JOURNAL AND PROCEEDINGS OF THE

ROYAL SOCIETY OF NEW SOUTH WALES

Volume 137 Parts 1 and 2
(Nos 411–412)

2004

ISSN 0035-9173

Published by the Society
Building H47 University of Sydney
NSW 2006 Australia

Issued August 2004

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ISSN 0035-9173

Journal & Proceedings of the Royal Society of New South Wales, Vol. 137, p. 01–31, 2004
ISSN 0035-9173/04/010001-31 $4.00/1

Cult and Archaeology at Pella in Jordan: Excavating the Bronze and Iron Age Temple Precinct (1994–2001)

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Abstract: This article summarises key discoveries of the University of Sydney excavations at Pella in Jordan between 1996–2001. Work centred on the excavation of a three-phase fortress temple complex on the south side of the city mound, and in the study of changing cult practice in the temple precinct over the 800 years of its occupation (ca 1600–800 BC). A detailed analysis of changing architectural form and cult practice is presented, and appropriate regional parallels both cultic and cultural outlined.

Keywords: archaeology, near east, Jordan, Bronze Age, religion, temple, cult practice

INTRODUCTION

The sequence of human occupation on the ancient tell and in the hills that surround the main settlement of Pella in Jordan stretches back over half a million years (Edwards & Macumber 1995). This long, well-nigh unbroken cultural sequence provides ideal circumstances under which to study the long history of human culture generally, and to identify key developments in this process.

With this general aim in mind, University of Sydney archaeologists have been excavating at Pella for the last 25 years. To date, 36 individual excavation fields have been opened across the settlement site and in the hills surrounding it (Bourke 1997), with two general research monographs (McNicoll et al. 1982, 1992) and more than 100 research articles focussing on individual aspects of the archaeological record.

One of the more recent research concerns has been the investigation of the Bronze and Iron Age temple precinct. Investigations began in 1994 when chance discoveries in the South Field (Area XXXII) revealed the presence of a massive stone building, the largest pre-Classical structure discovered at the site (Bourke et al. 2003). Intensified field investigations in the temple precinct began in 1996, and have become the primary focus of excavations in the last three field seasons (1997–2001). Results have been spectacular, and some of these form the focus of the present paper.

THE ARCHAEOLOGY OF CULT AT PELLA IN JORDAN

When the first massive stone blocks of the Bronze Age temple were revealed in 1994, little enough was known about pre-Classical religious practices at Pella. In 1984, two Iron Age (ca 850 BC) ceramic cult stands, rich in iconographic detail, had been recovered from pit deposits on the eastern edge of the site (Potts 1992). However, no trace of associated cult buildings was detected at the time, perhaps due to their being located west of the excavated area. Nonetheless, the two cult stands attested to the existence of elaborate cultic rituals associated with the worship of a female deity, in all likelihood Asherah, if iconographic details are correctly interpreted (Dever 1984). No major cult-related discoveries occurred between 1984 and 1994 to give these isolated finds any meaningful archaeological context, but the main focus of pre-Classical investigations was on earlier civic and military constructions (Bourke et al. 1994, 1998).

The discovery of the Bronze Age temple came about by accident. In trenches originally opened to intensify investigations into the rich

Fourth Millennium BC structures present along the southern edge of the site (Area XXXII), the discovery of a massive stone structure in the northeast corner of the excavated area was wholly unexpected. The importance of the structure was immediately apparent, but its sheer size (32 x 24 metres), location (under a modern cemetery precinct), and the presence of up to six metres of later occupation (dating between 200 BC and 1500 AD) across much of the area, meant that excavation of the structure could only proceed slowly. Nonetheless, over the course of seven field seasons (1994–2001) enough of the overall structure and associated finds have been recovered to allow a first (of necessity tentative) reconstruction of the architectural history and elements of cultic practice in one of the largest and best preserved fortress temples ever discovered.

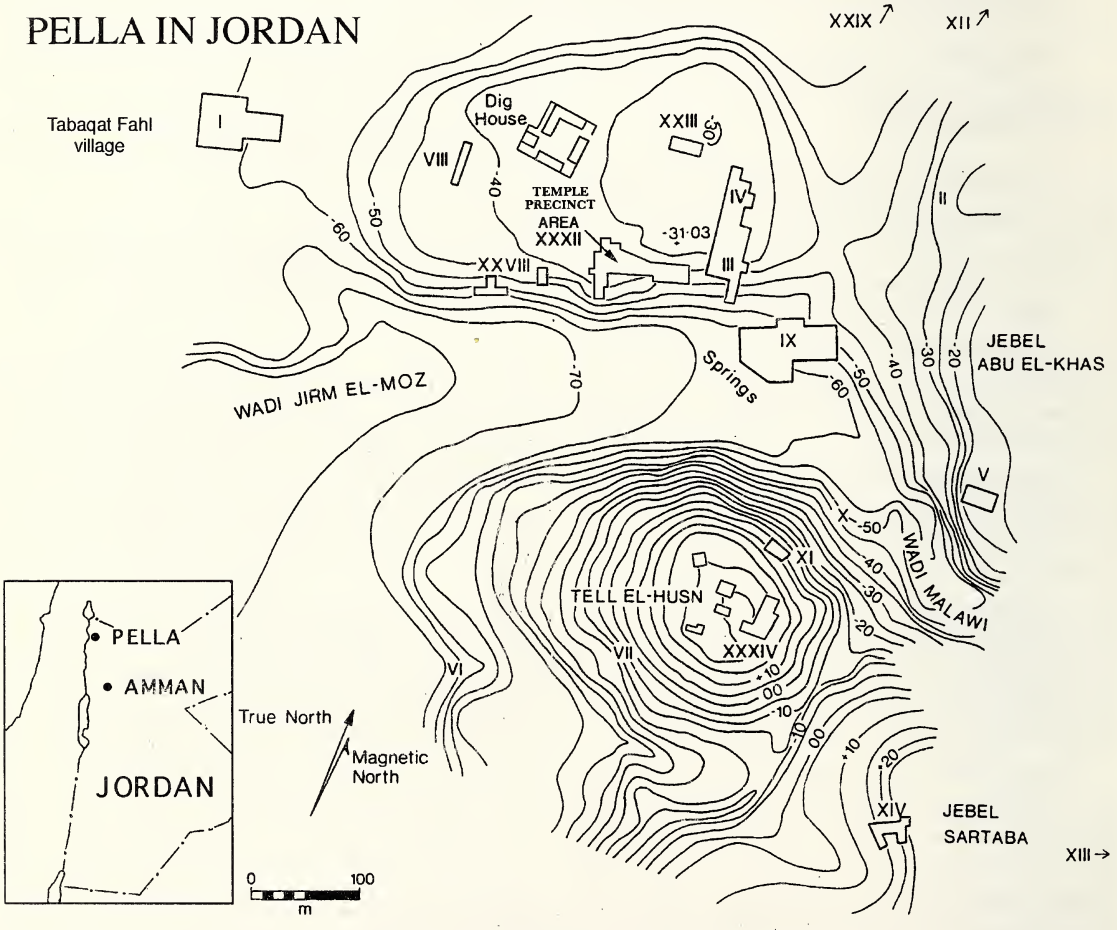

Figure 1: Pella contour plan/area locations.

Figure 2: View of Area XXXII temple precinct.

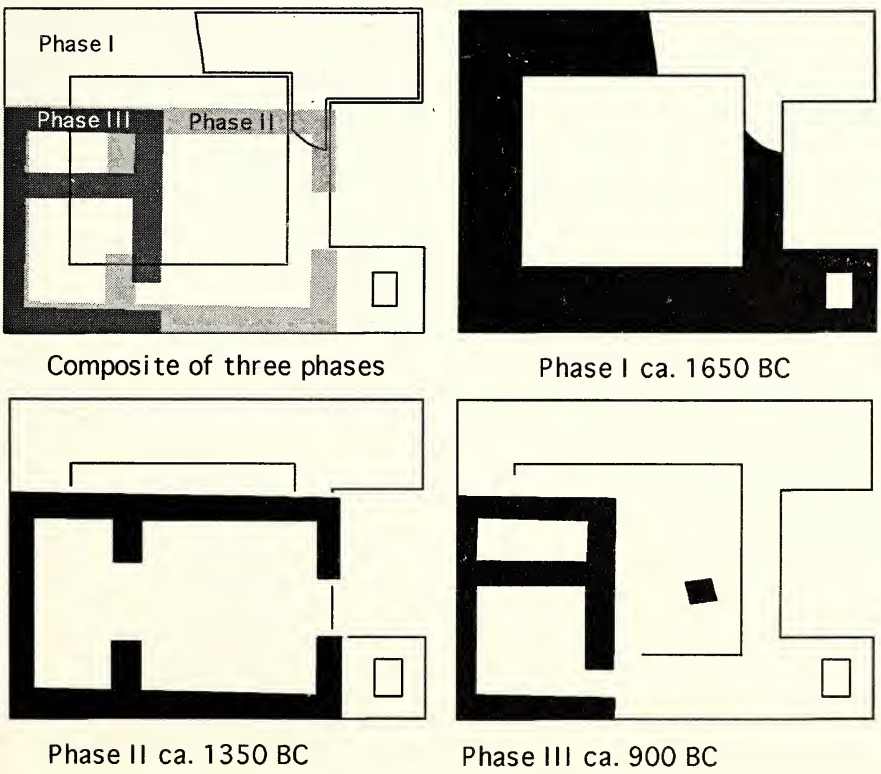

Figure 3: Schematic plans of three main phases of temple construction.

ARCHITECTURAL HISTORY OF THE TEMPLE PRECINCT

First Constructional Phase: Middle Bronze Age (ca 1650–1450 BC)

There are three distinct phases in the constructional history of the temple proper. The first phase of construction consisted of a thick-walled "hollow-box" rectangular structure. The key external features are two projecting square stone buttress/piers flanking a wide entrance way through the east wall. The interior consists of an open rectangular space provided with a neatly paved mud brick floor, but otherwise containing no internal dividing walls and apparently no ritual paraphernalia (cult statue, cult vessels or offerings) of any kind. There is no good evidence for any cult practice or offering deposits located within the temple during this early phase. The few offering deposits that have been detected are located outside the temple, to the south and east.

Cult paraphernalia favours the worship of a male deity, and the simplicity of architectural design (an empty box) would favour a numinous aniconic deity. We suggest that El, father of the gods and head of the Canaanite pantheon, best fits this description of the deity worshipped in this first phase of the Pella temple. We acknowledge that there is no consensus as to the specific architectural, archaeological or iconographic paraphernalia to be associated with the worship of each male deity in the Canaanite pantheon (Dever 1983). The majority of Levantine archaeological literature on the subject of Bronze Age gods generally opts for Baal, Hadad or Dagan as the three most likely candidates to have been worshipped in Bronze Age Canaanite temples (Mazar 1992).

It is curious how little archaeological presence is accredited to El, given that he was the head of the Canaanite pantheon and ruler over all the gods. Contemporary mythological texts make clear the dominance of El in the Middle Bronze Age Canaanite pantheon (Lewis 1996; Pitard 2002), and yet few of the many Canaanite temples discovered over the last hundred years of excavation in the region has ever been specifically attributed to his worship. We believe this to be in error, and would like to suggest that the massive rectangular "empty-box" temple form, as represented by the Middle Bronze Age temples from Shechem, Megiddo, Hazor (Area A), Tel Kittan, Tell Hayyat and Pella be associated with the worship of Canaanite El. Given the geographical proximity of most of the abovementioned sites to each other, it seems probable that a specific inland central Levantine aspect of Canaanite El was being venerated (Albright 1968).

Figure 4: View of MBA temple south wall (looking east).

Figure 5: View of MBA temple north wall (looking east).

Figure 6: View of south tower (looking southwest).

First Refurbishment: Late Bronze I (ca 1450 – 1350 BC)

At some stage in the early Late Bronze Age (ca 1450 BC) several alterations to the temple fabric took place. The first and potentially most important change was the construction of a cross-wall in the western quarter of the original "hollow-box" cella. This had the effect of defining a formal Holy of Holies for the first time. The floor area west of the cross wall (within the newly created Holy of Holies) was removed down to a depth of 1.5 metres, re-filled with multiple layers of medium-sized fieldstones, and sealed with a thick, yellow-white, lime plaster floor surface. The cross-wall also formed the foundation course for a formal threshold and entranceway into the Holy of Holies, although the exact format of this original threshold was obscured by later reconstructions.

The eastern facade of the temple was also remodelled, with two massive 5 x 5 metre hollow square towers built upon the projecting solid stone buttresses that flanked the original entrance to the temple. The change from the original stone and (presumably) solid brick pier superstructure to a hollow tower format may have been designed to reduce weight-stress on the abutting temple facade, or perhaps to facilitate the construction of high flanking towers.

It is no easy matter to evaluate the significance of these architectural changes for cult practice and religious belief. The changed architectural form of the early Late Bronze Age temple need not reflect any significant change in cult, but we suggest that it does. The action of dividing off a Holy of Holies for the first time is a significant departure from previous practice, and bespeaks an altered view of the relationship between man and god.

The Ugaritic religious epics (Pitard 2002) contain legends that document the triumph of Baal in a war between the gods, and is generally interpreted as recording the spread of Baal worship in early Late Bronze Age Canaan. This assumed pre-eminence seems to have led to the attribution of virtually all Late Bronze Age Canaanite temples to Baal, even though very few have any inscriptional evidence to favour such an association (Mazar 1992). Male iconography does predominate (figurines, cult statues, incense burners) so the worship of some male deity is not easily disputed. When Late Bronze Age texts do identify individual temples, they name Baal, Reshep, Hadad and Dagan as titular deities (van der Toorn et al. 1999).

As well, there is an undoubted presence (if not pre-eminence) of Baal worship in the southern Levantine Late Bronze Age, more specifically at Pella where ruling prince Mut-Balu proclaims his loyalty to Baal by his very name (Hess 1989). Thus the broad association of Baal, Hadad or Dagan worship with Late Bronze Age temples is not unreasonable. Explaining the apparent change from El to Baal worship is more of a problem, although the spread of Hurrian peoples and their distinctive religious beliefs into Canaan and southern Anatolia at this time is well documented (Na'aman 1994; Hess 1997). It may be that the spread of Baal worship into the southern Levant is broadly connected with the arrival of Hurrian immigrants and the rise of the Hurrian Mitannian empire (Klengel 1992). Indeed, it was this new presence of Hurrian Mitannians in the southern Levant that Thutmosis III claimed to have provoked his first military campaigns, which ultimately brought much of Canaan (including western Jordan) under Egyptian control for the first time (Redford 1992).

South Levantine Late Bronze Age temple architecture changes from the simple "empty-box" form of the Middle Bronze Age temples at Shechem, Megiddo and Hazor (Area A), to more architecturally complex internally subdivided structures such as those at Hazor (Area H), Lachish (Acropolis Temple) and Beth Shan (Mekal). Architectural change need not reflect change in cult practice, but when these architectural changes occur across the south Levantine landscape at the same time as new North Syrian Hurrian cultural traditions appear, there is more strength to arguments that seek to link changed architectural forms with changing re-

ligious beliefs (Hess 1989). We view the early Late Bronze Age changes to the original Middle Bronze Age temple form at Pella in this context of widespread change in cultural and religious beliefs, largely attributable to the influence of North Syrian Hurrian religious forms.

Figure 7: View of LBA temple cella Area (looking east).

Second Constructional Phase: Late Bronze Age II (ca 1350 – 1150 BC)

A major change to the re-modelled temple design occurred around 1350 BC, probably as a result of severe earthquake damage. Similar earthquake-related damage is found throughout the city and in buildings on nearby Tell Husn (Bourke et al. 1999). Two key alterations occurred thereafter. The entire temple structure was narrowed and the cella was provided with a colonnade.

The entire structure was levelled down to the stone foundations and new (much less massive) stone and mudbrick walls were built along the outer edge of the original east, south and western wall lines. However, a new north wall line was created five metres to the south of the Middle Bronze Age original, resulting in a significant narrowing of the entire structure. This was probably brought about by the sharp warping of the underlying foundations in the north temple area, still clear today from aerial photographs. At this time the original wide entrance to the Holy of Holies was narrowed and recentred, and rebuilt using roughly dressed limestone and more carefully dressed (and drilled) basalt orthostat blocks; the latter were probably reused from earlier structures. Two small basalt column bases now flanked the re-configured entrance to the Holy of Holies. The floor of the Holy of Holies was re-laid, with new small

stone foundational layers sealed by a thick, yellow, plaster floor surface. A number of distinct Egyptian-style foundation deposits were placed in shallow pits below this re-laid floor.

