

**SYDNEY UNIVERSITY NATURAL
RADIOCARBON MEASUREMENTS IV**

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The following list contains measurements made during the period 1972-5 which have not been previously published and which form part of a research project on marine shell dating (Gillespie, 1975). These sets of samples were measured to determine 1) "apparent age" of marine shells coll alive from Australian coastal waters before the advent of large-scale nuclear weapons testing, 2) the possibility of using post 1950 Australian marine shells as a modern reference, 3) "apparent age" of Australian marine shells in the past as shown by comparisons between stratigraphically equivalent charcoal and marine shell samples.

The procedures used were as described by Gillespie, Polach, and Temple (1972) and Gillespie and Temple (1973, 1976). Chemical pretreatment procedures are given in the text of each sec. In the absence of $^{12}\text{C}/^{13}\text{C}$ measurements, all charcoal samples were assumed to have $\delta^{13}\text{C} = -25 \pm 2\text{‰}$ and all marine shell carbonate samples $\delta^{13}\text{C} = 0 \pm 2\text{‰}$ relative to PDB (Craig, 1954; Polach, 1969; Lerman, 1972).

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SAMPLE DESCRIPTIONS

I. MARINE MOLLUSKS

Mollusk shells are represented throughout by code letters given in Table 2.

A. Marine mollusks collected alive before 1950

Samples obtained from mus collns, pretreated by soaking for 48 hr in 10% sodium hypochlorite solution to remove organic matter. Table 3 gives radiocarbon activities as $\delta^{14}\text{C}$, the measured deviation from 0.95 NBS oxalic acid, age-corrected for period between colln and 1950 (Broecker and Olson, 1959).

The error-weighted mean of all measurements is $\delta^{14}\text{C} = -8 \pm 4\text{‰}$. When corrected for the Suess effect in mid-lat surface ocean waters by the method of Mangerud and Gulliksen (1975), the mean value is $\delta^{14}\text{C} =$

TABLE 1
Interlaboratory crosschecks

Lab no.	SUA date	Other no.	Other date	Ref
SUA-191/2	610 ± 80	ANU-1625	640 ± 70	Polach (pers commun)
SUA-233/2	300 ± 80	ANU-1626	340 ± 70	"
SUA-263/2	450 ± 80	ANU-1627	600 ± 70	"
SUA-380	1870 ± 100	NSW-96	1990 ± 100	Carswell (pers commun)

TABLE 2
Species names for mollusks

Code	Species	Code	Species
A	<i>Anadara trapezia</i>	N	<i>Notohaliolis ruber</i>
B	<i>Austrocochlea constricta</i>	O	<i>Nerita atramentosa</i>
C	<i>Austrocochlea rudis</i>	P	<i>Patellanax peroni</i>
D	<i>Bankivia fasciata</i>	Q	<i>Pinctada margaritifera</i>
E	<i>Bembicium melanostomum</i>	R	<i>Pinna bicolor</i>
F	<i>Brachidontes rostratus</i>	S	<i>Pitar</i> sp
G	<i>Cabestana spengleri</i>	T	<i>Plebinonax deltoides</i>
H	<i>Cellana solida</i>	U	<i>Proxichione laqueata</i>
I	<i>Conuber incei</i>	V	<i>Pyrazus ebinezus</i>
J	<i>Katelysia rhytiphora</i>	W	<i>Saccostrea cucculata</i>
K	<i>Littorina unifasciata</i>	X	<i>Thais orbita</i>
L	<i>Mactra obesa</i>	Y	<i>Turbo (Ninella) torquata</i>
M	<i>Mytilus edulis planulatus</i>	Z	<i>Turbo (Subnina) undulata</i> .

