; mp, maxillary palp; lp, labial palp; hp, hypopharynx; cp, clypeus; 1st, 2th, 3th, thoracic legs; 1 mx, 2 mx, rudiment of 1st and 2nd maxillae; 1 ab, 2 ab, 1st and 2nd abdominal segments; pl, pleuropodium; s, serosa; am, amnion; gr, grumulus; v, ventral side of egg; d, dorsal side of egg.

* Fig. Nos. in Arabic are printed in Roman in text.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA NO. 40

By J. M. BLACK, A.L.S.

Summary

The six following species of *Stipa* will be described in English in the revised Part I of the Flora of South Australia.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA
No. 40

By J. M. Black, A.L.S.

[Read 9 October 1941]

Graminae

Stipa

The six following species of *Stipa* will be described in English in the revised Part 1 of the Flora of South Australia.

S. dura nov. sp. Gramen glabrum ad 60 cm. altum; folia pleraque basilaria; vaginae arctae absque supremâ amplectante; laminae subulatae rigidae junciformes 10-20 cm. longae; ligula 2-3 mm. longa ciliolata; nodi puberuli; panicula 15-25 cm. longa, 1-2 mm. lata, angusta densa, ramis 3-4 cm. longis; spiculae pallidae angustae; prima gluma 14-15 mm. longa, acuminata 3-nervis, secunda 12-13 mm. longa sub-5-nervis; gluma florifera apice integra 8 mm. longa (cum callo 2 mm. longo) albo-pubescens; arista gracilis leviter bigeniculata 7-8 cm. longa; columna 2½ cm. longa; palea glumam floriferam aequans.

Nullarbor Station (near Fowler's Bay), 1911.

Differs from *S. flavescens* Labill. and *S. juncifolia* Hughes in the longer glumes awn and column and in the lobeless flowering glume.

S. multispiculis nov. sp. Caulis rigidus 50-70 cm. altus, versus basin geniculatus; nodi pubescentes; vaginae laxae, infimae pubescentes; laminae rigidae subulatae vel prope basin latiusculae minute scabrae, usque ad 40 cm. longae; ligula brevissima ciliolata; panicula laxissima 20-30 cm. longa, 3-6 cm. lata, ramis multifloris quaternis ad sexternis 6-12 cm. longis; spiculae angustae pallidae demum hiantes; prima gluma 10-12 mm. longa 3-nervis, secunda 8-10 mm. longa sub-5-nervis; gluma florifera 6-8 mm. longa (cum callo acuto 1-2 mm. longo) albo-pubescens; arista gracilis leviter vel rectangule bigeniculata; columna 18-25 mm. longa; seta recta.

Morialta, Oct. 1925, *J. B. Cleland;* Port Noarlunga, Nov. 1926, *J. B. Cleland;* Ardrossan (Yorke Peninsula), Nov. 1932, *E. C. Black.*

Differs from *S. tenuiglumis* Hughes chiefly in the very loose, many-flowered panicle.

S. mundula nov. sp. Caulis gracilis 20-30 cm. altus inferne geniculatus; folia glabra pleraque basilaria; vaginae arctae suprema basin paniculae amplexans; laminae filiformes pleraeque curvatae 6-8 cm. longae; ligula oblonga glabra truncata 2-3 mm. longa; nodi pubescentes; panicula angusta sed laxula 5-8 cm. longa 1-2 cm. lata, ramis circa 3 cm. longis bi-trifloris; spiculae angustae parum hiantes; glumae acuminatae hyalinae, prima 14-16 mm. longa 3-nervis, secunda 10-11 mm. longa sub-5-nervis; gluma florifera 7 mm. longa (cum callo acuto 2½ mm. longo) albo-pubescens; arista gracillima 6½-7 cm. longa fere recta; columna 26-28 mm. longa; palea glumam floriferam aequans.

Chauncy's Line (N. of Lake Alexandrina), Oct. 1938, *J. B. Cleland.*

A small neat grass, with a short narrow erect few-flowered panicle, and a rather conspicuous oblong glabrous ligule.