The new (much narrower) rectangular cella to the east of the rebuilt Holy of Holies was provided with a central colonnade at this time, indicated by the presence of three pillar bases. The western and eastern column bases had relatively small sub-structural foundations, but the central column base was provided with a massive limestone sub-structure, implying that it was designed to be the major weight-bearing support. All three column base foundations were cut into the mud brick paving of the original cella floor. Traces of burnt wooden columns were found in direct association with both of the smaller column bases. Thin, off-white plaster floors were laid across the narrowed cella area and the lower regions of the interior wall surfaces were sealed with a thick, monochrome, pale brown mud plaster.

The eastern facade of the temple was also remodelled, although subsequent Iron Age re-use in this area has made the exact form of the Late Bronze Age structure difficult to reconstruct with any confidence. However, it seems probable that the two hollow-square towers flanking the early Late Bronze Age temple entrance collapsed in the earthquake and were not rebuilt. If this interpretation is correct, then the area to the east of the reconstructed east wall would have been an open pebble-paved plaza.

These alterations to the early Late Bronze Age temple form could be interpreted as a simple structural response to severe earthquake damage, in that virtually all changes could be seen as a necessary strengthening of the original structurally unsound "hollow-box" design. However, the construction of a pillared hall, the addition of flanking columns at the entrance to the Holy of Holies, and the presence of "Egyptianising" foundation deposits may all reflect a new cultural influence at work.

While we have no reason to posit major change in local religious beliefs in the Late Bronze Age II, the architectural remodelling of the Pella temple coincides closely with the first presence of the Egyptian Nineteenth Dynasty pharaohs in the region (Redford 1992). This Late New Kingdom dynasty profoundly changed the ways in which the Canaanite empire had been administered previously, being far more inclined to interfere directly in the running of vassal states (Weinstein 1981). From this time (ca 1300 BC) an accelerated "Egyptianisation" of local elite culture can be observed, as can direct Egyptian influence on local Canaanite architectural modes (Wimmer 1990; Higginbottom 1996). With this in mind, it may be that the Egyptianising foundation deposits and the pillared hall at Pella provide evidence for an increasingly pervasive Egyptianisation of local elite culture east of the Jordan during the later New Kingdom.

The remodelled temple remained in use until the end of the Bronze Age (ca 1150 BC), when the entire site of Pella suffered a major destruction. This may also have been due to earthquake activity, although human agency remains possible, as this is the time of the enigmatic Sea People descent on Egypt, generally (if not always reliably) associated with a widespread destruction horizon throughout the region at this time (Sandars 1978).

Iron Age I Temple Use (ca 1150 – 950 BC)

The post-destruction Iron Age I (ca 1150–950 BC) temple deposits were badly disturbed by later building activities. There is some meagre archaeological evidence for activity in and about the Holy of Holies during the two hundred years of the Iron I period, but the pillared hall and eastern facade seems to have collapsed into ruin. All areas surrounding the Holy of Holies were given over to domestic use, and much disturbed by numerous rubbish pits (Bourke et al. 2003). The immediate area in and about the Holy of Holies seems to have retained some measure of cultic function, although the mixture of cultic and domestic practice renders the precise nature of cult practice obscure.

Figure 8: View of Iron Age temple (looking east).

Third Constructional Phase: Iron Age II (ca 950 – 800 BC)

The third constructional phase marked a profound change to the form and (arguably) the function of the Pella temple. After the two hundred years of decline represented by the Iron Age I (ca 1150–950 BC), the area of the Late Bronze Age Holy of Holies was completely rebuilt as two separate storage and cultic rooms, with access to the cult room via an indirect entranceway in the southeast corner. The cult room was provided with benches around its west and north sides, and what appears to be a stepped mud brick podium was built against the eastern wall, perhaps for the display of cult paraphernalia. The northern room was filled with baskets of lentils and bags of grain, all burnt in the final destruction. Most cultic items, favissae and offering debris were located in the open courtyard area immediately to the east of the cult room. The roughly square courtyard area was dominated by a massive stone altar, positioned roughly in the centre of the courtyard. The major cult items, which included the ceramic "Cow Box", and associated incense cups and a chalice, were found in destruction debris beside the stone altar.

Direct architectural parallels for the Iron Age II temple form are elusive. At Shechem (Stager 1999) and Tel Kittan (Eisenberg 1977), Iron Age II structures were reconstructed directly on top of Late Bronze Age originals, although the architectural forms are not particularly close to those at Pella. However, reasonably close parallels are found with the Iron II temples from Tel Qasile (Mazar 1980) on the Palestinian coast, and some individual design elements are paralleled in Iron Age temples at nearby Beth Shan (Rowe 1940). The contemporary material culture (and cult practice) at these two sites display an eclectic mixture of

local Canaanite and "Aegean-Cypriot" influences, which many researchers equate (rather shakily) with the "Sea Peoples" (Tubb 2001), or more specifically with the better-known Biblical Philistines (Dothan 1982).

Architectural parallels are consistent with a significant change in cult practice, and offering vessels and figurines display relatively unambiguous links with the Palestinian coast for the first time during these Iron I-II horizons. Whilst it is probably unwise to equate specific politico-historical events with changing archaeological circumstances, the sharp change in cult practice at Pella does seem to indicate the presence of a major new influence in the region, with all archaeological indicators favouring a source on the Palestinian coastal plain (Singer 1994). It is difficult not to view these purely archaeological circumstances as consistent with Biblical testimony relating to the penetration of the originally coastal Philistine peoples into the eastern Jezreel Valley, which many regard as occurring at precisely this time (Raban 1991; Singer 1994).

The remodelled Iron Age II temple precinct at Pella was in use for perhaps 150 years (ca 950–800 BC) before the temple and the entire settlement was destroyed in an extensive conflagration (Bourke et al. 2003). While earthquake activity has been suggested as the likely cause for similarly dated destruction horizons at Deir 'Alla (Franken 1992), the same horizon of destruction at nearby Tell Hammeh (Cahill et al. 1987) and Tel Rehov (Mazar 1999) has been attributed to the military activities of either Egyptian (or just possibly) Aramaean invaders. At Pella, while earthquake destruction is still considered the most probable cause, significant militaria (specifically iron arrowheads and scale armour) are consistently associated with this destruction horizon. Whatever the ultimate cause, this destruction proved to be catastrophic to the long-term well-being of the city of Pella, as settlement ceased across the site for the next 500 years, only reviving with the Seleucid occupation of the region after 200 BC (Bourke 1997).

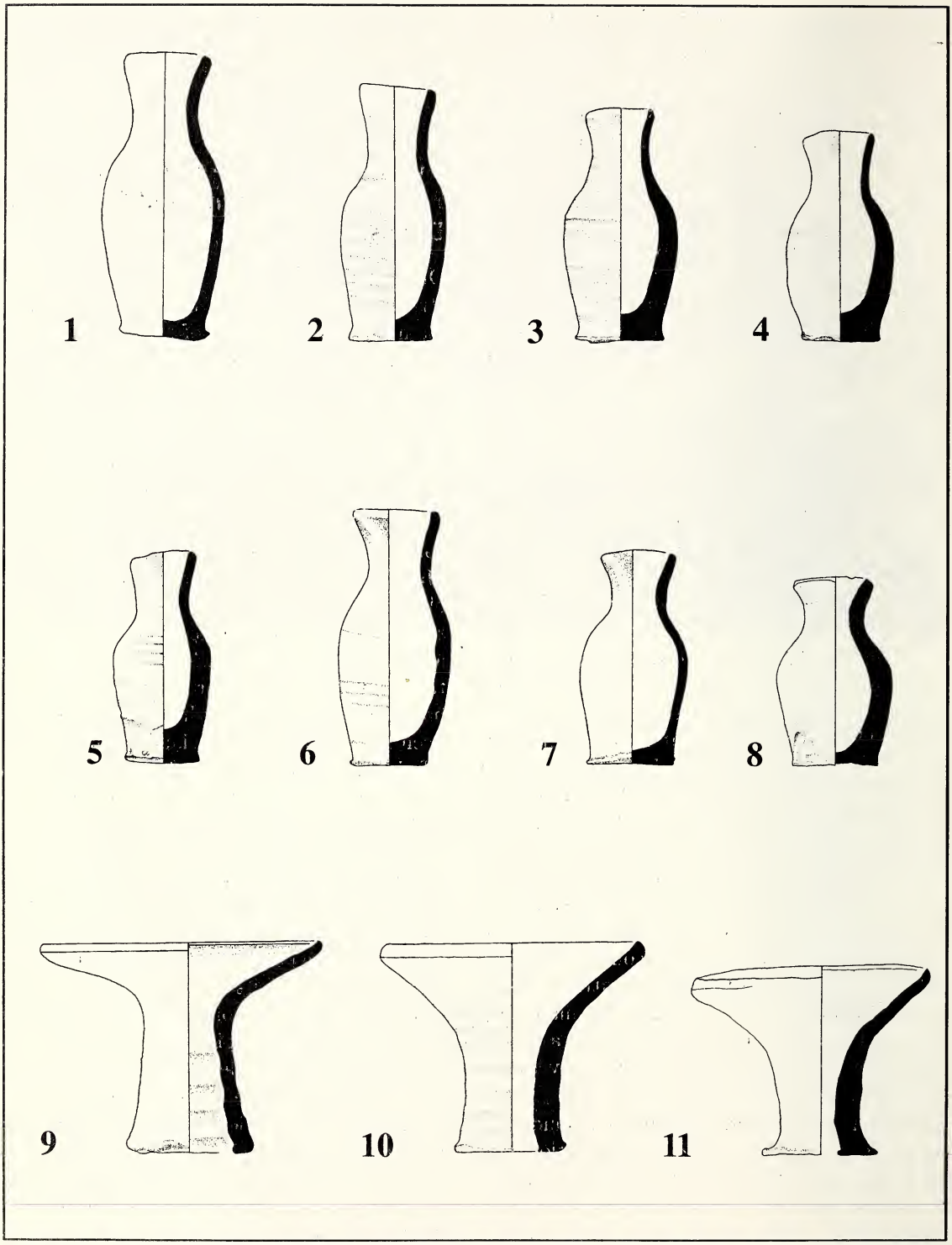

Figure 9: Pottery from MBA temple plastered bins.

ARTEFACTUAL DISCOVERIES AND CULTIC FUNCTION

The Middle Bronze Age Temple: Funerary Offerings and Libation Deposits

Elaborate offering deposits, dating to the initial Middle Bronze and early Late Bronze Age phases of the temple, were discovered some ten metres to the south of the temple. Associated with the Middle Bronze Age phase of temple use is a series of plaster-lined (and plaster-sealed) bins that showed evidence of repeated re-plastering. One contained numerous complete small and/or miniature ceramic bowls, platters, jars, juglets and plates, as well as an Egyptian faience lid. Two others held a series of rough-finished ceramic funnels, small pinch-spouted bottles, a unique locally-made gypsum bowl, and an exquisite Egyptian calcite jar, specifically associated with funerary libations in Egypt (Bourke et al. 2003).

Rough-finished ceramic funnels were found in direct association with late Middle Bronze Age tombs at Pella (Smith 1973) and Megiddo (Guy 1938). We know that funerary libations played a critical element in Levantine ancestor worship (Pitard 1994), and have come to suspect that public facilities existed to both sanctify new and purify decommissioned utensils used in such ancestor worship (Pitard 1996). Although some uncertainty must remain as to the function of the Pella bin contents, we suggest that they most probably contain examples of decommissioned funerary libation vessels. The small (but neatly constructed) mud brick room associated with the bins may be a temple repository connected with the funerary rituals (Fleming 1992).

As the bin-deposits (and the small mud brick repository) were found in close association with the main temple structure, this may suggest that a number of distinct "religious" functions took place within the one temple precinct. A similar state of affairs seems to have existed in the temple precinct at Tel Haror in southern Israel (Oren 1997), where a fortress-type temple is associated with a small repository building and similar votive deposits.

The Late Bronze Age II Temple: Foundation, Offering and Destruction Deposits

Objects associated with the second major constructional phase can be divided into the three main findspot categories of foundation, offering and destruction deposits. The first category of material is that deliberately deposited as part of foundation rituals during constructional events. Materials in this category come from small shallow pits, set immediately below floor packing material and sealed by thick plaster floors.

The second (and most numerous) category consists of objects deriving from offering rituals. Materials of this sort consist of broken cult objects, generally substantially complete but shattered, found alongside a restricted range of animal and plant remains. Offering pits containing cultic objects are generally found to have been cut through earlier temple floors, and been sealed by later associated surfaces. Most offering pits are found within the temple, although some are found in the open areas immediately surrounding the temple. As yet it is not clear whether offering pits contain the residues of cyclical (seasonal) offering events, or periodic "cleansing/votive" rituals, during which various offerings were interred. While it is no easy task to differentiate between "offering" and "rubbish clean-up" pit deposits at first exposure, detailed contents analysis is normally able to highlight the presence of the typical offering assemblages that make up votive deposits.

Finally, there are materials found in situ within the destruction deposits which mark the end of the Late Bronze Age temple (ca 1150 BC). These materials are normally found upon the floor surfaces, and therefore may well instruct on the spatial patterning of cult practices, although much material is found within a thick destruction deposit that sealed the en-

tire area. Materials found within this deposit could theoretically derive from upper storey and rooftop locations, as well as lower storey floor levels.

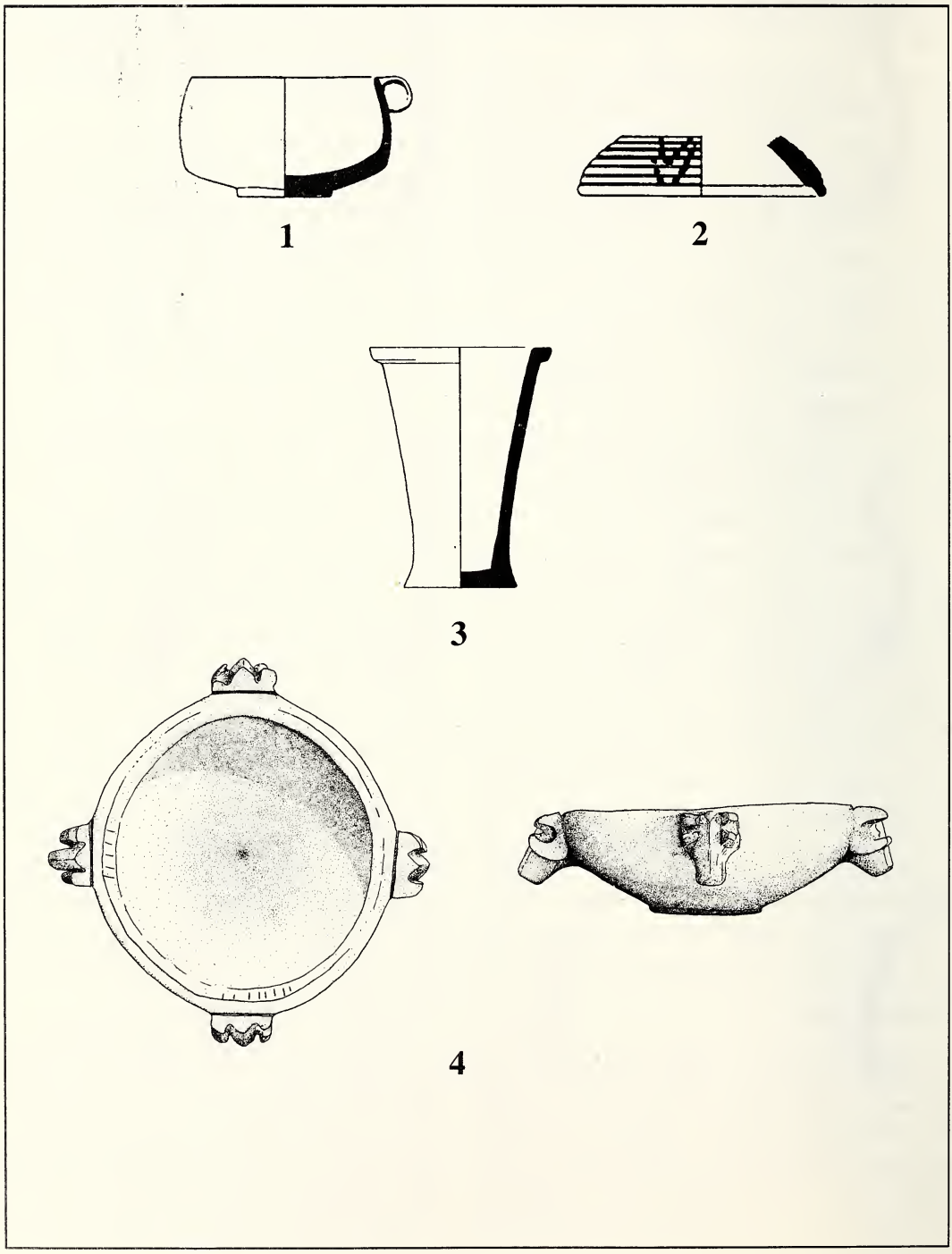

Figure 10: Non-ceramic objects from MBA temple plastered bins.