TABLE 3
Marine mollusk collected alive before 1950

Lab no.	Location	Colln yr	Species (Table 2)	δ ¹⁴ C ‰
SUA-354/1	Torres Strait (ca 10°S, 143°E)	1875 ± 3	L	-8 ± 8
SUA-354/2	Torres Strait (ca 10°S, 143°E)	1875 ± 3	R	-6 ± 10
SUA-357	Torres Strait (ca 10°S, 143°E)	1909	Q	+1 ± 10
SUA-355	Garden Is, WA (32°15'S, 115°40'E)	1930	U	-5 ± 10
SUA-393	Adelaide, SA (ca 35°S, 13°E)	1937 ± 2	T	-20 ± 10
SUA-356	Narooma, NSW (36°13'S, 150°07'S)	1950	J	-8 ± 10

$-5 \pm 4\%$, equivalent to $\Delta = -55 \pm 4\%$ and an "apparent age" of 450 ± 35 yr for Australian coastal waters.

B. Marine mollusks collected alive in 1973

Table 4 lists the radiocarbon activity in percentage modern for marine mollusk shells coll alive from Australian coastal waters in 1973. These measurements fall into 2 groups, each having a normal distribution; samples from E coast with a mean activity $106.8 \pm 2.3\%$ modern, and samples from S coasts with mean activity $117.4 \pm 4.5\%$ modern. Difference between means is significant at 0.1% level by t test. Activities from Australian E coast compare with those from Makara, New Zealand (Rafter, pers commun) of $110.7 \pm 0.7\%$ modern. Different activities on S and E coasts may be explained by different surface ocean currents supplying these regions (Knox, 1963).

The range of activities between species at same location, and for same species at different locations are consistent with results from Baltic Sea (Erlenkeuser & Willkomm, 1973; Erlenkeuser *et al*, 1975) and indicate that these mollusk shells cannot be used to estimate a modern ref for marine carbonate.

II. ARCHAEOLOGIC SAMPLES

Measurements on charcoal and marine shells from Australian coastal middens, made to determine relationship between radiocarbon ages of stratigraphically equivalent terrestrial organic and marine shell carbon. Shell species names in Table 2. Charcoal pretreated with dilute phosphoric acid and sodium hydroxide/sodium pyrophosphate solutions (Goh and Molloy, 1972). Shells etched in dilute hydrochloric acid to remove ca 15% by weight of surface carbonate.

Bass Point series

Midden on Bass Point, N S W ($34^{\circ} 36' S$, $150^{\circ} 46' E$) excavated 1972 by R Gillespie and P J Hughes, Dept Prehist, Australian Natl Univ, who reported on depositional environment (Lampert and Hughes, 1974). Previous excavation at site reported by Bowdler (1970).

SUA-47.	320 ± 75
Charcoal 10 to 15cm below surface.	AD 1630
SUA-45/S1.	725 ± 65
Shell Species M, 10 to 15cm.	AD 1225
SUA-45/S2.	680 ± 65
Shell Species P, 10 to 15cm.	AD 1270
SUA-45/S3	695 ± 65
Shell Species Y, 10 to 15cm.	AD 1255

SUA-45/S4. Shell Species G, 10 to 15cm.	665 ± 70 AD 1285
SUA-146. Charcoal, 30 to 40cm.	985 ± 100 AD 965
SUA-145/S1. Shell Species M, 30 to 35cm.	1100 ± 65 AD 850
SUA-145/S2. Shell Species P, 30 to 35cm.	1250 ± 65 AD 700
SUA-145/S3A. Shell Species Y > 3cm diam, 30 to 35cm.	1290 ± 65 AD 660
SUA-145/S3B. Same, < 3cm diam, 30 to 35cm.	1290 ± 65 AD 660
SUA-145/S3C. Operculae of same, 30 to 35cm.	1285 ± 65 AD 665
SUA-145/S4. Shell Species N, 30 to 35cm.	1270 ± 75 AD 680
SUA-145/S5. Shell Species G, 30 to 35cm.	1130 ± 75 AD 820
SUA-145/S6. Shell Species X, 30 to 35cm.	1190 ± 75 AD 760
SUA-25. Charcoal, 50 to 60cm.	2650 ± 70 700 BC
SUA-24/S1A. Shell Species Y, 50 to 55cm, no pretreatment.	2480 ± 70 530 BC
SUA-24/S1B. Same, with standard acid etching pretreatment.	2870 ± 80 920 BC
SUA-24/S2A. Shell Species G, 50 to 55cm, no pretreatment.	1990 ± 80 40 BC
SUA-24/S2A. Same, standard pretreatment.	2180 ± 80 230 BC