S. breviglumis nov sp. Gramen robustum glabrum rigidum usque ad 1 m. altum, ad nodos glabros saepe ramosum; vaginae, absque supremâ arctâ, laxae latae marcescentes; ligula oblonga truncata glabra 2-3 mm. longa; laminae filiformes 10-20 cm. longae; panicula cylindrata densiuscula cito exserta 10-18 cm. longa, 2-3 cm. lata, ramis erecto-patentibus 4-5 cm. longis spiculas fere ad basin gerentibus; spiculae in medio turgidae; glumae exteriores subaequales 5-6 mm. longae 3-nerves; gluma florifera 4 mm. longa (cum callo obtuso brevissimo) albo-pubescens, arista tenuissima obtuse semel geniculata 2½-3 cm. longa; columna circa 15 mm. longa; seta recta; palea glumam floriferam aequans.

Lyndoch, Oct. 1927, *J. B. Cleland;* Mount Brown, Nov. 1881 (in Tate Herb.).

Distinguished by very short outer glumes, conspicuous glabrous ligules and stout branching stems. Its broad outer glumes place it in Miss Hughes's section, *Turgidulae.*

S. falcata Hughes, nov. var. **minor.** Variat glumis exterioribus 6-7 mm. longis mucronato-obtusiusculis, columnâ 8-10 mm. longâ.

Flinders Range.

S. plagiopogon nov. sp. Caulis robustus circa 1 m. altus; vaginae laminaeque inferiores molliter pubescentes; summae vaginae annulo pilorum cinctae; laminae longae subulatae canaliculatae; nodi pubescentes; ligula brevissima ciliolata; panicula exserta densa 15-25 cm. longa, 2-3 cm. lata, ramis 4-5 cm. longis; spiculae angustae pallidae non hiantes; glumae exteriores ad nervos scabrae, prima 20-25 mm. longa 3-nervis, secunda 18-21 mm. longa sub-5-nervis; gluma florifera 8-9 mm. longa (cum callo 3 mm. longo) albo-pubescens; palea aequilonga; arista gracilis 8-10 cm. longa, leviter bigeniculata; columna unilatere plumosa, 2-3 cm. longa, pilis secus setam rectam per 1-2 cm. productis.

Victor Harbour; Inman Valley, 1926, *J. B. Cleland;* Mount Pleasant, 1933, *E. C. Black;* Wilpena Pound, 1930, *J. B. Cleland.*

S. indeprensa nov. sp. Caulis rigidus circa 1 m. altus; folia pleraque basilaria; vaginae arctae pubescentes; laminae rigidae subulatae vel canaliculatae scabrae 12-25 cm. longae; nodi pubescentes; ligula brevissima ciliolata; summae vaginae annulo brevi pilorum cinctae; panicula exserta subdensa 20-30 cm. longa, 1-2½ cm. lata, ramis 4-6 cm. longis; spiculae angustae pallidae subhiantes; glumae exteriores ad nervos scabrae, prima 14-15 mm. longa 3-nervis, secunda 12-13 mm. longa sub-5-nervis; gluma florifera 7-8 mm. longa (cum callo 2 mm. longo) albo-pubescens; arista gracilis 6 cm. longa bigeniculata; columna unilatere plumosa 16-18 mm. longa, pilis per fere dimidium setae rectae productis.

Minnipa (Eyre Peninsula), 1915, *J. M. Black.*

Both these species are near *S. hemipogon* Benth. but differ in the larger size of the panicle and other parts of the plants, and in the scabrous outer glumes.