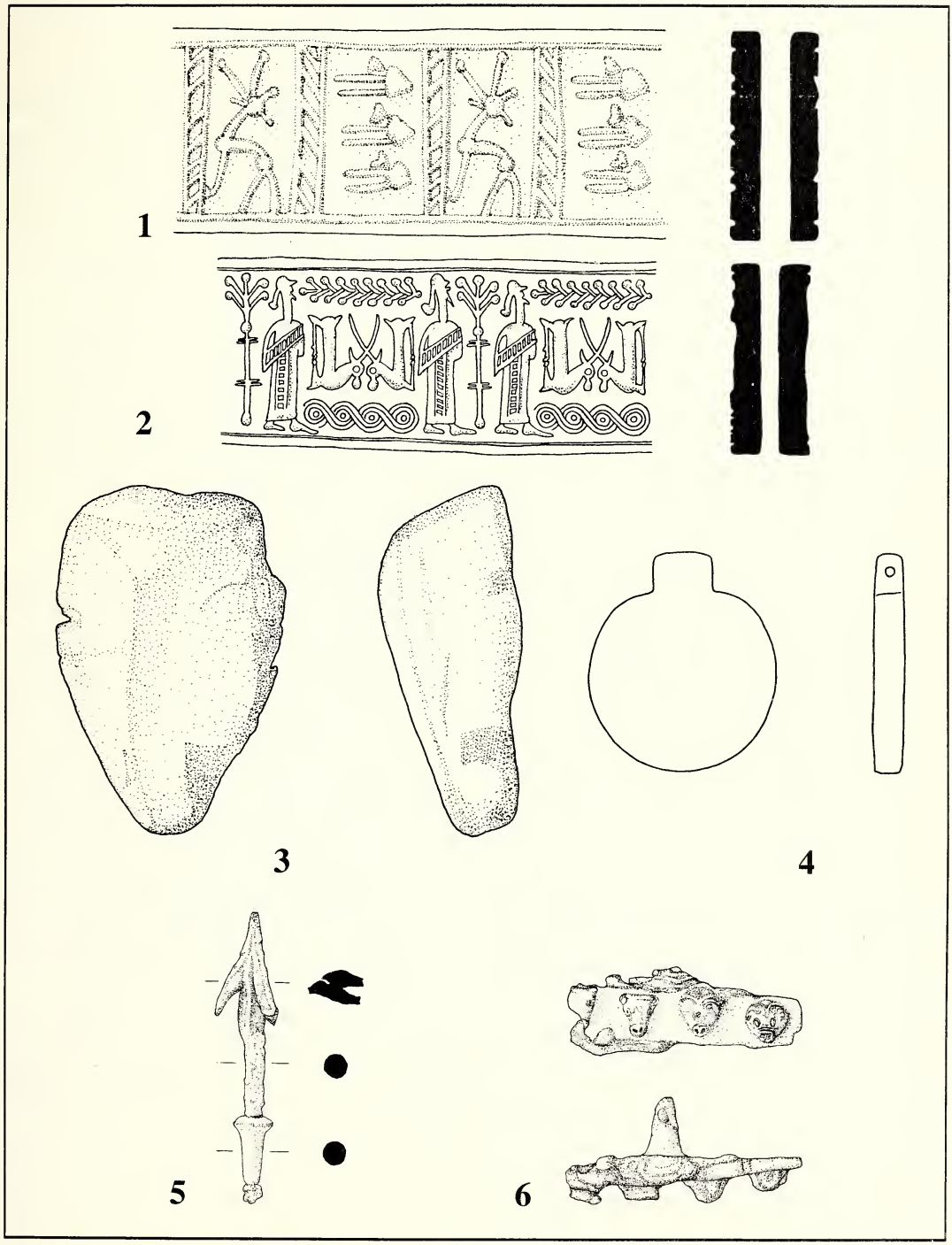

Figure 11: Objects from LBA temple foundation deposits.

Foundation Deposits

Foundation deposits were confined to the area of the Holy of Holies. The main deposits derived from a number of small (40 cm diameter x 20 cm deep) pits excavated into floor makeup layers, sealed by the small stone packing and thick, yellow, plaster floors of the LB II temple reconstruction. One small pit contained faience cylinder seals and Mycenaean Greek pottery cups. A second very shallow pit contained a glass ingot and a glass plaque, along with many faience, glass, agate and lapis beads (perhaps from a necklace). A third deposit contained a miniature bronze harpoon and a small bronze strip with modelled animal heads.

The cylinder seals are of the Mitannian Common Style, with close parallels in contemporary Beth Shan (Parker 1949; James & McGovern 1993), Megiddo (Lamon & Shipton 1939) and Gezer (Parker 1949). Cylinder seals were employed in temple foundation deposits (or as votive offerings) in the LB II temples at nearby Beth Shan (James & McGovern 1993) and at Tell Mevorakh on the Palestinian coast (Stern 1984). It is not yet clear whether the specific subject matter on each seal is significant in their selection for foundation deposits, but as no obvious religious allusions occur in the Pella examples, significance more probably resides in their broad Mitannian/Hurrian cultural association. However, in the absence of inscriptions, very many scenes remain poorly understood.

Glass ingots were found at contemporary Beth Shan (James & McGovern 1993) and Ashdod (Dothan & Porath 1993). Glass plaques of similar type to the Pella example are known from contemporary temple contexts at Beth Shan (McGovern 1985), Megiddo (Loud 1948) and Tell Mevorakh (Stern 1984). The glass plaques are normally seen as derivative of Mesopotamian lapis originals. They are tentatively identified with the planet Venus, and may indicate an offering to Ishtar. Although the exact Levantine equivalent to Mesopotamian Ishtar remains controversial, it is generally held to be Astarte, wife of Baal (van der Toorn et al. (eds) 1999).

Of the metal finds, the small spearhead resembles a barbed "harpoon" discovered in a LB II hoard at Tell Munbaqa on the Euphrates (Werner 1998). If this small spearhead is correctly identified as a miniature harpoon, the symbol of Egyptian Seth, the Canaanite Baal (Albright 1957), then the foundation offering may represent a generic offering to Baal, or a more specific offering against the chaos of earthquake. The miniature bronze strip with a beautifully modelled frieze of alternating frontal ram and bulls heads is unique. While it most probably forms a small part of a much larger furniture inlay, the continuous strip design is reminiscent of contemporary bronze-bound wooden gates. It might be that the small decorated bronze strip formed part of a miniature bronze-bound votive gateway, perhaps seeking ritually to guard the temple against intrusion.

Cultic Vessels

Offering pits are found throughout the temple, both within the Holy of Holies and the cella, as well as in areas outside the temple to the south and west of the structure. Many pits contained animal offerings, which would normally consist of young sheep or goat, more occasionally young cow or (rarely) deer and bird, but never pig, dog, horse or other domestic/wild species. Along with the meat offerings a variety of grain, pulse and fruit residues was detected. These findings are broadly in line with previous studies of animal (Wapnish and Hesse 1991) and cereal/fruit (Magness-Gardiner and Falconer 1994) offering deposits in Bronze Age temples.

Many pits contained smashed cultic vessels, broken into pieces but largely complete. These help us reconstruct both the cultic assemblage employed in offering rituals, and (very occasionally) allow us to address some of the belief structures that lay behind ritual observances. This process may best be illustrated by the description and discussion of the iconography of a unique painted ceramic fenestrated stand, described more fully below. It came form a shallow offering pit cut into the floor of the Holy of

Holies. Fragments of a large offering bowl were found in association with the stand, along with a small quantity of fine grey ash, perhaps the residue of burnt incense.

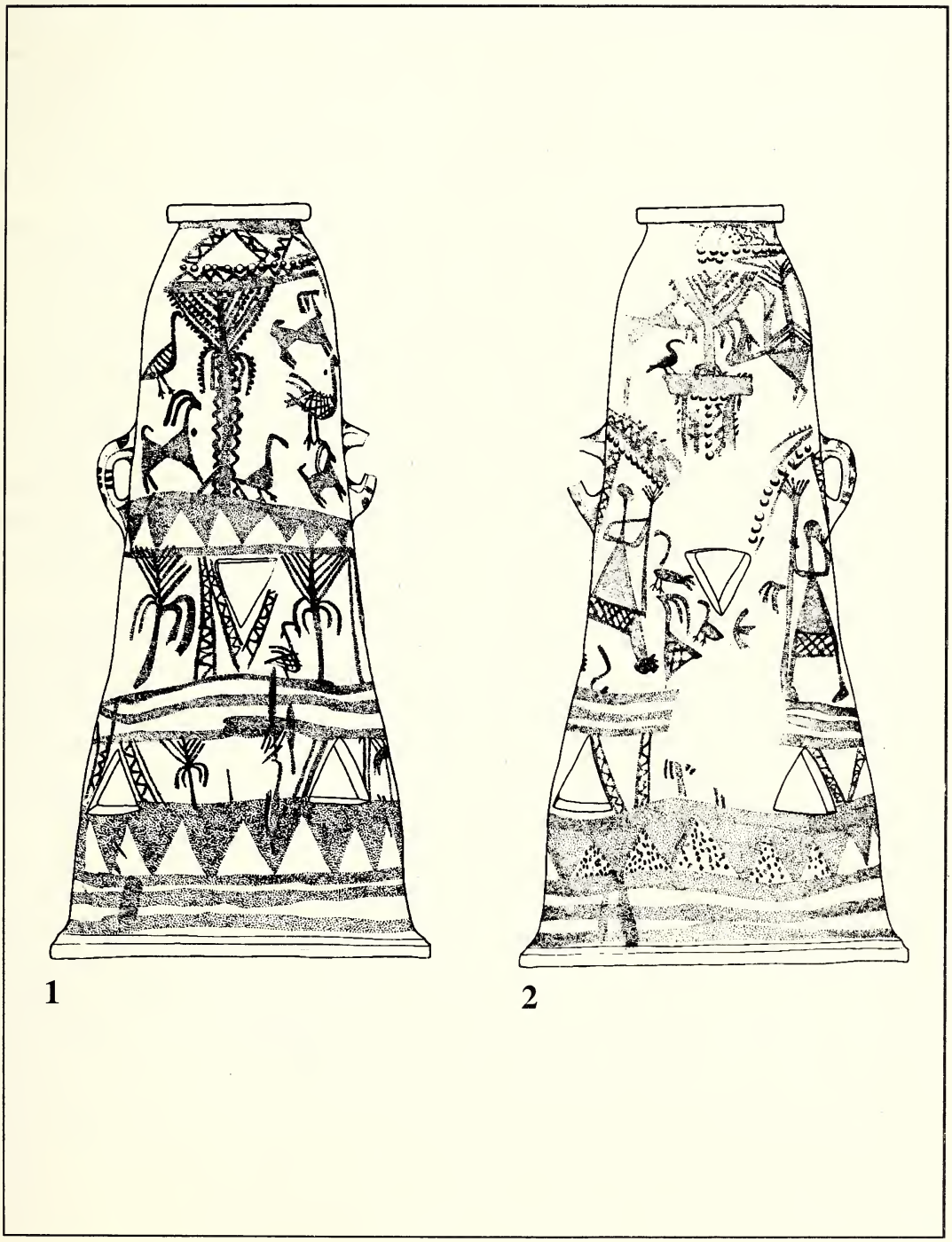

Figure 12: Ceramic fenestrated stand from LBA temple.

Ceramic Cult Stand

The cult stand is approximately 95 cm high and nearly 50 cm wide. It is conical in form, thrown in at least three pieces and joined together quite roughly. It has a double register of triangular fenestrations cut into the lower and mid body. While the form of the stand is well known at nearby Beth Shan (Rowe 1940) and Megiddo (Loud 1948), the painted decoration is uniquely interesting.

The bottom register consists of numbers of solid pendant triangles, interleaved with "spot painted" (obverse) and hollow (reverse) triangles at base. Above these, and interwoven with the first register of fenestrations, is a frieze of trees apparently framed by a latticework fence. The trees have pendant from their branches either fruit or ribbon fetishes. Either way, it seems likely that some form of sacred grove is being represented, and in Canaanite religion the grove is sacred to Astarte, the female consort of Baal, (Dever 1984; van der Toorn et al. 1999). In the freize that runs around the mid-body, also interleaved with fenestrations is another sacred grove, this time more clearly associated with a latticework enclosure, which served to delimit sacred from secular space. Several different types of water fowl and larger birds (geese/pelicans) stand on the ground line (reverse).

The main mid-body register is dominated by two standing male figures, each holding what looks like a winnowing tool (thyrsus), although it may be the less well known "palm spear", used to fertilise the fields during spring rituals of renewal (Pitard 2002). The figures feature geometric triangular shaped bodies, crosshatched lower garments (tasseled or pleated?), and overlarge, but nonetheless, carefully delineated feet. Both figures appear to be bearded. The left-hand figure brandishes the thyrsus in the air, and the right-hand figure leans against/upon the thyrsus and touches his beard/chin with the unemployed hand, perhaps a sign of lamentation/mourning. The first has a collection of animals (birds, ibex and mouflon) facing him when he brandishes the thyrsus; the second has animals facing his back while he laments. The first has what may be a snake beneath his legs. Both figures flank an elaborate painted swept-horn motif, delineated by a line of plastic-added ceramic "buttons". The human figures, the variety of animals and the dominant swept-horn (ibex) motif should perhaps be seen as parts of a sequential narrative, rather than as a series of disconnected motifs. It may be that the two male figures represent lamentation (death) and triumph (rebirth) scenes within a single ritual, perhaps an annual fertility ritual marking the changing of the seasons.

The uppermost register is a combination of formal motifs and a collection of animals set in a freefield format. The obverse illustrates a garlanded altar, a small bird and a large "sacred tree" motif. This tree is flanked by two goats which reach up to nibble at the leaves of the tree – the familiar "ram in a thicket" motif. The reverse is dominated by a large sacred tree motif. The tree has a number of "streamer-like" garlands hanging from it and is surrounded by geometric-bodied ibex and mouflon (strikingly like Greek Geometric forms) and several different types of migratory water bird, some facing the sacred tree, some not.

Taken together, the painted motifs suggest a dominant male deity, connected with wild animals and migratory birds, performing some form of annual fertility ritual, perhaps promoting animal fertility. That the human figure represented is likely to be an aspect of Baal seems probable, as Baal is the source of animal fertility (Pitard 2002).

An alternative possibility would see the deity as Hauron, master of the desert lands (Albright 1936). Hauron has been associated with the earlier MBA Shechem temple (Albright 1957) and the later Iron Age Tel Qasile complex (Mazar 1980); both have close architectural and iconographic links with the Pella temple. Hauron is most commonly associated with the isolated desert communities of the Sinai, the mountainous regions east of the Jordan, and the east Syrian steppe (van Dijk 1989). In Ugaritic legend, Hauron is master of snakes and wild animals, consistent with the deity represented on the Pella cult stand.