TABLE 4
Marine mollusks collected alive in 1973

Lab no.	Location	Species (see Table 2)	^{14}C activity % modern $\pm 1\sigma$
SUA-23/1	Bass Point NSW (34°36'S, 150°46'E)	M	103.7 \pm 0.6
SUA-23/2	" "	P	107.7 \pm 0.6
SUA-23/3	" "	Y	107.4 \pm 0.6
SUA-23/4	" "	G	105.2 \pm 0.9
SUA-23/5	" "	W	108.7 \pm 0.6
SUA-23/6	" "	O	109.6 \pm 1.1
SUA-27/1	Cottlesloe, WA (32°01'S, 115°45'E)	C	116.9 \pm 0.9
SUA-27/2	" "	K	113.4 \pm 1.2
SUA-27/3	Fremantle, WA (32°03'S, 115°47'E)	E	124.0 \pm 1.3
SUA-209/1	Moruya, NSW (35°54'S, 150°07'E)	T	107.1 \pm 0.9
SUA-209/2	" "	D	104.1 \pm 0.9
SUA-218/1	Macleay Is Qld (27°39'S, 153°22'E)	M	105.9 \pm 0.8
SUA-218/2	" "	V	104.6 \pm 0.8
SUA-220	Broadwater, NSW (29°00'S, 153°29'E)	I	109.9 \pm 0.9
SUA-273/1	Swan Bay, Victoria (38°17'S, 144°40'E)	J	118.6 \pm 1.0
SUA-273/2	" "	Z	118.6 \pm 0.9
SUA-294/1	Bruny Is Tas (43°21'S, 147°20'E)	M	110.9 \pm 0.9
SUA-294/2	" "	H	114.6 \pm 0.9
SUA-294/3	" "	B	111.3 \pm 1.1
SUA-300/1	Noarlunga, SA (35°10'S, 138°28'E)	H	121.9 \pm 1.0
SUA-300/2	" "	N	122.2 \pm 1.0
SUA-311	Pt Stuart, NT (12°13'S, 131°53'E)	W	117.6 \pm 1.0

General Comment: shell ages from 10 to 15cm level in good agreement, mean age difference from charcoal, + 379 yr. Similarly, mean difference for 30 to 35cm level, + 241 yr. For 50 to 55cm level, shell ages SUA-24/S1A and B indicate standard pretreatment necessary and effective for re-

moving younger contamination, SUA-24/S2A and B, partly recrystallized (22% calcite), pretreatment not effective.

Jervis Bay series

Midden at Cemetery Point (35° 10' S, 150° 32' E) excavated 1973 by R J Lampert, Prehist Dept, Australian Natl Univ.

SUA-260C. CP1B/10	390 ± 70
Charcoal, 65cm below surface.	AD 1560
SUA-260/S1.	800 ± 60
Shell Species M, 65cm.	AD 1150
SUA-260/S2.	720 ± 60
Shell Species P, 65cm.	AD 1230
SUA-261C. CP1B/15	1790 ± 90
Charcoal, 104cm.	AD 160
SUA-261/S1.	970 ± 75
Shell Species Y, 104cm.	AD 980
SUA-261/S2.	970 ± 75
Shell Species M, 104cm.	AD 980
SUA-262C. CP1B/22	910 ± 60
Charcoal, 148cm.	AD 1040
SUA-262/S1.	1285 ± 70
Shell Species Y, 148cm.	AD 665
SUA-262/S2.	1275 ± 80
Shell Species O, 148cm.	AD 675
SUA-262/S3.	1125 ± 80
Shell Species P, 148cm.	AD 825
SUA-262/S4.	1265 ± 70
Shell Species M, 148cm.	AD 685

General Comment (RJL): only SUA-261C is anomalous within series. Aboriginal occupants of site probably burnt stranded driftwood on their fires, some of which were perhaps old at time of colln. Shell dates, then, forming very consistent series and agreeing well with other charcoal dates, may be more reliable indicators of antiquity at coastal midden sites. Mean age difference for 65cm level is +370 yr, and for 148cm level is +328 yr.