Polygonaceae

**Rumex roseus* L. Pink Dock. An annual with broad pink wings to the fruiting valves.

Oratunga, near Blinman, Sept. 1941, *H. M. Cooper.* "Spreading rapidly in that district during the last few years." It was collected on waste land near a suburb of Adelaide about 1915, probably as a garden escape.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Receipts and Payments for the Year ended September 30, 1941.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED)

Receipts and Payments for the Year ended 30 September 1941

RECEIPTS

	£	s.	d.	£	s.	d.
To Balance, 1 Oct 1940				308	0	8
,, Subscriptions				124	19	0
,, Govt. Grant for Printing				172	5	2
,, University of Adelaide—Contribution to Cost of Printing Paper				30	0	0
,, Use of Room by other Societies	7	4	0			
,, Sale of Publication ..	6	13	6			
				13	17	6
,, Interest — Transferred from Endowment Fund				207	17	8
				£857	0	0

PAYMENTS

	£	s.	d.	£	s.	d.
By Transactions (Vol. 64, Pt. 2, and Vol. 65, Pt. 1)—						
Printing	326	15	10			
Illustrating	92	3	6			
Publishing	15	15	3			
				434	14	7
,, Librarian				38	0	0
,, Library, Fittings, etc. ...				44	5	1
,, Sundries—						
Conversazione	10	1	8			
Lighting and Epidiascope	4	14	5			
Printing, Postages, and Stationery	27	4	6			
Petties, Bank Fee, etc.	4	9	3			
Insurances	6	10	0			
				52	19	10
,, Balances, 30 Sept. 1941—						
Savings Bank of S.A....	269	3	1			
Bk. of Aust. £19 15 5 *Less* Outstand. Chqs. 4 0 0	15	15	5			
Cash to Bank	2	2	0			
				287	0	6
				£857	0	0

ENDOWMENT FUND as at 30 September 1941

(Capital—Stocks at Cost Price £5,798 6s. 1d.)

	£	s.	d.	£	s.	d.
1940 October 1						
To Balance—						
Aust. Inscribed Stock	5,762	0	0			
Savings Bank of S.A.	36	6	1			
				5,798	6	1
,, Interest—						
Inscribed Stocks ...	198	16	6			
Saving Bank of S.A.	9	1	2			
				207	17	8
				£6,006	3	9

	£	s.	d.	£	s.	d.
1941—September 30						
By Revenue Account				207	17	8
,, Balance—						
Aust. Inscribed Stock	5,762	0	0			
Savings Bank of S.A. ..	36	6	1			
				5,798	6	1
				£6,006	3	9

RESEARCH FUND as at 30 September 1940

	£	s.	d.
1940—October 1			
To Balance	16	0	0
	£16	0	0

	£	s.	d.
1941—September 30			
By Grant—R. M. Berndt	10	0	0
,, Balance—Savings Bank of S.A.	6	0	0
	£16	0	0

Audited and found correct. We have verified the Government Stocks at the Registries of Inscribed Stock, Adelaide, and the respective Bank Balances.

O. GLASTONBURY, F.A.I.S., A.F.I.A. }
F. M. ANGEL } Hon. Auditors

HERBERT M. HALE,
Hon. Treasurer

Adelaide, 7 October 1941

AWARDS OF THE SIR JOSEPH VERCO MEDAL

LIST OF FELLOWS, MEMBERS, ETC.
AS ON 30 SEPTEMBER 1941

Those marked with an asterisk (*) have contributed papers published in the Society's Transactions.
Those marked with a dagger (†) are Life Members.
Any change in address or any other changes should be notified to the Secretary.
Note - The publications of the Society are not sent to those members whose subscriptions are in arrear.

AWARDS OF THE SIR JOSEPH VERCO MEDAL

1929 Prof. Walter Howchin, F.G.S.
1930 John McC. Black, A.L.S.
1931 Prof. Sir Douglas Mawson, O.B.E., D.Sc., B.E., F.R.S.
1933 Prof. J. Burton Cleland, M.D.
1935 Prof. T. Harvey Johnston, M.A., D.Sc.
1938 Prof. James A. Prescott, D.Sc., A.I.C.

LIST OF FELLOWS, MEMBERS, ETC.

AS ON 30 SEPTEMBER 1941

Those marked with an asterisk (*) have contributed papers published in the Society's Transactions. Those marked with a dagger (†) are Life Members.

Any change in address or any other changes should be notified to the Secretary.

Note.–The publications of the Society are not sent to those members whose subscriptions are in arrear.

Date of Election.

Honorary Fellows.