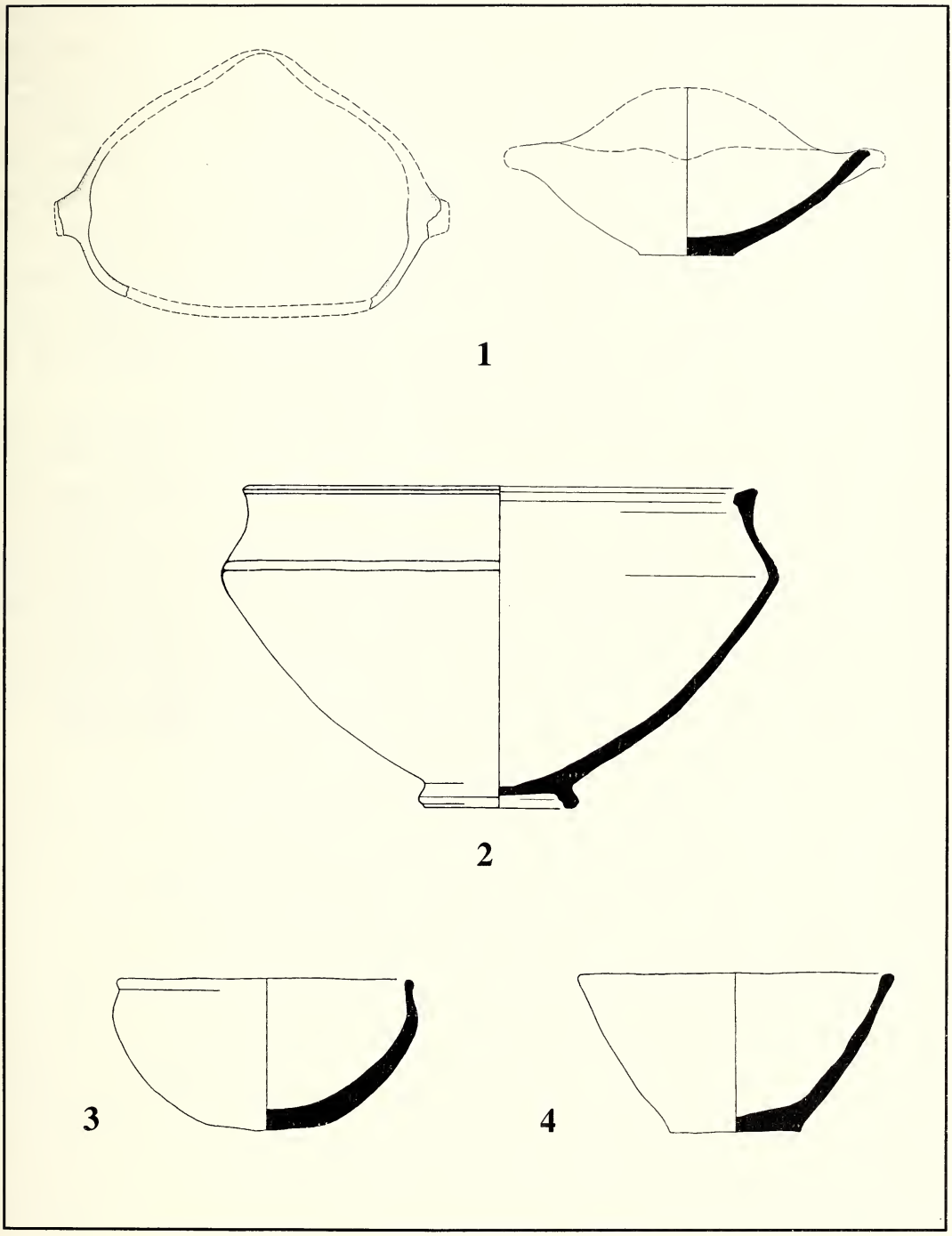

Figure 13: Pottery from destruction of LBA temple.

Destruction Deposits; Ceramic Objects

A variety of offering utensils were recovered, sometimes in pieces, sometimes more or less intact, either contained within or sealed below a thick layer of ash and brick debris. These included kidney-shaped bowls used to collect blood offerings, kraters for mixing water, wine and juice offerings, serving bowls for both solids and liquids, and chalices for libation offerings. Most bowls and platters were found in and around the entrance to the Holy of Holies, while kraters, chalices and kidney-shaped bowls were mostly confined to the cella. This might suggest that meat/solid food offerings were associated more directly with the Holy of Holies, while libations and liquid offerings occurred in the cella or towards the entrance of the temple. Similar ceramic offering vessel assemblages are well known from contemporary temples at Lachish (Tufnell et al. 1940), Beth Shan (Rowe 1940), and Megiddo (Loud 1948).

Towards the eastern end of the cella, a group of non-ceramic objects was found close together on the floor by the southern wall. The group consist of two small bronze cymbals, two small bronze balance pans and a small faience bowl. The faience bowl is of the "Kassite bucket" type, generally associated with incense offerings. The form originated in Babylonia, although many examples found their way to Canaan (Clayden 1998). Close parallels from nearby sites include one example from the contemporary temple at Deir 'Alla (Franken 1992), and two others from Megiddo (Guy 1938; Loud 1948). Bronze cymbals are widely attested in contemporary contexts. Local parallels come from Tell Batash (Kelm & Mazar 1995), Megiddo (Loud 1948), and the temple at Tell Mevorakh (Stern 1984). Similar balance pans are known from Megiddo (Guy 1938), Ashdod (Dothan and Porath 1982) and Tel Michal (Herzog et al. 1989). The balance itself was probably made from wood, and not preserved.

It would seem that all three object types were connected. Faience vessels such as the "Kassite bucket" type contained incense offerings. Balance pans were used to measure out an exact quantity of incense, and the cymbals were probably used to summon the deity, either to witness the outlay, or to partake of the offering. Together these three items provide an insight into a specific aspect of cult practice, the offering of incense, which seems to have taken place in the eastern cella of the building.

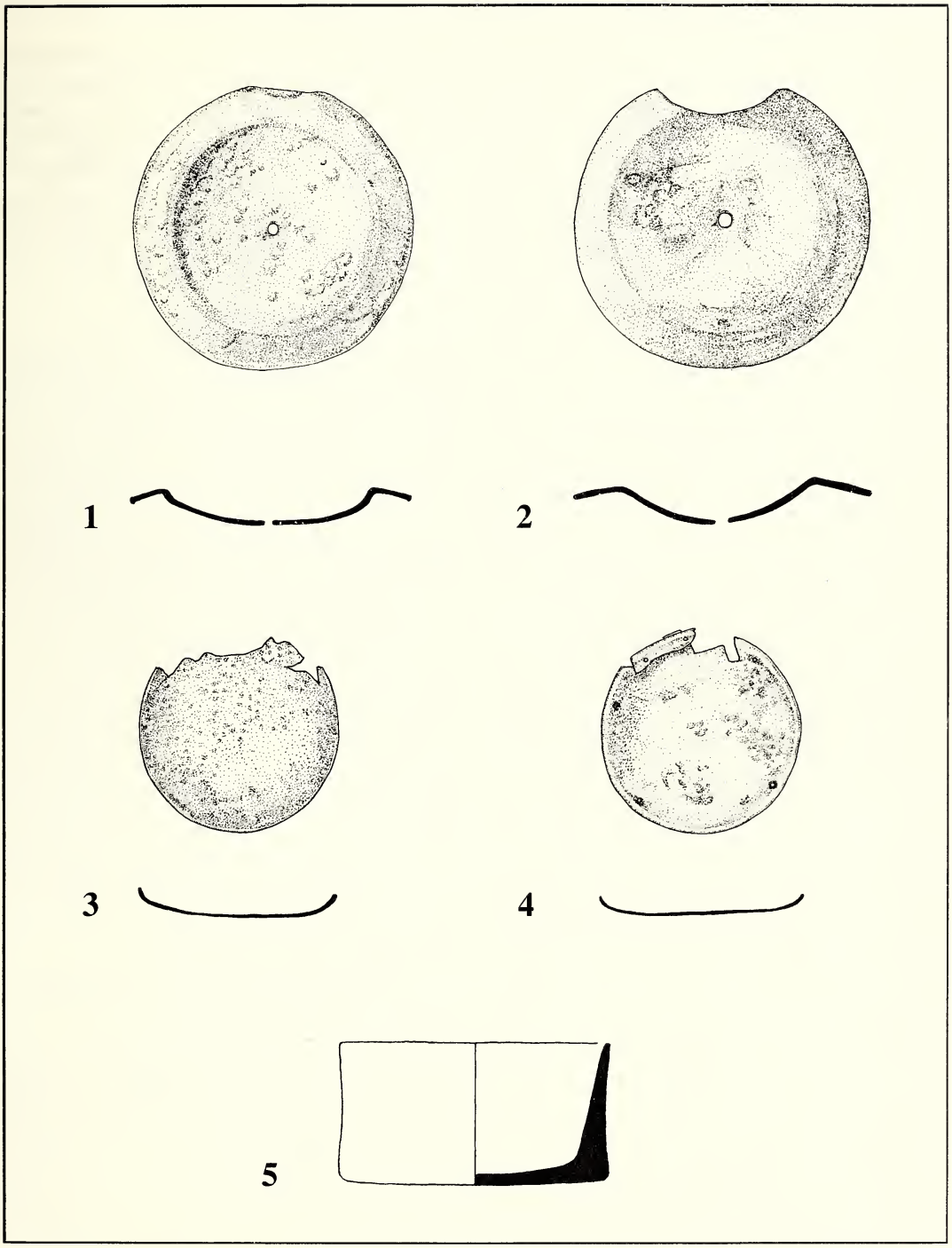

Figure 14: Non-ceramic objects from destruction of LBA temple.

The Iron Age II Temple: Offering and Destruction Deposits

The third main constructional phase Iron II temple was a much smaller edifice. The temple proper was confined to the area of the Bronze Age Holy of Holies, although the formal courtyard east of the temple contained a large centrally placed altar. Archaeological deposits associated with this phase can be divided into offering deposits and destruction deposits. There were no formal foundation deposits associated with the Iron II temple phase.

Offering Deposits

Offering deposits consisted of a large number of distinct pit fills. Many quite large pits took up virtually all of the area of the formal east courtyard, as well as much of the more open spaces to the north and south of the Iron II temple. A number of smaller pits was dug below the temple floors, but while these contained some broken cultic items, they were largely given over to the refuse of animal offerings, mostly young sheep/goats. Destruction deposits consisted of the thick layers of ash and brick debris, which lay over occupational surfaces, sealing a number of important cultic objects in situ on the floor surfaces.

Ceramic assemblages consisted of the familiar jugs, kraters and bowl types used in offering rituals. However, for the first time a fair number of domestic utensils such as cooking pots and storage jars appear within the ceramic assemblage. This suggests that sacred and secular activities may not have been so rigidly segregated in the Iron II temple precinct. Alternately, the "mixed" ceramic assemblage may reflect a genuine change in offering rituals.

Non-ceramic objects are dominated by a variety of basalt bowls, braziers and scoops. Hard stone, tripod-legged bowls were generally employed as simple braziers or to contain material burnt as part of offering rituals. Our examples are quite fine, perhaps suggestive of their use as offering vessels. Similar hard stone tripod-legged bowls were found at contemporary Hazor (Yadin et al. 1958; Yadin et al. 1960), Megiddo (Lamon & Shipton 1939) and Tell Beit Mirsim (Albright 1943).

The two ceramic wheels are rare finds, and probably come from separate models, a four-wheeled covered wagon and a two-wheel light chariot, both generally regarded as appropriate votive offerings to a warrior or storm deity. Broad parallels can be found at Ashdod (Dothan & Porath 1993), Jerusalem (Eshel & Prag 1995) and Tell Jemmeh (Petrie 1928).

Destruction Deposits

The destruction of the Iron II temple (ca 800 BC) ended significant occupation in the area for more than five hundred years. Thick deposits of ash and brick debris sealed the temple proper and most nearby areas. Interpretation of the final Iron II destruction horizons is complicated by the large and intrusive Late Antique (ca 550 AD) foundation trenches that cut through much of the area, largely frustrating attempts to study the spatial patterning of objects found in situ below destruction horizons. The Iron II temple proper suffered quite severely from later constructional activity. However, the area of the eastern courtyard surrounding the central altar was largely undisturbed, and it was here that many cult objects were identified. These include the ceramic model shrine (the "Cow-Box"), perforated ceramic cups, used for incense offerings, and the painted ceramic chalice, used in libation offerings. This collection is described in detail below.

Ceramic Model Shrine and Associated Objects

The ceramic model shrine is made up of a hollow rectangular box with five attached bovine heads. Three heads are attached to the front wall and project above the rim of the box. Two heads are attached to the back wall of the box, and also project above the rim. Rather unexpectedly all five heads face in the same direction, providing a formidable group stare, much ameliorated by their jolly smiles. The box is painted all over in a dark red pigment, and hand

burnished in places. The inside base of the box and a sloping section of three of the inner wall surfaces are all blistered and burnt, suggesting the repetitive burning of a viscous but not quite liquid material, which we suggest to have been incense.

This surmise is bolstered by the presence of three small cups, stored within the box at the time of destruction. These tripod-based perforated cups are commonly associated with Iron II incense offerings (Michel Daviau 2001). A large painted ceramic chalice was found beside the "Cow-Box". Together this assemblage would seem to consist of a model shrine and associated incense containers, and a chalice for liquid/libation offerings. All were found adjacent to the large square stone altar that dominated the centre of the courtyard.

This assemblage is unique as a group, although each individual element has a number of parallels within contemporaneous assemblages. The rectangular model shrine type is well known in Canaan, although each example tends to display unique features that make the identification of close parallels well-nigh impossible. Close in concept is a ceramic box from Tell Mumbaqat on the Euphrates (Werner 1998), and more generic parallels are known from Beth Shan (Rowe 1940) and Megiddo (May 1935). The incense cups are widely attested in contemporary Iron II deposits (Michel Daviau 2001), as is the painted chalice form (May 1935, Amiran 1970). However, found together in situ beside the altar, this group represents a unique indicator of the type of cultic activity that occurred in association with the Iron II temple. Although the disruption to much of the destruction horizon within the temple proper gives grounds for some uncertainty, it nonetheless seems reasonably secure from the surviving patterns of deposition recovered to date that the majority of cult offerings were presented at or around the stone altar in the eastern courtyard, outside of the temple proper.

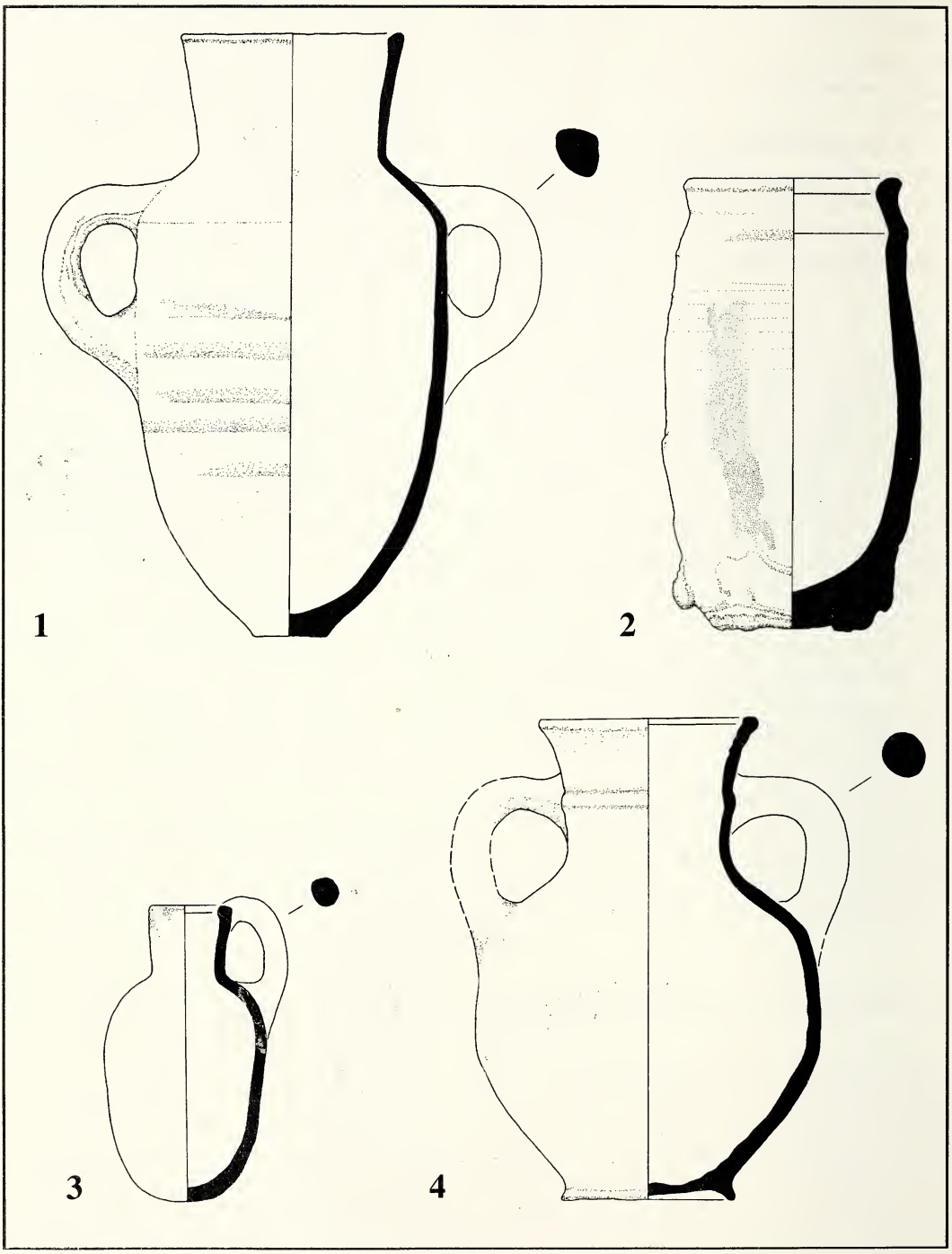

Figure 15: Pottery from Iron II temple surrounds.