Tamboon Inlet series

Midden in E Victoria (37° 47' S, 149° 17' E) excavated 1974 by P J F Coutts, Archaeol & Aboriginal Relics Office, Melbourne.

SUA-377C. **360 ± 85**
AD 1590
Charcoal, 40 to 50cm below surface.

SUA-377S. **660 ± 95**
AD 1290
Shell Species F, 40 to 50cm.

SUA-378C. **220 ± 85**
AD 1730
Charcoal, 10 to 20cm.

SUA-378S. **420 ± 100**
AD 1530
Shell Species F, 10 to 20cm.

Old Beach series

Midden on E side of Derwent Estuary, Tasmania (42° 46' 25" S, 147° 15' 30" E) excavated 1973 by W R Sigleo, Geog Dept, Univ Tasmania.

SUA-306. OB001 **5800 ± 130**
3850 BC
Charcoal, 35cm below surface.

SUA-307. OB002 **6010 ± 90**
4060 BC
Shell Species F, 35cm.

Swansea Inlet series

Midden on Swansea Channel, near Newcastle, N S W (33° 06' S, 151° 40' E) excavated by L K Dyall, Chem Dept, Univ Newcastle.

SUA-238C. **1965 ± 90**
15 BC
Charcoal, 0 to 4cm below surface.

SUA-238/S1. **2690 ± 90**
740 BC
Shell Species W, 0 to 4cm.

SUA-238/S2. **2480 ± 90**
530 BC
Shell Species A, 0 to 4cm.

General Comment: shell ages SUA-238/S1 and 2 agree well, mean age difference from charcoal SUA-238C is +620 yr.

Broughton Island series

Midden on small island off N S W coast (32° 35' S, 152° 20' E) excavated 1974 by R V S Wright, Anthropol Dept, Sydney Univ.

SUA-402C. **445 ± 179**
AD 1505
Charcoal, 50 to 60cm below surface.

SUA-402/S1. **420 ± 85**
AD 1530
Shell Species O, 50 to 60cm.

SUA-402/S2. **600 ± 85**
AD 1350
Shell Species P, 50 to 60cm.

General Comment: shell ages SUA-402/S1 and 2 agree well, mean age difference from charcoal SUA-402C is +65 yr.

Connection Creek I series

Midden in lower Macleay Valley, N S W (31° 15' S, 152° 55' E) excavated 1972 by G E Connah, Prehist Dept, Univ New England.

SUA-395C. CCI.73.62 **3720 ± 100**
1770 BC
Charcoal, 50 to 60cm below surface.

SUA-395S. CCI.73.65 **3750 ± 100**
1800 BC
Shell Species W, 50 to 60cm.

SUA-396C. CCI.73.132 **3400 ± 100**
1450 BC
Charcoal, 100 to 110cm.

SUA-396S. CCI.73.141 **3790 ± 100**
1840 BC
Shell Species A, 100 to 110cm.

Hooka Point series

Further samples from midden near Lake Illawarra, N S W (34° 30' S, 150° 51' E) excavated 1973 by J P White, Anthropol Dept, Sydney Univ. Other samples from site pub in R, 1976, v 18, p 96-109.

SUA-65/1. DK13/7 **5650 ± 85**
3700 BC
Shell Species A, 10cm below surface.

SUA-65/2. DL/DM 13/9C **5230 ± 85**
3280 BC
Shell Species A, 40cm.

SUA-65/3. **5570 ± 85**
3620 BC
Shell Species A, 80cm.

General Comment: ages not related to depth due to reworking of midden material by storm waves (Emmerson, 1973; Hughes and Sullivan, 1974).

Currarong II series

Rock shelter midden near Currarong, N S W (35° 01' S, 150° 49' E) excavated 1973 by P J Hughes.

SUA-241/1.	2040 ± 70 90 BC
Shell species W, 30 to 40cm below surface.	
SUA-241/2.	1600 ± 70 AD 350
Shell Species V, 30 to 40cm.	
SUA-241/3.	1660 ± 70 AD 290
Shell Species Y, 30 to 40cm.	
SUA-242/1.	3700 ± 70 1750 BC
Shell Species W, 80 to 90cm.	
SUA-242/2.	3670 ± 90 1720 BC
Shell Species V, 80 to 90cm.	
SUA-224.	5990 ± 80 4040 BC
Shell Species W, 100 to 120cm.	