1910. *Bragg, Sir W. H., O.M., K.B.E., M.A., D.C.L., LL.D., F.R.S., Director of the Royal Institution, Albemarle Street, London (Fellow 1886).
1926. *Chapman, F., A.L.S., "Hellas," 50 Stawell Street, Kew E4, Victoria.
1894. *Wilson, Prof. J. T., M.D., Ch.M., F.R.S., Cambridge University, England.

Fellows.

1935. Adam, D. B., B.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide—**Council**, 1939-.
1925. Adey, W. J., M.A., C.M.G., 32 High Street, Burnside, S.A.
1927. *Alderman, A. R., Ph.D., M.Sc., F.G.S., University, Adelaide—**Council**, 1937-.
1931. Andrew, Rev. J. R., 5 York Street, Henley Beach.
1935. *Andrewartha, H. G., M.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
1935. *Andrewartha, Mrs. H. V., B.Agr.Sc., M.S., 29 Claremont Avenue, Netherby, S.A.
1929. Angel, F. M., 34 Fullarton Road, Parkside, S.A.
1939. *Angel, Miss L. M., M.Sc., University, Adelaide.
1936. Barrien, Miss B. S., M.Sc., University, Adelaide.
1932. Begg, P. R., D.D.Sc., L.D.S., 219 North Terrace, Adelaide.
1939. *Berndt, R. M., S.A. Museum, Adelaide.
1928. Best, R. J., M.Sc., F.A.C.I., Waite Institute (Private Mail Bag), Adelaide.
1940. Birch, L. C., B.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
1934. Black, E. C., M.B., B.S., Magill Road, Tranmere, Adelaide.
1907. *Black, J. M., A.L.S., 82 Brougham Place, North Adelaide—**Verco Medal**, 1930; **Council**, 1927-1931; **President**, 1933-34; **Vice-President**, 1931-33.
1940. Bonython, Sir J. Lavington, 263 East Terrace, Adelaide.
1923. Burdon, R. S., D.Sc., University, Adelaide, S.A.
1922. *Campbell, T. D., D.D.Sc., D.Sc., Dental Dept., Adelaide Hospital, Adelaide—**Rep.-Governor**, 1932 33; **Council**, 1928-32, 1935; **Vice-President**, 1932-34; **President**, 1934-35.
1907. *Chapman, Sir R. W., Kt., C.M.G., M.A., B.C.E., F.R.A.S., 23 High Street, Burnside, S.A.—**Council**, 1914-22, 1939 41.
1929. Christie, W., M.B., B.S., Education Department, Adelaide—**Treasurer**, 1933-8.
1895. *Cleland, Prof. J. B., M.D., University, Adelaide—**Verco Medal**, 1933; **Council**, 1921-26, 1932-37; **President**, 1927-28; 1940-41; **Vice-President**, 1926 27, 1941-.
1929. Cleland, W. P., M.B., B.S., M.R.C.P., Dashwood Road, Beaumont.
1930. *Colquhoun, T. T., M.Sc., Waite Institute (Private Mail Bag), Adelaide.
1907. *Cooke, W. T., D.Sc., A.A.C.I., University Adelaide—**Council**, 1938-1941, **Vice-President**, 1941-.
1938. *Condon, H. T., S.A. Museum, Adelaide.
1929. *Cotton, B. C., S.A. Museum, Adelaide.
1924. de Crespigny, Sir C. T. C., D.S.O., M.D., F.R.C.P., 219 North Terrace, Adelaide.
1937. *Crocker, R. L., B.Sc., Waite Institute (Private Mail Bag), Adelaide.
1929. *Davidson, Prof. J., D.Sc., Waite Institute (Private Mail Bag), Adelaide—**Council**, 1932-35; **Vice-President**, 1935-37, 1938-39; **President**, 1937-38; **Rep. Fauna and Flora Board**, 1940-.
1927. *Davies, Prof. E. H., Mus.Doc., The University, Adelaide.

Date of Election.