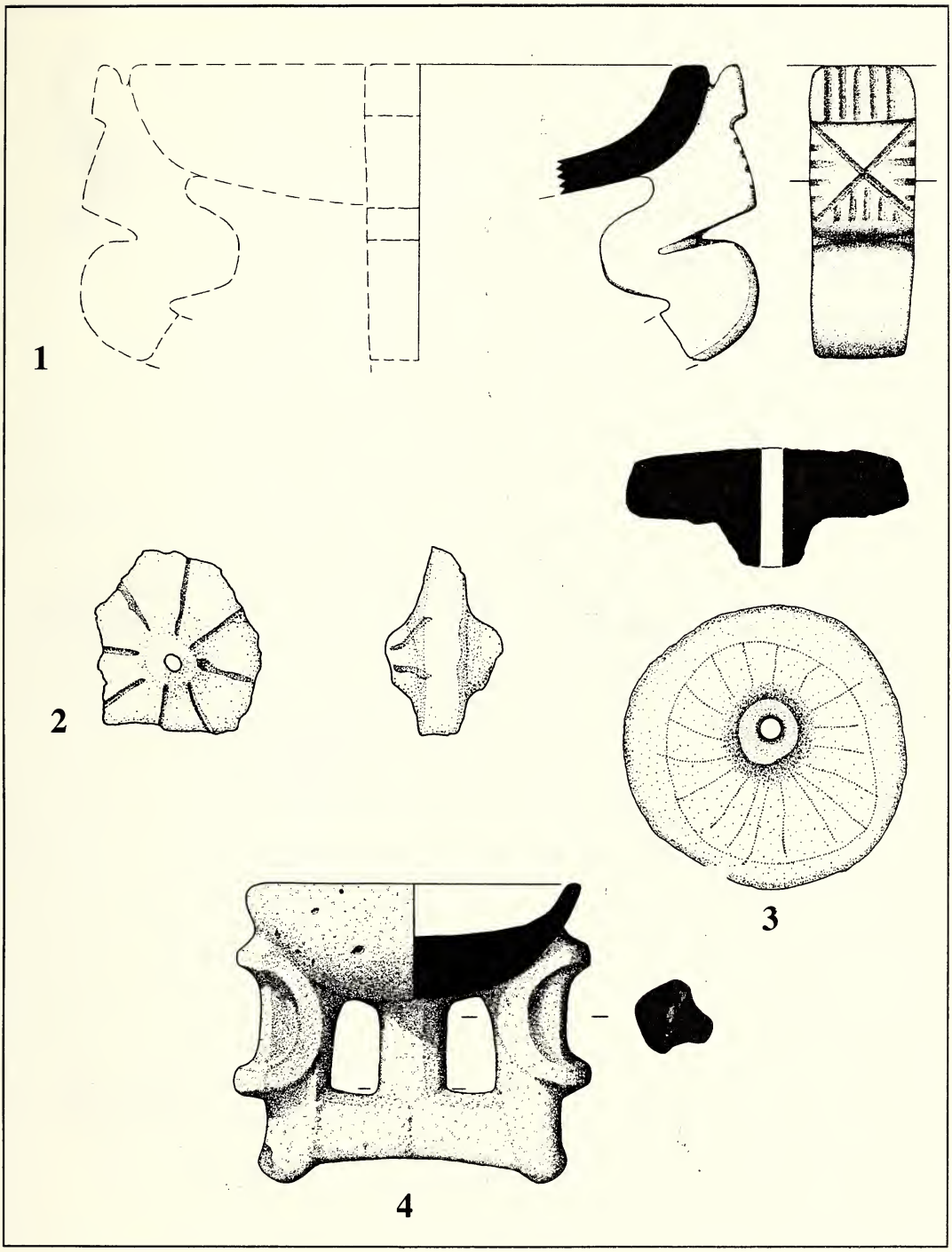

Figure 16: Non-ceramic objects from Iron II temple surrounds.

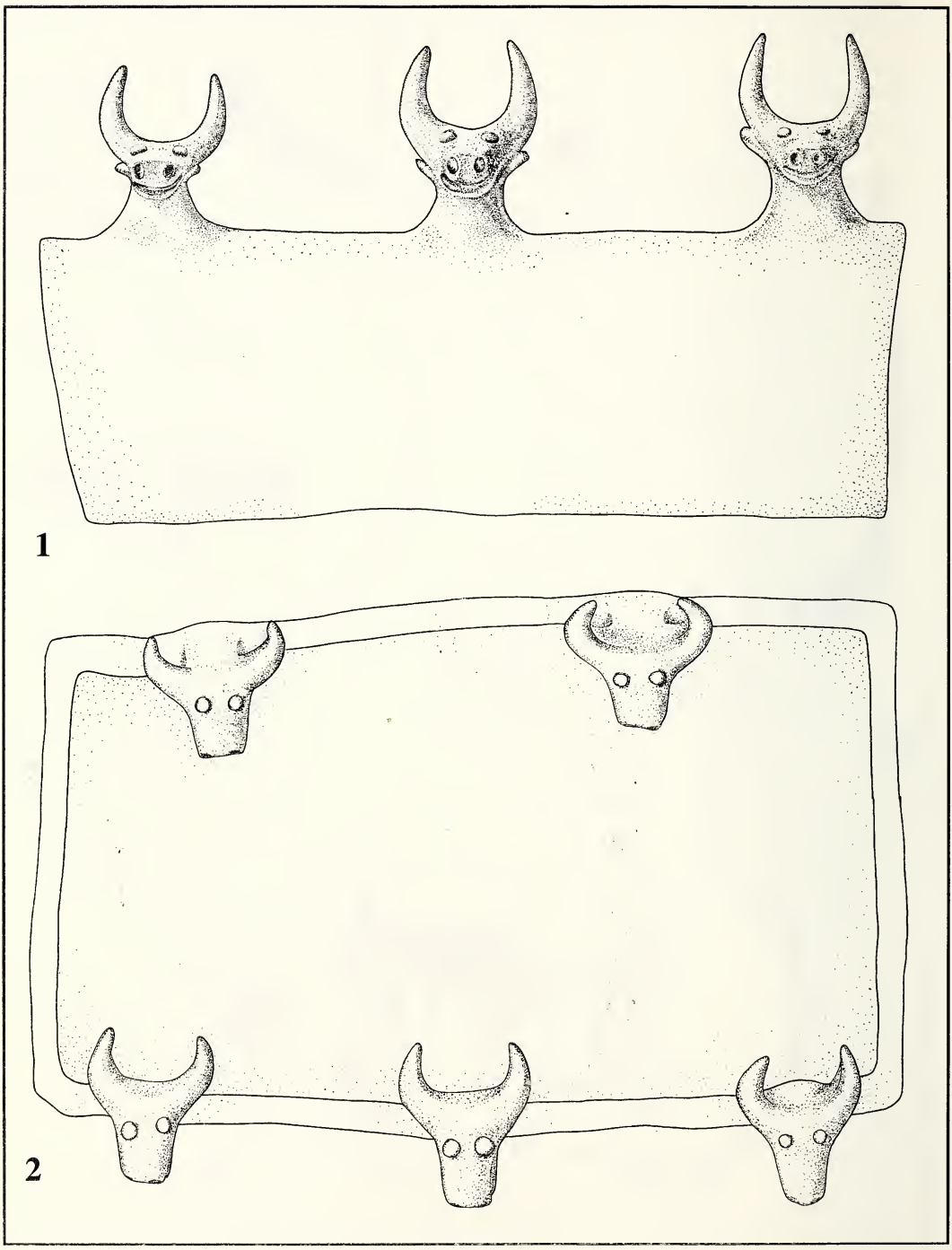

Figure 17: Ceramic model shrine from Iron II temple courtyard.

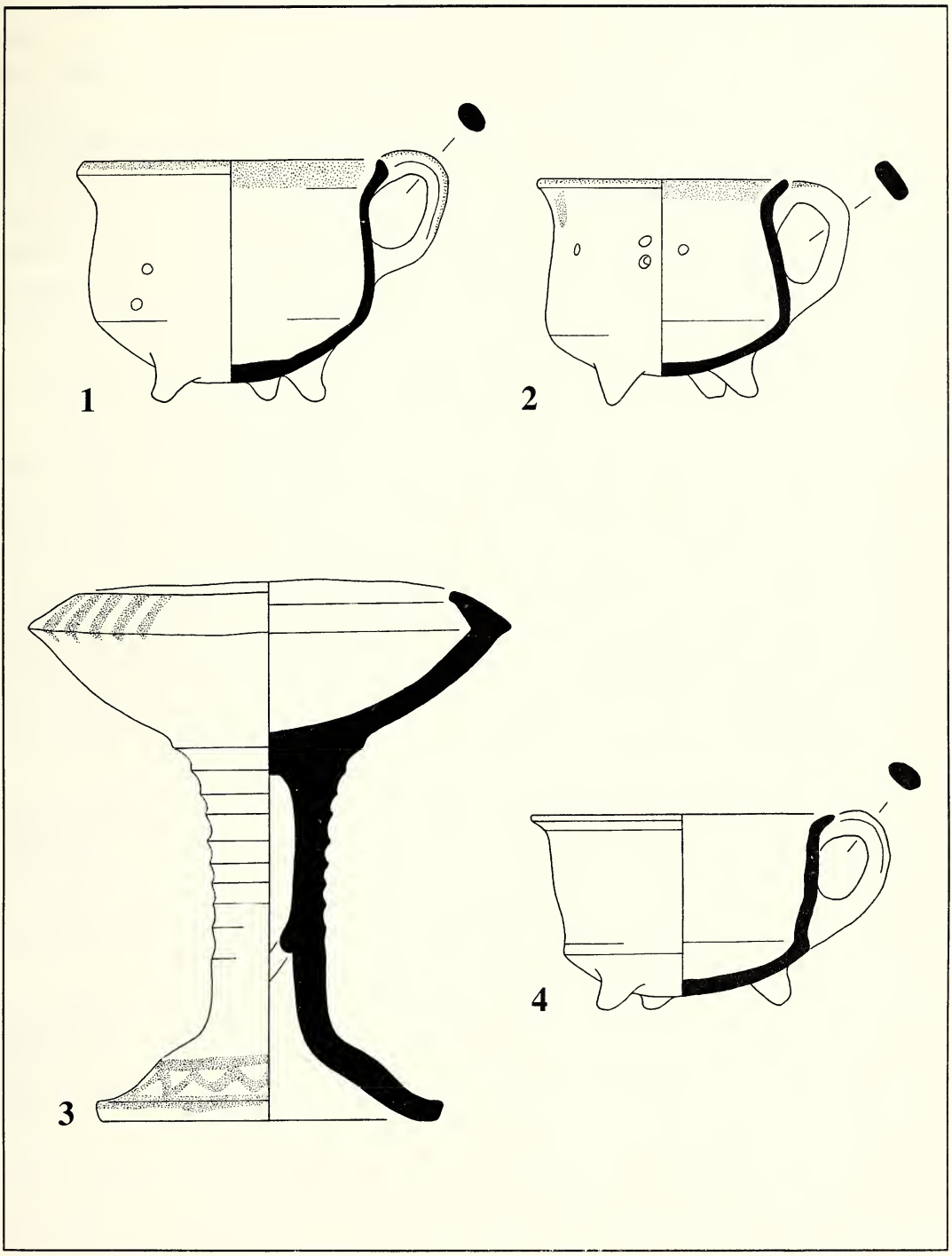

Figure 18: Ceramic incense cups and chalice from Iron II temple courtyard.

CONCLUSION

The study of changing cult practice at Pella in Jordan has only just begun. Detailed comparative analyses of the ceramic and non-ceramic materials from the many pit and occupation deposits contained within the temple precinct are far from complete. Numerous botanical and faunal samples have been processed, but these await quantitative analysis. However, the very great richness of these artefactual and zoobotanical assemblages, and the relatively undisturbed nature of most contexts, gives promise that much can be achieved in the years to come. We aim to be able to provide firm data on changing patterns of cult practice at Pella, and through comparative analysis develop perspectives on the changing nature of regional cultic regimes over time.

This explicitly archaeological database can be employed to redress the balance of a hitherto overwhelmingly text-derived picture of Canaanite cult practice (Dever 1983). Archaeological evidence is of limited use when seeking after religious belief structures (Coogan 1987), but properly employed it can provide productive lines of enquiry on matters of cult practice, while acting as a corrective to purely literary critiques that hold out little promise of advancing knowledge of actual Canaanite cult practice. Pella is located on the eastern edge of the heartland of the Biblical world, apparently often in line of sight to major historical events recorded in Biblical and extra-Biblical sources. We anticipate results that will be broadly relevant to the continuing re-assessment of the changing religious landscapes of the Old Testament world.

REFERENCES

Albright, W., 1936. The Canaanite god Hauron. *American Journal of Semitic Languages and Literatures*, **53**, 1–12.

Albright, W., 1938. *The Excavation of Tel Beit Mirsim II: The Bronze Age.* American Schools of Oriental Research, New Haven.

Albright, W., 1943. *The Excavation of Tell Beit Mirsim III: The Iron Age.* American Schools of Oriental Research, New Haven.

Albright, W., 1957, *From the Stone Age to Christianity.* 2nd ed., Doubleday, Garden City.

Albright, W., 1968. *Archaeology and the Religion of Israel.* 5th ed., Doubleday, Garden City.

Amiran, R., 1970. *Ancient Pottery of the Holy Land.* Israel Exploration Society, Jerusalem.

Bass, G., 1986. A bronze age shipwreck at Ulu Burun (Kas): 1984 Campaign. *American Journal of Archaeology*, **90**, 269–296.

Bonfil, R., 1997. Analysis of the temple. In: A. Ben-Tor, R. Bonfil, Y. Garfinkel, R. Greenberg, A. Maeir and A. Mazar, *Hazor V.* Israel Exploration Society, Jerusalem, pp. 85–101.

Bourke, S., 1997. Pre-classical Pella in Jordan: a conspectus of ten year's work (1985–1995). *Palestine Exploration Quarterly*, **129**, 94–115.

Bourke, S., Sparks, R., Sowada, K. and Mairs, L., 1994. Preliminary report on the fourteenth season of excavation by the University of Sydney at Pella in Jordan. *Annual of the Department of Antiquities Jordan*, **38**, 81–126.

Bourke, S., Sparks, R., Sowada, K., McLaren, P. and Mairs, L., 1998. Preliminary report on the University of Sydney's sixteenth and seventeenth seasons of excavations at Pella (Tabaqat Fahl) in 1994/95. *Annual of the Department of Antiquities Jordan*, **42**, 179–211.