General Comment: good agreement between shell ages from some levels, may be compared with charcoal ages from different excavation at this site: NSW-76, 37.5cm, 1520 ± 100 (Djohadze, pers commun), ANU-386, 105cm 3740 ± 100 (Lampert, 1971).

All dates in this sec indicate that aboriginal shell middens are not ideal sites for determination of past values for “apparent age” of marine shell carbonate by comparison with stratigraphically equivalent charcoal. The range of age differences between shell and charcoal samples is consistent with remarks of Ambrose (1967) and Hughes and Sullivan (1974) about potential hazards of midden archaeol. Other sites where deposition of terrestrial organic and marine carbonate samples can be considered contemporaneous are needed.

REFERENCES

- Ambrose, W R, 1967, Archaeology and shell middens: Archaeol & Phys Anthropol in Oceania, v 2, p 169-187.
- Bowdler, S, 1970, Bass Point: the excavation of a South-East Australian shell midden showing cultural and economic change: Unpub BA thesis, Univ Sydney.
- Broecker, W S and Olson, E A, 1959, Lamont radiocarbon measurements VI: Radiocarbon, v 1, p 111-132.
- 1961, Lamont radiocarbon measurements VIII: Radiocarbon, v 3, p 176-204.
- Craig, Harmon, 1954, Carbon-13 in plants and the relationship between carbon-13 and carbon-14 in Nature: Jour Geol, v 62, p 115-148.
- Emmerson, P, 1973, Hooka Point: a disturbed site: Unpub BA thesis, Univ Sydney.
- Erlenkeuser, H and Willkomm, H, 1973, University of Kiel radiocarbon measurements VII: Radiocarbon, v 15, p 113-126.
- Erlenkeuser, H, Metzner, H, and Willkomm, H, 1975, University Kiel radiocarbon measurements VIII: Radiocarbon, v 17, p 276-300.

- Gillespie, Richard, 1975, The suitability of marine shells for radiocarbon dating: Unpub PhD thesis, Univ Sydney.
- Gillespie, R, Polach, H A, and Temple, R B, 1972, Sydney University natural radiocarbon measurements I: Radiocarbon, v 14, p. 413-417.
- Gillespie, R and Temple, R B, 1973, Sydney University natural radiocarbon measurements II: Radiocarbon, v 15, p 566-573.
- 1976, Sydney University natural radiocarbon measurements III: Radiocarbon, v 18, p 96-109.
- Goh, K M and Molloy, B P J, 1972, Reliability of radiocarbon dates from buried charcoals: 8th internatl radiocarbon conf Proc, New Zealand, p G29-45.
- Hughes, P J and Sullivan, M E, 1974, The redeposition of midden material by storm waves: Jour Royal Soc NSW, v 107, p 6-10.
- Knox, G A, 1963, The biogeography and intertidal ecology of the Australian coasts: Annual Rev Oceanog Marine Biol, v 1, p 341-404.
- Lampert, R J, 1971, Burrill Lake and Currarong: coastal sites in southern NSW: Terra Australis, v 2, ANU Prehist Dept.
- Lampert, R J and Hughes, P. J, 1974, Sea level change and aboriginal coastal adaptations in southern NSW: Archaeol & Phys Anthropol in Oceania, v 9, p 226-235.
- Lerman, J C, 1972, Carbon dating: origin and correction of isotope fractionation errors in terrestrial living matter: 8th internatl radiocarbon conf Proc, New Zealand, p H16-28.
- Mangerud, J and Gulliksen, S, 1975, Apparent radiocarbon ages of recent marine shells from Spizsbergen, Norway and Arctic Canada: Quaternary Research, v 5, p 263-273.
- Polach, H A, 1969, Optimization of liquid scintillation radiocarbon age determinations and reporting of ages: Atomic energy in Australia, v 12, p. 21-28.