1930. Dix, E. V., Hospitals Department, Adelaide, S.A.
1932. Dunstone, H. E., M.B., B.S., J.P., 124 Payneham Road, St. Peters, Adelaide.
1921. Dutton, G. H., B.Sc., 12 Halsbury Avenue, Kingswood, Adelaide.
1931. Dwyer, J. M., M.B., B.S., 25 Port Road, Bowden. (A.I.F. abroad.)
1933. *Eardley, Miss C. M., B.Sc., University, Adelaide.
1902. *Edquist, A. G., 19 Farrell Street, Glenelg, S.A.
1938. *Evans, J. W., M.A., D.Sc., Government Entomologist. Hobart, Tasmania.
1917. *Fenner, C. A. E., D.Sc., 42 Alexandra Av., Rose Park, Adelaide—**Rep. Governor,** 1929-31; **Council,** 1925-28; **President,** 1930-31; **Vice-President,** 1928-30; **Secretary,** 1924-25; **Treasurer,** 1932-33; **Editor,** 1934-7.
1935. *Fenner, F. J., M.B., B.S., 42 Alexandra Avenue, Rose Park. (A.I.F. abroad.)
1927. *Finlayson, H. H., 305 Ward Street, North Adelaide—**Council,** 1937-40.
1923. *Fry, H. K., D.S.O., M.D., B.S., B.Sc., F.R.A.C.P., Town Hall, Adelaide—**Council,** 1933-37; **Vice-President,** 1937-38, 1939-40; **President,** 1938-1939.
1932. *Gibson, E. S. H., B.Sc., 297 Cross Roads, Clarence Gardens, Adelaide.
1935. *Glastonbury, J. O. G., B.A., M.Sc., Dip.Ed., No. 1 Service Flying Sch., Pt. Cook, Vic.
1919. †Glastonbury, O. A., Adelaide Cement Co., Grenfell Street, Adelaide.
1927. **Godfrey, F. K., Robert Street, Payneham, S.A.**
1935. †Goldsack, H., Coromandel Valley.
1939. Goode, J. R., B.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide. (A.I.F. abroad.)
1925. †Gosse, J. H., Gilbert House, Gilbert Place, Adelaide.
1910. *Grant, Prof. Kerr, M.Sc., F.I.P., University, Adelaide.
1933. Gray, J. H., M.D., B.S., Orroroo, S.A.
1930. Gray, J. T., Orroroo, S.A.
1933. Greaves, H., Director, Botanic Gardens, Adelaide.
1904. Griffith, H. B., Dunrobin Road, Brighton, S.A.
1934. Gunter, Rev. H. A., 10 Broughton Street, Glenside, S.A.
1922. *Hale, H. M., Director, S.A. Museum, Adelaide—**Council,** 1931-34; **Vice-President,** 1934-36, 1937-38; **President,** 1936-37; **Treasurer,** 1938-.
1939. Harvey, Miss A., B.A., Dequetteville Terr., Kent Town, Adelaide.
1927. Holden, The Hon. E. W., B.Sc., Dequetteville Terrace, Kent Town, Adelaide.