Bourke, S., Sparks, R. and Mairs, L., 1999. Bronze age occupation on Tell Husn (Pella): report on the University of Sydney's 1994/95 field seasons. *Mediterranean Archaeology*, **12**, 51–66.

Bourke, S.J., Sparks, R., McLaren, B., Mairs, L., Meadows, J., Reade, W., Sowada, K. and Hikade, T., 2003. Preliminary report on the University of Sydney's eighteenth and nineteenth seasons of excavation at Pella (Tabaqat Fahl) in 1996/97. *Annual of the Department of Antiquities Jordan*, **47**.

Bull, R., 1960. A re-examination of the Shechem temple. *Biblical Archaeologist*, **23**, 110–119.

Cahill, J., Lipton, G. and Tarler, D., 1987. Tell el-Hammah, 1985–1987. *Israel Exploration Journal*, **37**, 280–283.

Clayden, T., 1998. Faience buckets. *Baghdad Mitteilungen*, **29**, 47–80.

Coogan, M., 1987. Of cults and cultures: reflections on the interpretation of archaeological evidence. *Palestine Exploration Quarterly*, **119**, 1–8.

Dever, W., 1983. Material remains and the cult in ancient Israel: an essay in archaeological systematics. In: C. Meyers and M. O'Connor (eds), *The Word of the Lord Shall Go Forth: Essays in Honor of David Noel Freedman.* Eisenbrauns, Winona Lake, pp. 571–587.

Dever, W., 1984. Asherah, consort of Yahweh: new evidence from Kuntillet 'Ajrud. *Bulletin of the American Schools of Oriental Research*, **255**, 21–37.

van Dijk, J., 1989. The Canaanite god Hauron and his cult in Egypt. *Gottinger Miszellen*, 107, 59–68.

Dothan, T., 1982. *The Philistines and their Material Culture.* Israel Exploration Society, Jerusalem.

Dothan, M. and Porath, Y., 1982. *Ashdod IV: Excavation of Area M., 'Atiqot 15.* Israel Antiquities Authority, Jerusalem.

Dothan, M. and Porath, Y., 1993. *Ashdod V: Excavation of Area G., 'Atiqot 23.* Israel Antiquities Authority, Jerusalem.

Edwards, P. and Macumber, P., 1995. The last half million years at Pella. In: S. Bourke and J-P. Descoeudres (eds), *Trade, Contact and the Movement of Peoples in the Eastern Mediterranean: Studies in Honour of J.B. Hennessy.*, Mediterranean Archaeology (Sydney), pp. 1–14.

Eisenberg, E., 1977. The temples at Tell Kittan. *Biblical Archaeologist*, **40**, 78–81.

Eshel, I. and Prag, K. (eds), 1995. *Excavations by K.M. Kenyon in Jerusalem 1961–1967: The Iron Age Cave Deposits on the South-East Hill and Isolated Burials and Cemeteries Elsewhere.*, Oxford University Press, Oxford.

Fowler, M., 1986. A closer look at the "Temple of El-Berith" at Shechem. *Palestine Exploration Quarterly*, **118**, 49–53.

Fleming, D.E., 1992. The rituals from Emar: evolution of an indigenous tradition in second millennium Syria. In: M.W. Chavalas and J.L. Hayes (eds), *New Horizons in the Study of Ancient Syria.* Undena Publications, Malibu, pp. 51–61.

Franken, H., 1992. *Excavations at Tell Deir 'Alla. The Late Bronze Age Sanctuary.* Peeters, Louvain.

Guy, P.L.O., 1938. *Megiddo Tombs.* The Oriental Institute, Chicago.

Harif, A., 1981. Common architectural features at Alalakh, Megiddo and Shechem. *Levant*, **13**, 162–167.

Herzog, Z., Rapp, G. Jr. and Negbi, O., 1989. *Excavations at Tel Michal, Israel.* Institute of Archaeology, Tel Aviv.

Hess, R., 1989. Cultural aspects of onomastic distribution in the Amarna texts. *Ugarit Forschungen*, **21**, 209–216.

Hess, R., 1997. Hurrians and other inhabitants of late Bronze Age Palestine. *Levant*, **29**, 153–156.

Higginbottom, C., 1996. Elite emuation and Egyptian governance in Ramesside Canaan. *Tel Aviv*, **23**, 154–169.

James, F. and McGovern, P., 1993. *The Late Bronze Egyptian Garrison at Beth Shan: A Study of Levels VII and VIII.* University of Pennsylvania Museum, Philadelphia.

Kelm, G. and Mazar, A., 1995. Timnah: A Biblical City in the Sorek Valley. Eisenbrauns, Winona Lake.

Klengal, H., 1992. *Syria 3000 to 300 B.C.* Akademie Verlag, Berlin.

Lamon, R. and Shipton, G., 1939. *Megiddo I. Seasons of 1925–34. Strata I-V.* The Oriental Institute, Chicago.

Lewis, T., 1996. The identity and function of El/Baal Berith. *Journal of Biblical Literature*, **115**, 401–423.

Loud, G., 1948. *Megiddo II. Season of 1935–39. Strata VI-XX.* The Oriental Institute, Chicago.

May, H., 1935. *Material Remains of the Megiddo Cult.* The Oriental Institute, Chicago.

Mazar, A., 1980. *Excavations at Tell Qasile.* The Hebrew University, Jerusalem.

Mazar, A., 1992. Temples of the Middle and Late Bronze Ages and the Iron Age. In: A. Kempinski and R. Reich (eds), *The Architecture of Ancient Israel.* Israel Exploration Society, Jerusalem, pp. 161–187.

Mazar, A., 1999. The 1997–1998 excavations at Tel Rehov: preliminary report. *Israel Exploration Journal*, **49**, 1–42.

McGovern, P., 1985. *Late Bronze Palestinian Pendants. Innovation in a Cosmopolitan Age.* Journal for the Society of the Old Testament, Sheffield.

McNicoll, A., Smith, R. and Hennessy B., 1982. *Pella in Jordan 1.* Australian National Gallery, Canberra.

McNicoll, A., Edwards, P., Hanbury-Tenison, J., Hennessy, J., Potts, T., Smith, R., Walmsley, A. and Watson, P., 1992. *Pella in Jordan 2.* Mediterranean Archaeology, Sydney.

Michele Daviau, P., 2001. Family Religion: Evidence for the Paraphernalia of the Domestic Cult. In: P. Michele Daviau, J. Wevers and M. Weigl (eds), *The World of the Aramaeans II*, Journal for the Study of the Old Testament, Sheffield, pp. 199–229.

Magness-Gardiner, B. and Falconer, S., 1994. Community, polity and temple in a Middle Bronze Age Levantine village. *Journal of Mediterranean Archaeology*, **7**, 127–164.

Na'aman, N., 1994. The Hurrians and the end of the Middle Bronze Age in Palestine. *Levant*, **26**, 175–187.

Oren, E.D., 1997. The "Kingdom of Sharuhen" and the Hyksos Kingdom. In: E. Oren (ed.), *The Hyksos: New Historical and Archaeological Perspectives.* University of Pennsylvania Museum, Philadelphia, pp. 253–83.

Parker, B., 1949. Cylinder seals from Palestine. Iraq, **11**, 1–43.

Petrie, W., 1928. *Gerar.* British School of Archaeology in Egypt, London.

Philip, G., 1989. *Metal Weapons of the Early and Middle Bronze Ages in Syria-Palestine.* British Archaeological Reports, Oxford.

Potts, T. F., 1992. The Middle and Late Bronze Ages. In: A.W. McNicoll, P.C. Edwards, J. Hanbury-Tenison, J.B. Hennessy, T.F. Potts, R.H. Smith, A. Walmsley and P. Watson (eds), *Pella in Jordan 2.* Mediterranean Archaeology, Sydney, pp. 40–81.

Pitard, W., 1994. The libation installations of the tombs of Ugarit. *Biblical Archaeologist*, **57**, 20–37.

Pitard, W., 1996. Care of the dead at Emar. In: M.W. Chavalas (ed.), *Emar: The History, Religion and Culture of a Syrian Town in the Late Bronze Age.* CDL Press, Bethesda, pp. 123–140.

Pitard, W., 2002. Voices from the dust: the tablets from Ugarit and the Bible. In: M. Chavalas and K. Younger Jr. (eds), *Mesopotamia and the Bible*, Baker Academic, Grand Rapids, pp. 251–275.

Raban, A., 1991. The Philistines in the western Jezreel Valley. *Bulletin of the American Schools of Archaeological Research*, **284**, 17–27.

Redford, D., 1992. *Egypt, Canaan and Israel in Ancient Times.* Princeton University Press, Princeton.

Renfrew, C., 1985. *The Archaeology of Cult.* British School of Archaeology at Athens, London.

Rowe, A., 1940. *The Four Canaanite Temples of Beth Shan.* University of Pennsylvania Museum, Philadelphia.

Sandars, N., 1978. *Sea Peoples – Warriors of the Ancient Mediterranean 1250–1150 BC.* Thames and Hudson, London.

Smith, R.H., 1973. *Pella of the Decapolis Vol 1. The 1967 Season of The College of Wooster Expedition to Pella.* The College of Wooster, Wooster.

Stager, L., 1999. The fortress-temple at Shechem and the "House of El, Lord of the Covenant". In: P.H. Williams Jr. and T. Hiebert (eds), *Realia Dei: Essays in Archaeology and Biblical Intepretation in Honor of Edward F. Campbell Jr. at His Retirement.* Scholars Press, Atlanta, pp. 228–249.

Stager, L. and Wolff, S., 1981. Production and commerce in temple courtyards: an olive press in the sacred precinct at Tel Dan. *Bulletin of the American Schools of Oriental Research*, **243**, 95–102.

Starr, R., 1937. *Nuzi.* Harvard University Press, Cambridge MA.

Stern, E., 1984. *Excavations at Tel Mevorakh (1973–1976). Part 2: The Bronze Age.* The Hebrew University, Jerusalem.

Singer, I., 1994. Egyptians, Canaanites and Philistines in the period of the emergence of Israel. In: I. Finkelstein and N. Na'aman (eds), *From Nomadism to Monarchy.* Israel Exploration Society, Jerusalem, pp. 282–338.

van der Toorn, K., Becking, B. and van der Horst, P. (eds), 1999. *Dictionary of Deities and Demons in the Bible.* 2nd. edn, Brill, Leiden.

Tubb, J., 2000. Sea peoples in the Jordan Valley. In: E. Oren (ed.), *The Sea Peoples.* University of Pennsylvania Museum, Philadelphia, pp. 181–196.

Tufnell, O., Inge, C. and Lankester Harding, G., 1940. *Lachish II. The Fosse Temple.* Oxford University Press, London.

Wapnish, P. and Hesse, B., 1991. Faunal remains from Tel Dan: perspectives on animal production at a village, urban and ritual center. *Archaeozoologia*, **4**, 9–86.

Weinstein, J., 1981. The Egyptian empire in Palestine: a reassessment. *Bulletin of the American Schools of Oriental Research*, **242**, 1–28.

Werner, P., 1998. *Tall Munbaqa: Bronzezeit in Syrien.* Hamburg Museum for Archaeology, Neumünster.

Wimmer, S., 1990. Egyptian temples in Canaan and Sinai. In: S. Groll (ed.), *Studies in Egyptology Presented to Miriam Lichtheim.* The Hebrew University, Jerusalem, pp. 1065–1106.

Wimmer, S., 2000. El, Mekal and Ramses: the statue from Beisan again. *Journal of Palestinian Archaeology*, **1**, 32–35.

Yadin, Y., Aharoni, Y., Amiran, R., Dunayevsky, I. and Perrot, J., 1958. *Hazor I.* Israel Exploration Society, Jerusalem.

Yadin, Y., Aharoni, Y., Amiran, R., Dunayevsky, I. and Perrot, J., 1960. *Hazor II.* Israel Exploration Society, Jerusalem.

Yadin, Y., Aharoni, Y., Amiran, R., Dunayevsky, I. and Perrot, J., 1961. *Hazor III-IV. The Plates.* Israel Exploration Society, Jerusalem.

Yadin, Y., Aharoni, Y., Amiran, R., Dunayevsky, I., Perrot, J. and Ben-Tor, A., 1989. *Hazor III-IV. The Text.* Israel Exploration Society, Jerusalem.

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(Manuscript received 01.06.2004)

Journal & Proceedings of the Royal Society of New South Wales, Vol. 137, p. 33–42, 2004
ISSN 0035-9173/04/010033–10 $4.00/1

Presidential Address delivered before The Royal Society of New South Wales on 7th April, 2004

2021

KARINA KELLY

Abstract: The Royal Society of New South Wales was first founded in 1821 as the Philosophical Society of Australasia. At that time New South Wales encompassed the states of Queensland, NSW, Victoria and Tasmania as well as New Zealand. The Society has had a rich and interesting history and is the oldest scientific society in Australia. Founded by interested amateurs, the Society has had some interesting and influential members over the last one hundred and eighty three years. This paper documents some of the history of the Society and also speculates on where science of the present day and the Royal Society of New South Wales may be headed in the future.

Keywords: Royal Society of New South Wales, NSW History, Science History, Australian Science

THE EARLY SOCIETY

I wish to acknowledge that we are here today on the land of the Gadigal people, part of the Eora Nation. We pay tribute to the Gadigal people, to their traditions and to the memory of their ancestors. It is right and just to acknowledge the people whose country this is, who have held it in trust for so long, and who now share it with all of us.

I have called this talk *2021* because in that year our Society will have its 200th birthday. It gives me the opportunity to look back at our beginnings and forward to our future. While 200 years is a very short time in comparison with the many thousands of years this country has been occupied by its original inhabitants, it is almost all of the time that Europeans have been living here.

1821 was the year of the formation of the *Philosophical Society of Australasia.* Therefore, this is our Society's 183rd Anniversary. In 1821, the colony was 33 years old.

Let me try to paint a picture of what it was like. New South Wales *was* Australasia at that time. It included the areas that would become Tasmania (in 1825), South Australia (in 1836), New Zealand (in 1841), Victoria (in 1851) and Queensland (in 1859). At this time, the word of the Governor of NSW was law. The Legislative Council, the forerunner to the State Parliament of NSW, was yet to be formed. The colony had just come to the end of eleven years of fairly stable governance by Major General Lachlan Macquarie who had undertaken a major building program with the help of his favourite architect, Francis Greenway. Blaxland, Lawson and Wentworth had crossed the Blue Mountains for the first time in 1813 with a road being built over the mountains in 1815, opening up huge areas to the west of the mountains to European settlement. This paved the way for the Gold Rushes of the early 1850s that brought with them a dramatic increase in population.

In 1821, a full census of the population was yet to be done. The first, called "the muster", was held in 1828 and found that the colony had 36,598 people. "People" meant Europeans. Aborigines were not counted in official figures until 1971! Only one in 15 of those counted was free or had been born in the colony – the vast majority were convicts.

And convicts were still being sent. Transportation would only finally come to an end –

after much agitation by the settlers of NSW – in 1848.

In 1821, the Sydney Herald was still ten years from being started. It would become the Sydney Morning Herald in 1842. The Australian Museum, first known as the Colonial Museum, did not open its doors until 1827, six years after the formation of our Society. The flag, the NSW Ensign, would not be designed for another 11 years. It dates to 1832.

There were only 10 original members of our Society and these were interested amateurs rather than professional scientists. They met in turn in each other's houses to discuss the latest ideas and to lend each other books. The first President of the Philosophical Society of Australasia was the sixth Governor of New South Wales, Major General Sir Thomas Brisbane, who was a keen stargazer and a graduate of the University of Edinburgh. He brought with him the latest astronomical equipment and a professional astronomer, the appropriately named Dr Charles Stargard Rumker (Elkin 1968). In fact Brisbane was so keen he established, at his own expense, an observatory at Parramatta and from 1822 meteorological observations were also recorded – the first systematic land-based observations carried out in the new Colony.

Another of the founding members of the Philosophical Society of Australasia was Henry Grattan Douglass, M.D. In 1848, he convinced F.L.S. Merewether and W.C. Wentworth (the same Wentworth who had first crossed the Blue Mountains) to support his idea for a University in Sydney and by 1850 the first Senate of the University had been appointed and Douglass was a member. In fact, his coat of arms was one of ten carved at the eastern end of the Great Hall of Sydney University. Douglass was a man who got things done.

It was clear that the Society needed him. Unfortunately the Philosophical Society of Australasia broke up amid political bickering in 1822. It was Douglass who managed to revive it in 1850 with the help of Dr Alexander Berry after whom the NSW south coast town of Berry is named. Berry had been on the Council of the earlier Philosophical Society of Australasia and agreed to join Douglass on the Council on the revived *Australian Philosophical Society.* Berry was probably Australia's first millionaire; his estate at the time of his death in 1873 was worth one and a quarter million pounds Sterling, a tidy sum in those days. A member of the Legislative Council from 1829 until 1861, he was a medical graduate of the Universities of Edinburgh and St Andrews. His bequest is believed to have saved St Andrews (recently attended by Prince William) from financial ruin. He also left money for the town of Berry to build a hospital.

So, thirty years after the founding of the original Society came its rebirth. The population of the colonies had dramatically increased. There were now 8 times as many people and some 44,000 of them lived in Sydney. The British Parliament had given the Australian colonies self-government. With all these changes, the society changed its name again, to *The Philosophical Society of New South Wales*, in 1855. The Reverend W.B. Clarke, one of Australia's greatest geologists and Vice President of the Society from 1856–67, had hoped to get more members from the wider community but had given up on "persons whose leisure is generally given to the frivolities of ephemeral excitement, or whose mental occupation is only exercised by sensational novels" (Elkin 1968). Some things never change.

Clarke thought that the name "Philosophical" may have been one of the reasons why they were not attracting more members. Thus Queen Victoria's sanction was sought to change the Society's name yet again to The Royal Society of New South Wales and this occurred at the end of 1866. In the course of 45 years, the Society had had four different names.

W.B. Clarke was determined to find a home for the Society. "A home for meetings and for the library and not be like dwellers in the desert living in tents, without a spot of earth to call our own" (Elkin 1968). In the year of his death, the Society bought its first home "Elizabeth House" at 5 Elizabeth Street. Incorporation followed in 1881.

One of the great pioneers of aviation, Lawrence Hargrave, became a member of the Royal Society of New South Wales in 1877. There were three underlying aeronautical concepts in the first successful aircraft that Hargrave had developed. These were the cellular box-kite wing, the curved wing surface, and the thick leading wing edge or aerofoil (Naughton 2003). He published his papers in the *Journal and Proceedings of the Royal Society of New South Wales* between 1884 and 1909. Hargrave was recognised by the French working in the field – indeed when Gabriel Voisin built the first commercially available aircraft based on the stable lifting surfaces of Hargrave's box kites, he called them "Hargraves".

Hargrave believed in the free interchange of ideas and so never patented any of his designs. He noted "Workers must root out the idea that by keeping the results of their labours to themselves a fortune will be assured to them. Patent fees are so much wasted money. The flying machine of the future will not be born fully fledged and capable of a flight for 1000 miles or so. Like everything else it must be evolved gradually. The first difficulty is to get a thing that will fly at all. When this is made, a full description should be published as an aid to others" (Chanute 1893).

By 1892 Hargrave made known his opposition to connecting flying machines to dynamite missiles. His views about the peaceful promulgation of knowledge were so strict that only one Museum met his conditions and so the Deutsches Technological Museum in Munich received 176 of Hargrave's working models. It is a sad irony that most of them were destroyed during the Allied aerial bombardment of Germany during World War II (Naughton 2003).

He also speaks of the difficulty true visionaries have in convincing the broader community that they are not crazy. "The people of Sydney who can speak of my work without a smile are very scarce; it is doubtless the same with American workers. I know that success is dead sure to come and therefore do not waste time and words in trying to convince unbelievers" (Chanute 1893).

Professor Archibald Liversidge was a powerful driving force for the Society for the last quarter of the 19^{th} century. It was he who suggested a federation of the scientific bodies that existed in Australia. Called the Australasian Association for the Advancement of Science, it was formed in 1888 and in 1930 became ANZAAS with the addition of New Zealand.

In his prophetic address to the Society in 1901, Liversidge proposed an organization rather like the prestigious Scientific Academies of Europe. The place for such an Academy would be the nation's capital when it was chosen. This became the Academy of Science in 1955. In the same address, Liversidge suggested that we should adopt the metric system of weights and measures and make our currency metric (he suggested we call the new denomination the "Victoria") and argued its introduction would save our children a year or two of school time which could be devoted to modern languages, elementary science and English composition (Elkin 1968).

At the turn of the last century, several members of *The Royal Society of NSW* were lamenting that politicians and the public did not appreciate the contribution made by scientists – just as they do today. Mr C.O. Burge warned in 1904 that we should emulate Germany in promoting science and technical education or, he warned, we would be "rudely awakened from self complacency by some crushing loss in trading or in war." Ten years later, the war came and we discovered that we had become dependent on Germany for fundamental materials. Realising how much a country relies on its scientific research, the Australian National Research Council was formed in 1919 and the CSIR (the Council for Scientific and Industrial Research) in 1920. Members of our Society were crucial to their formation.

THE FIRST ROYAL SOCIETY

The Royal Society in Britain, on which our Society is modelled, is one of the most influential scientific bodies in the world. It was the first society to be given Royal patronage, which is why there is no other identifying name. This honour was bestowed by the newly restored monarch, Charles II, in 1661. The Royal Society was based on the ideas of Sir Francis Bacon who was Lord Chancellor under King James I some fifty years earlier.

When he wasn't being Lord Chancellor, Bacon was an essayist. He argued eloquently for a major shift in the way science was done and seen to be done. He wrote about the "new" scientist because he wished to distance science from the old science of alchemy. The alchemists wanted to change base metals into gold. Some wanted to create a tiny human like Tom Thumb, called an homunculus. These people, Bacon argued, were not using observation and objectivity as the basis for their work. This was the great push towards empirical science which some have argued led to a massive expansion of scientific endeavour and the blossoming of British science. Bacon's ideas were to become the foundation stones of the Royal Society.

Bacon argued that far from setting themselves above God, the "new" scientists were working to uncover the greatness of God. This helped them avoid the wrath of the all-powerful church, at least in part.

Perhaps most interestingly, he argued for a change in attitude from the scientists themselves. "For men have entered into a desire of learning and knowledge, sometimes upon a natural curiosity and inquisitive appetite; sometimes to entertain their minds with variety and delight; sometimes for ornament and reputation; and sometimes to enable them to victory of wit and contradiction; and most times for lucre and profession; and seldom sincerely to give true account of their gift of reason to the benefit and use of men" (Bacon 1605).

These words, though archaic, still have great relevance to the role of scientists today. How much of our scientific research is aimed at producing commercially successful products? How much is directed at benefiting humanity? Again Bacon writes:

"Lastly I would address one general admonition to all; that they consider what are the true ends of knowledge, and that they seek it not wither for pleasure of the mind, or power or any of these inferior things; but for the benefit and use of life; and that they perfect and govern it in charity" (Bacon 1620).

Sadly, Bacon paid the ultimate price for his belief in observational science. In March, 1626 while driving near Highgate, he decided to conduct an experiment on meat to see if reducing its temperature slowed down the meat's decay. So he bought a fowl and stuffed it with snow. However, in the process, he caught a cold, developed bronchitis and died on April 9^{th}. While that experiment could not have benefited Bacon less, it had the potential to benefit mankind as a whole, although modern refrigeration had to wait several hundred years to come to fruition.

THE PROGRESS OF SCIENCE

We pay lip service to the sentiments of Bacon here at the beginning of the 21^{st} Century – we have ethics committees and departments of History and Philosophy of Science but in reality how much do we really encourage independent thought and altruistic research? Scientists, unless blessed with independent wealth, have always needed support or patronage. For the great astronomer Galileo Galilei, it was Cosimo II, Grand Duke of Tuscany and his Medici family. For Sir William Herschel, who discovered the planet Uranus, it was King George III of England.

By the middle of the Twentieth Century, most of the world's scientists were employed by governments, many of whom upheld the independence of these scientists merely by supporting them with salaries and research funds. Here in Australia, our democratically elected governments set the priorities for our tax-funded scientific research institutes. Hence it was the

Australian public that decided what we wanted our scientists to investigate. As a result, scientists at the CSIRO were among the most trusted members of our society. We knew that they were independent of commercial interests because we paid them to find the truth. They had no need to conceal from us what they had found. As Sir Isaac Newton wrote very early in his scientific career, "Plato is my friend, Aristotle is my friend, but my best friend is truth". Newton was able to be independent. His work was supported by a Fellowship at the University of Cambridge.

You may know that the CSIRO, our government research organisation, is now mostly required to raise 30 percent of its funding from "outside sources". If they enter into an agreement with a private company in order to obtain that 30%, they can be subject to confidentiality agreements that make the substance of their work unavailable to the public and also to the broader science community. Fair enough, you might say, the company is paying good money for the research – 30% to be exact. But who is paying the remaining 70%? We, the taxpayers of Australia are. And yet we have no say about which research is to be done and may have no access to the results when it is completed. Does this seem like a sensible way for us to invest our money? Does it seem like a way to direct our scientific endeavours in order to answer the big questions? Where do we come from? What exists at the far reaches of the universe? How do our brains and bodies work? Are there really many universes? How best can we fight disease?

After atomic bombs were dropped on the Japanese cities of Hiroshima and Nagasaki to end the Second World War in 1945, we came to realise that scientific research can produce great destructive power. The Cold War that followed saw an alarming stockpiling of Nuclear Weapons which had the world afraid for decades that it would blow itself up. Despite that, no major conflagration occurred and the aggression and competitiveness between the world's two greatest powers was diverted at least in part into the space race. In order to prove itself as competent as the USSR – which had already launched the sputnik – the United States declared it would be the first to land a man on the Moon. The competitiveness of the two nations was diverted to something that had many scientific spin-offs and inspired everyone on Earth. We were now truly in the space age. There was nothing we couldn't do if we set our minds to it and gave the problem adequate resources.

Landing people on the Moon was not something that could happen by chance. Market forces would never have made it happen. It did not make large profits for those who undertook it. But it did pay dividends because it inspired all of the Earth's people. Anyone old enough to remember the first moon landing of Neil Armstrong and Buzz Aldrin on 20th July, 1969 can tell you where they were when it happened. How often is the whole of humanity united like this in wonder? Certainly, it was a propaganda exercise and the role of the USSR in being the first to launch a satellite and first to put a person into orbit was downplayed in the West. Despite that, it was a high point for humanity. It may even be that those images of the Earth as seen from the Moon changed us philosophically. We could not help but see a beautiful but lonely little planet floating precariously in the vast reaches of space, a powerful image for those arguing for greater protection of the Earth's environment.

If we compare the space race of the late 1960's with the way the West is spending its resources now, what do we find?

◇ A "War on Terror" which we are fighting without really knowing who the enemy is or where they are. The uncertainty of this "war" could see us spend far too much on security measures without ensuring our safety, money that could otherwise be spent on the hospitals, schools and public transport so desperately in need of resources.

◇ A War on Iraq because the dictator in charge had "weapons of mass destruction". Despite much searching, these weapons have not been found.

◇ A new Star Wars program aimed at shooting

down missiles within minutes of their launch, a program regarded by many as technically unfeasible.

So, in the world's most powerful nation, the United States, we see public funding of scientific research being increasingly diverted into secretive and aggressive programs. How will these projects benefit and inspire mankind? How will people interpret this trend in the future? Not favourably, is my guess. One might even conclude that we are entering a "New Dark Age".

This is an age where maintaining loyalty to a company or organization is more important than truth and objectivity. Our scientific objectives are being dictated by a desire for profit rather than the wellbeing of humanity. Through restricting research funding and salaries and increasing teaching hours we have reduced the effectiveness of our academics as leading independent thinkers in our community. In my opinion, a community that cannot "afford" to support people who think differently, who are independent of the most powerful forces in the land, is not a civilized community. A community that does not adequately support an independent public broadcaster is not a civilized community. If you grind down Australia's academics, its independent journalists and those who do not agree with the status quo, you grind away at the sophistication and humanity of our society.

With the downsizing of government in the last few decades, we have seen substantial changes in the way science is done in this country. Scientists, once held in the highest regard by the community, are no longer so revered. Many, in order to maintain support for their work, have thrown their lot in with commercial interests. Sometimes this has worked out well, but sometimes it hasn't. The community knows that there are scientists who still maintain, against the evidence of thousands of other scientists, that human-induced global warming is not happening. There are, as well, scientists who have argued against the detrimental health effects of smoking tobacco.

By throwing their lot in with the money makers, scientists have become partisan. By signing confidentiality agreements, they can no longer publish and inform their fellow scientists of the work they have done. New ideas stay in limbo – perhaps to be re-invented by someone else. Work may be duplicated or lost because of this secretive behaviour. The *efficient* functioning of our scientific research and the dissemination of new ideas can be compromised and I use the word *efficient* deliberately. By representing itself so often as a means to making money, science has lost the moral and philosophical high ground. The reason for science is not to make money. The reason for science is to help us understand the world and ourselves and so to better serve humanity, the animal world and the environment generally.

Our mania for commercialisation is causing great damage to science. We have told ourselves that by reducing the size of government, we can operate more efficiently. The argument is that we need to reduce government, because private companies can provide services more efficiently than government departments. How do they do this? They can in part by being lean and less bureaucratic, partly because the companies are smaller and employees are not as able to form powerful unions to demand better pay and working conditions. Partly, perhaps, these companies are not as answerable to the public about the way they treat their workforce.

The private company may well be more *efficient* than the government department it has replaced, but there is an underlying philosophical problem with this solution. The two entities, the government department and the private company, do not exist for the same reason. The company exists to make money for its owners. Profit taking is its primary function. The government department exists to provide a service to its owners and these are the people who elect the government – the broader community.

How have we got to the stage where we believe *efficiency* is more important than *intention*? Is it better to be an *efficient* housebreaker than an *inefficient* locksmith? Why have we concluded that those who are inefficient should

sink rather than being taught how to swim or given floatation devices? Is it that we think only the fit should survive? And where has this philosophy come from? Perhaps it came from one of the greatest natural scientists of them all – Charles Darwin. Have we become so imbued with the theory of evolution that we believe we should apply it to human society? Has Darwin made us believe that society is a jungle and one must fight to survive?

It seems to me ironic that we are clinging to this misapplication of evolutionary theory at a time when we are doing our best to cheat evolution anyway. IVF is making men and women fertile who otherwise would not have been, and it's a good bet that many IVF babies will also need technological assistance when they want to reproduce. In addition, the human genome project and its discovery of thousands and thousands of human genes has got us thinking about how we can do gene therapy – fix up those little mis-prints in the Book of Life. Is the selfish gene teaching us what the economic rationalists would also have us believe – that altruism is good, but it isn't how the world works? People are basically selfish, but what if that proposition is not true? What does telling people it is true do to them? Matt Ridley in his The Origins of Virtue writes, "If people are not rational maximizers of self-interest, then to teach them that such behaviour would be logical is to corrupt them" (Ridley 1996).

The "Prisoners Dilemma" is the most famous game in the new mathematical discipline called Game Theory. It's all about lying and cheating versus co-operation and the calculations that go on in our heads about which is the best tactic. Life would certainly be a lot simpler if everyone told the truth. We wouldn't need the police, most of the tax office, or the legal profession. Think what it would save us!

The Prisoner's Dilemma applies wherever there is a conflict between self-interest and the common good. The classic scenario goes like this. Two prisoners are held on charges of a crime they are accused of having committed together. Each prisoner has two choices – either testifying against the other (and so reducing his own sentence) or keeping his mouth shut. If he says nothing, one of two things will happen to him, depending on what the other prisoner does. If his fellow prisoner also keeps quiet, both of them would be convicted on a lesser charge or set free due to lack of evidence (and this is the best outcome for the two of them). If he says nothing and the other prisoner "defects", and pins the crime on him, then he will have been cheated and end up worse off, serving a longer sentence for the crime. But if he "defects" and tells the tale on his partner, then he can ensure that the worst scenario doesn't happen to him. In most cases, the argument goes, people defect because they don't believe that the other person is to be trusted.