1933. Hosking, H. C., B.A., 24 Northcote Terrace, Gilberton, Adelaide.
1930. *Hosking, J. S., B.Sc., Waite Institute (Private Mail Bag), Adelaide.
1924. *Hossfeld, P. S., M.Sc., Northern Australia Survey, Box 24, P.O. South Brisbane, Qld.
1928. Ifould, P., Kurralta, Burnside, S.A.
1918. *Jennison, Rev. J. C., 7 Frew Street, Fullarton, Adelaide.
1910. *Johnson, E. A., M.D., M.R.C.S., "Tarni Warra," Port Noarlunga, S.A.
1934. Johnston, J., A.S.A.S.M., A.A.I.C., A.A.C.I., Sewage Treatment Works, Glenelg, S.A.
1921. *Johnston, Prof. T. H., M.A., D.Sc., University, Adelaide—**Verco Medal,** 1935; **Rep. Governor,** 1927-29; **Council,** 1926-28, 1940-; **Vice-President,** 1928-31; **President,** 1931-32; **Secretary,** 1938-40; **Rep. Fauna and Flora Board,** 1932-39.
1939. †Khakhar, M. H., Ph.D., M.B., Khakhar Buildings, C.P. Tank Road, Bombay, India.
1933. *Kleeman, A. W., M.Sc., University, Adelaide.
1939. Leask, J. C., A.M.I.E., 9 Buller Street, Prospect.
1922. Lendon, G. A., M.D., B.S., M.R.C.P., North Terrace, Adelaide. (A.I.F. abroad.)
1930. *Louwyck, Rev. N. H., 85 First Avenue, St. Peters, Adelaide.
1938. *Love, Rev., J. R. B., M.C., D.C.M., M.A., Ernabella, via Oodnadatta, S.A.
1931. *Ludbrook (Mrs. W. V.), N. H., M.A., Elimatta Street, Reid, A.C.T.
1938. Madfern, C. B., B.D.S., D.D.Sc., Shell House, North Terrace, Adelaide.
1922. *Madigan, C. T., M.A., B.E., D.Sc., F.G.S., Sch. Milit. Eng., Liverpool, N.S.W.—**Council,** 1939-33; **Vice-President,** 1933-35, 1936-37; **President,** 1935-36.
1923. Marshall, J. C., Mageppa Station, Comaum, S.A.
1939. Marshall, T. J., M.Agr.Sc., Ph.D., Waite Institute (Private Mail Bag), Adelaide.
1933. Magarey, Miss K. de B., B.A., B.Sc., 19 Ashbourne Avenue, Mitcham, S.A.
1932. Mann, E. A., C/o Bank of Adelaide, Adelaide.
1929. Martin, F. C., M.A., Technical High School, Thebarton, S.A.
1905. *Mawson, Prof. Sir Douglas, O.B.E., D.Sc., B.E., F.R.S., University, Adelaide—**Verco Medal,** 1931; **Rep. Governor,** 1933-40; **President,** 1924-25; **Vice-President,** 1923-24, 1925-26—**Council,** 1941-.
1938. *Mawson, Miss P. M., M.Sc., University, Adelaide.
1920. Mayo, H., LL.B., K.C., 16 Pirie Street, Adelaide.

Date of Election.

1934. McCloughry, C. L., B.E., A.M.I.E. (Aust.), Town Hall, Adelaide.
1929. McLaughlin, E., M.B., B.S., M.R.C.P., 2 Wakefield Street, Kent Town, Adelaide.
1907. Melrose, R. T., Mount Pleasant, S.A.
1939. Mincham, V. H., Beltana, S.A.
1925. †Mitchell, Prof. Sir W., K.C.M.G., M.A., D.Sc., Fitzroy Ter., Prospect, SA.
1933. Mitchell, Prof. M. L., M.Sc., University, Adelaide.
1938. Moorhouse, F. W., M.Sc., Chief Inspector of Fisheries, Flinders Street, Adelaide.
1924. Morison, A. J. Town Clerk, Town Hall, Adelaide.
1940. Mortlock, J. A. T., 39 Currie Street, Adelaide.
1936. *Mountford, C. P., 25 First Avenue, St. Peters, Adelaide.
1925. †Murray, Hon. Sir G., K.C.M.G., B.A., LL.M., Magill, S.A.
1930. Ockenden, G. P., Public School, Norton's Summit, S.A.
1913. *Osborn, Prof. T. G. B., D.Sc., University, Oxford, England — **Council,** 1915-20, 1922-24; **President,** 1925-26; **Vice-President,** 1924-25, 1926-27.
1937. Parkin, L. W., M.A., B.Sc. c/o Nth. Broken Hill Ltd., Box 20C, Broken Hill, N.S.W.
1929. Paull, A. G., M.A., B.Sc., Eglinton Terrace, Mount Gambier.
1928. Phipps, I. F., Ph.D., B.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
1926. *Piper, C. S., M.Sc., Waite Institute (Private Mail Bag), Adelaide.
1925. *Prescott, Prof. J. A., D.Sc., A.I.C., Waite Institute (Private Mail Bag), Adelaide—**Verco Medal,** 1938; **Council,** 1927-30, 1935 39; **Vice-President,** 1930-32; **President,** 1932-33.
1926. Price, A. G., C.M.G., M.A., Litt.D., F.R.G.S., St. Mark's College, North Adelaide.
1937. *Rait, W. L., M.Sc., St. Peter's College, Adelaide.
1925. Richardson, A. E. V., C.M.G., M.A., D.Sc., 314 Albert Street, East Melbourne.
1905. *Rogers, R. S., M.A., M.D., D.Sc., F.L.S., 52 Hutt Street, Adelaide—**Council,** 1907-14, 1919-21; **President,** 1921 22; **Vice-President,** 1914 19, 1922-24.
1933. Schneider, M., M.B., B.S., 175 North Terr., Adelaide.
1924. *Segnit, R. W., M.A., B.Sc., Assist. Govt., Geol., Flinders St., Adelaide—**Secretary,** 1930-35; **Council,** 1937-38; **Vice-President,** 1938-39, 1940-41; **President,** 1939-40.
1925. *Sheard, H., Nuriootpa, S.A.
1936. *Sheard, K., S.A. Museum, Adelaide.
1934. Shinkfield, R. C., Salisbury, S.A.
1938. *Simpson, Mrs. E. R., M.Sc., Warland Road, Burnside.
1924. Simpson, F. N., Pirie Street, Adelaide.
1925. †Smith, T. E. Barr, B.A., 25 Currie Street, Adelaide.
1936. Southwood, A. R., M.D., M.S. (Adel.), M.R.C.P., Wootoona Terr., Glen Osmond, S.A.
1936. Sprigg, R. C., Toddville Street, Seaton Park, Adelaide.
1938. Stephens, C. G., M.Sc., Waite Institute (Private Mail Bag), Adelaide.
1935. Strickland, A. G., M.Agr.Sc., 11 Wootoona Terr., Glen Osmond, Adelaide.
1932. Swan, D. C., M.Sc., Waite Institute (Private Mail Bag), Adelaide—**Secretary,** 1940-.
1934. Symons, I. G., Murray Street, Mitcham.
1929. *Taylor, J. K., B.A., M.Sc., Waite Institute (Private Mail Bag), Adelaide—**Council,** 1940-.
1940. Thomson, J. M., 302 The Terrace, Port Pirie, S.A.
1923. *Tindale, N. B., B.Sc., South Australian Museum, Adelaide—**Secretary,** 1935-36.
1937. *Trumble, H. C., D.Sc., M.Agr.Sc., Waite Institute (Private Mail Bag), Adelaide.
1894. *Turner, A. J., M.D., F.R.E.S., Dauphin Terr., Brisbane, Qld.
1925. Turner, D. C., National Chambers, King William Street, Adelaide.
1933. Walkley, A., B.A., B.Sc., Ph.D., Waite Institute (Private Mail Bag), Adelaide.
1912. *Ward, L. K., B.A., B.E., D.Sc., Govt. Geologist, Flinders Street, Adelaide—**Council,** 1924-27, 1933-35; **President,** 1928-30; **Vice-President,** 1927-28.
1941. Wark, D. C., M.Agr.Sc., Waite Institute, Private Mail Bag, Adelaide.
1939. Warhurst, Miss B. W., B.Sc., Commonwealth Munitions Lab., Maribyrnong, Vict.
1936. Waterhouse, Miss L. M., 35 King Street, Brighton, S.A.
1939. Weeding, Rev. B. J., Eudunda.
1931. Wilson, C. E. C., M.B., B.S., "Woodfield," Fisher Street, Fullarton, Adelaide.
1938. *Wilson, J. O., Nutrition Laboratory, University, Adelaide.
1935. Winkler, Rev. M. T., B.A., D.D., 20 Austral Terrace, Malvern, Adelaide.
1930. *Womersley, H., F.R.E.S., A.L.S., Museum, Adelaide—**Secretary,** 1936-37; **Editor,** 1937-.
1923. *Wood, Prof. J. G., D.Sc., Ph.D., University, Adelaide—**Council,** 1938-40; **Vice-President,** 1940-; **Rep. Fauna and Flora Board,** 1940-; **President,** 1941-.

GENERAL INDEX.

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