This cheery little branch of mathematics was created in the middle of last century and one of its practitioners was John Nash, the Princeton mathematician who won a Nobel Prize in Economics for it in 1994, but perhaps more famously was portrayed by Russell Crowe in the Hollywood film, *A Beautiful Mind.*

Cornell University Professor Robert Frank conducted a series of human experiments to further explore the Prisoner's Dilemma. He wanted to know if all people made the assumption that the other person is not to be trusted. Was this human nature or was it cultural? What he found was indeed enlightening. Using the resource closest to him, the University's students, he put students from different disciplines through the tests. Were the proportion of cynics and altruists the same? They were not. Economics students, indoctrinated with modern economic theory were much more likely to defect than astronomy students (Frank 1988). It seems that if you believe that "greed is good" and people are bad it becomes a self-fulfilling prophecy.

Ridley makes the point that, evolutionarily, it makes sense to admire and advocate "virtuous" behaviour such as dying for your country because it's good for the tribe or community as a whole. It's good to *advocate* it but not necessarily to *do* it yourself. So how do we get

people behaving in a co-operative and trusting manner? Ridley believes human beings, for the most part do – that we distinguish ourselves from other animals because of our "groupishness". We co-operate closely with people who do not share our genes. He argues if you pit one group of people where everyone is out to help only themselves against another group of people where there is a culture of trust, then the trusting group will win.

But we have created a society where we do not co-operate, and yet it is our ability to co-operate which has got us where we are. We wouldn't have lasted long hunting big game without it. Co-operation and trust within a community will help that community survive longer than one where all the individuals are pitted against each other. The alarming rises in health costs have been brought about largely by skyrocketing insurance premiums for doctors. And of course the insurance premiums have gone up ten or twenty times in some cases because so many of us are suing our doctors. It's a perfect example of non-cooperation damaging the community as a whole.

Adam Smith, one of the founders of modern economics, knew that economic life couldn't be separated from the habits, customs and morals of the society in which it occurs. He knew that it operated against a backdrop of culture. This is also true of technological and scientific innovation. Our culture is much more than the marketplace. If the choice is between finding the gene for obesity in humans in order to sell a weight-loss cure, and developing a vaccine for malaria, one would be more lucrative and the other would be more socially important. As a community then, we would choose the vaccine, but as shareholders we could very well urge our company to choose the weight-loss cure. Our primary objective as a community is not to make money. There are grander and more inspiring things for us to do. But from where should we get our inspiration?

Quite often it will come from the imagination of the writers of fiction, those who allow their imaginations freer reign than the rest of us. Jules Verne was a master of technological prediction. His stories of travel to the Moon may well have inspired the boys and girls who later made it fact. He predicted submarines, helicopters and calculators. He also wrote (Evans 1995) an unpublished novel called *Paris in the 20th Century*, which was completed in 1863, but only uncovered by Verne's great grandson in 1989 and recently translated into English. Verne's 20th Century Paris has skyscrapers of glass and steel, high-speed trains, cars that run on petrol, fax machines and a global communications network. He's out by a few decades on some of it since he's describing Paris in 1960 but it's still very impressive.

But, unlike most of his pro-progress novels, *Paris in the 20th Century* is a tragedy where Verne laments that art, literature and music have either disappeared or become only utilitarian, where education is for vocational purposes only and women dress like men. This is a place where multinational companies hold the real political power and electricity illuminates the streets and commercial advertising, but is also used for executions. The novel does not have a happy ending.

Verne's publisher Pierre-Jules Hetzel refused the manuscript. He wrote "My dear Verne, even if you were a prophet, no one today would believe this prophecy . . . they simply would not be interested in it" (della Riva 1994).

So, what am I saying with all this social science and fiction? I'm saying that the future of technology and our scientific endeavour is far too important to be left only to market forces. We must decide as a community what we want. We must learn again how to prioritise. We won't always get it right but we must try. The free market is a good way of making sure that we get fresh carrots and zucchinis at the right price but it cannot help us decide how to deal with Aboriginal health, our homeless or our prisoners. As Charles Handy writes, "The market is a mechanism for sorting the efficient from the inefficient, it is not a substitute for responsibility" (Handy 1995). We cannot expect the market to provide us with a vision of the future, or to help

us decide what sort of future we want.

I'll give you an example of where things didn't go the way they should have. Barry Marshall and his colleagues at the Royal Perth Hospital found that stomach ulcers were caused not by acid in the stomach but by a bug called *Helicobacter pylori*. At the time, drug companies were selling the most lucrative pharmaceutical agents in the world – H2 receptor blockers. The beauty of these drugs was that the patient had to keep taking them for life! It was a gold mine. Then Barry Marshall claims he can cure ulcers with old drugs – out of patent (and therefore able to be produced by any company). The silence from the drug companies was deafening. It took years for the research to be completed, because no one would fund the research. Eventually Marshall and his colleagues were heard but it took far longer than it should have.

I sometimes wonder if we have also been guilty of selling science as something that provides certainty in this troubling and uncertain world. Perhaps we should hand that one back to the bishops and rabbis and mullahs. Science does not provide certainty and the great discoveries bring with them even more questions. Sometimes great "truths" are found to be untrue. Science is exhilarating precisely because it keeps challenging us and surprising us with its answers. Think about the last few decades. So many of the things we've held to be true have been found not to be.

◇ Chocolate and red wine are *not* bad for you (in moderation).

◇ The majority of physicists now believe in a myriad of universes – not just one.

◇ Low fat, high carbohydrate diets are *not* good for you.

◇ Women are *not* born with all their eggs, it seems they make them throughout their lives.

◇ The expansion of the Universe is speeding up, *not* slowing down.

Yet in order to make a breakthrough a researcher needs to believe with tremendous conviction that they are right. It is so much easier to bring something down than it is to create something new. The culture of science - that one must abide by the rules of experimental objectivity, that one must listen to the evidence - is crucial to its working efficiently. It's hard enough for scientists to fight their own emotional attachment to ideas. If they also have to fight the company they work for because what they've found might threaten profits, they may be overwhelmed.

THE FUTURE

When we dream of the future what do we see? I can't hope to match the vision of Jules Verne but I can imagine a society a hundred years hence – perhaps 2121 when our society will be celebrating 300 years of existence – when our attitude to animals and our consumption of them as meat will be seen as barbaric. As barbaric as we now find the use of the rack, the thumbscrew and burning at the stake. A form of meat might still be eaten in the future and enjoyed even more because it will come without guilt. Grown in vats, no sentient will be killed to provide it. Our belief in the market as a way of organising society will be laughed at as being naive and unsophisticated, like an adolescent who has great skill with computer programming but not the faintest idea what to do with it.

What's next in science and technology very much depends on us. We must decide on what sort of a future we want. Just as Jules Verne inspired young men and women to take us to the moon, the vision must come first. Once we pose the right questions and provide resources to carry out the right research, then science can take us wherever we want to go.

For the Royal Society of New South Wales, the climate in which we operate has changed radically in the last hundred years. We are no longer the place where today's Lawrence Hargrave would publish his findings. There are specialist publications for that.

But the Society has a role to play at the beginning of the 21st Century and it is this. New South Wales needs a Society that overarches all the specialties in science. The specialist societies act as professional bodies for those in the

burgeoning number of science specialties. However, sometimes scientists in different fields approach the same problem from different angles. Sometimes people from outside the field can offer insight that is useful. The Royal Society of New South Wales, Australia's first scientific society, must also return to its roots and be a society open to all who are interested in new ideas, not just professional scientists. In this way, our lectures and discussions can make a substantial contribution to the intellectual life of Sydney and New South Wales. We need to co-operate more with the Royal Societies in other states so that we do not duplicate efforts in areas such as publications. Our joint sponsorship – at New South Wales' instigation – of a Eureka award (worth $10,000) for interdisciplinary science is the first example of what we hope will be further co-operation.

The Council of the Royal Society of New South Wales has accepted a generous offer from the Vice Chancellor of Sydney University, Professor Gavin Brown. We have just taken up residence at 121 Darlington Road as this publication goes to press. I know that the Royal Society of New South Wales will be around to celebrate its Bicentenary in 2021. It may by then have changed its name again, who knows? But our Society has a proud and illustrious history and, I believe, an even greater future.

REFERENCES

Bacon, F., 1605, *The Advancement of Learning*, Book 1, Works 3, p. 294. In: Montague, B., ed., 1850, *The Works of Francis Bacon, Lord Chancellor of England*, Carey and Hart, Philadelphia.

Bacon, F., 1620, *Magna Instauratio*, Preface, Works, 4, pp. 20–21. In: Montague, B., ed., 1850, *The Works of Francis Bacon, Lord Chancellor of England*, Carey and Hart, Philadelphia.

Chanute, O., 1893, *Aeroplanes*, Facsimile reprint (1976) by Lorenz & Herzog, Publishers, Long Beach, CA.

della Riva, P.G., 1994. Préface. In: Verne, J., 1994, *Paris au XXe siécle*, Hachette, Paris, pp. 15–16.

Elkin, A.P., 1968, The challenge to science, 1866; the challenge of science, 1966. In: *A Century of Scientific Progress, The Centenary Volume of the Royal Society of New South Wales*, Royal Society of New South Wales, Sydney.

Evans, A.B., 1995, "Verne: a friend to every boy", *Science Fiction Studies*, **22**, 35–46.

Frank, R.H., 1988, *Passions Within Reason*, Norton, New York.

Handy, C., 1995, *The Empty Raincoat – Making Sense of the Future*, Arrow Books, London, p. 12.

Naughton, R., 2003, The pioneers: Hargrave; Celebrating the Bi-Centennial of Aviation: 1804–2004, http://www.ctie.monash.edu.au/hargrave/hargrave.html, p. 5.

Ridley, M., 1996. *The Origins of Virtue*, Viking, New York, p. 145.

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(Manuscript received 15.06.2004)

Journal & Proceedings of the Royal Society of New South Wales, Vol. 137, p. 43–68, 2004
ISSN 0035-9173/04/010043–26 $4.00/1

Thesis Abstract: The Ecology of Coral Larvae: Settlement Patterns, Habitat Selection and the Length of the Larval Phase

ANDREW H. BAIRD

Abstract of a Thesis submitted for the Degree of Doctor of Philosophy, James Cook University, Townsville, Queensland 2001

Underestimating the capacity of larvae to influence their fate has been a recurrent theme of marine ecology. Consequently, ecologists have focused on post-settlement processes to explain the distribution and abundance of benthic marine organisms. Coral larvae, in particular, are typically viewed as simple organisms with little capacity to control their position in the water column or sense their environment. In this thesis, I demonstrate that coral larval ecology can have a profound affect on adult distributions. Firstly, I examined the depth patterns of coral settlement over a two-year period at four locations around Lizard Island on the Great Barrier Reef. Many taxa showed a pronounced and consistent decline with depth. In particular, settlement of *Isopora* and *Pocillopora* was largely restricted to the reef crest. A similar pattern was evident in the adults of these taxa, suggesting that larvae can recognize and respond to cues from the parental habitat. To test this hypothesis the larvae of six common coral species, with contrasting depth distributions, were introduced into aquaria containing tiles conditioned at a depth of 2 m, 12 m and unconditioned tiles. Larval substratum preferences generally corresponded with those predicted on the basis of the depth distribution of the adults. Zone-specific species showed a clear and pronounced preference for tiles conditioned in the parental habitat. For example, *Goniastrea aspera* a reef-flat species, settled on shallow tiles in densities 4 times greater than on deep tiles. Similarly, *Fungia horrida*, a species locally restricted to deeper water, was 6 times more abundant on deep tiles. These results confirm that the depth distribution of these species is influenced, in part, by patterns established at settlement. Another area where coral larval ecology has been neglected is in investigating the scale of dispersal. To test the likelihood of localised recruitment and the potential of coral larvae for long distance dispersal, I compared the frequency distribution of settlement and the longevity of larvae in four *Acropora* and two faviid corals. Some settlement was record within 4 d of gamete release in all species, indicating a shorter pre-competent period in these species than has been generally accepted. Competence peaked at over 50% of the surviving cohort within 7-10 d after which the proportion competent to settle dropped rapidly in all species except *A. valida* and *A. millepora*, where 50% of the surviving cohort remained competent for over 30 d. Maximum competence periods were 110 d for *A. valida*, 60 d for *A. millepora*, 36 d for *G. retiformis*, 34 d for *A. gemmifera* and *P. daedalea*. These competence periods should produce sufficient gene flow to prevent populations diverging over a wide geographical area. However, larval survivorship was low in all species with less than 50% of larvae alive after 14 d and less than 10% alive after 30 d. Low survivorship combined with a rapid drop in the proportion of larvae competent to settle after two weeks suggests that numbers of migrants are unlikely to be sufficient to sustain population abundance on distant reefs.

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Thesis Abstract: The Molluscan Nudibranch Family Dendrodoridídae (Anthobranchia: Doridoidea) in Australia: Systematics and Phylogenetic Relationships

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Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
James Cook University, Townsville, Queensland 2004

The *Doridoidea* is a very diverse superfamily of marine molluscs, which includes all "dorid" nudibranchs (Gastropoda: Opisthobranchia: Nudibranchia), except the Antarctic *Bathydoridídae*. Three of an estimated twenty-five doridoidean families, including the family Dendrodoridídae, are unusual because its members lack the characteristic molluscan radula or feeding organ. This makes these families very intriguing in an evolutionary sense.

Historically the family Dendrodoridídae consists of two genera, Dendrodoris and Doriopsilla. The putative Australian members of these two genera, many of which have an Indo-west Pacific distribution, have never been systematically examined or reviewed before the current study. This has made both taxonomic and phylogenetic analysis of the family at a broader level difficult. The first aim of this project was to undertake a taxonomic investigation of members of the family Dendrodoridídae in Australia, placing considerable emphasis on internal dissection, microstructural analysis and the examination of type material. This task has never been attempted before, with the relevant literature being scattered throughout publications spanning the last 170 years. In spite of the relative rarity of several of the species studied I was able to collate informative taxonomic data for all of the sixteen previously recorded Australian species.

Twelve species of Dendrodoris and four species of Doriopsilla were confirmed as valid and occurring in Australian waters. Dendrodoris was found to possess well-defined generic features, while each species possessed distinctive characteristics. On the other hand, although Doriopsilla was found to possess several worthy generic features, well-defined species characteristics were lacking, making species identification fraught with difficulty.

The little-known temperate species Dendrodoris maugeana was found to be unique within the dendrodorids examined, possessing a reproductive system quite different from other members of the family. The relatively common species Dendrodoris nigra was also found to be unusual, possessing symbiotic bacteria in its reproductive system; a phenomenon previously unrecognised within any gastropod mollusc. Another new feature found by the present study in several Dendrodoris species was the presence of a very distinct muscular sphincter within the walls of the anal papilla just prior to the anus.

Dendrodoris and Doriopsilla were found to be anatomically different, particularly in the arrangement of the anterior part of the digestive system. Members of Dendrodoris were clearly united by the possession of a ptyaline gland and a uniquely glandular oesophagus while previously undescribed complex notal glands and an anal papilla located to the left of the gill branchia united Doriopsilla. Except for general plesiomorphic features of doridoidean nudibranchs (e.g., dorso-posterior gill position) and adaptations related to feeding method (i.e. a ventral mouth and highly modified digestive system), features that unite these two genera together into a family were lacking.

Another aim of this project was to investigate phylogenetic relationships both within the family Dendrodoridídae and between Dendrodoridídae and other radula-less Doridoidea. Debate has existed as to whether radular loss has

occurred more than once in the doridoidean nudibranchs and thus whether or not radula-less taxa should be grouped together as the infraorder Porostomata. Previous phylogenetic studies involving these groups have given conflicting results, therefore emphasising a need for new character sets.

Thirteen dendrodorids were investigated in detail for the phylogenetic study (10 Dendrodoris and 3 Doriopsilla species) using traditional morphological methods and histological techniques. The histological techniques were used to compare organ microstructure, particularly of glandular tissues. Representative members of the other radula-less doridoidean families (Mandeliidae and Phyllidiidae) and of radula-bearing Doridoidea (including both phanerobranch and cryptobranch taxa) were also investigated as outgroups. The cladistic analyses supported the monophyly of the radula-less Doridoidea (= Porostomata) and therefore a single occurrence of radular loss. However, the family Dendrodorididae (Dendrodoris + Doriopsilla) was found to be polyphyletic and there is little support for its retention as presently constituted.

Three alternatives for a new classification are presented, with the favoured option being an increase in the number of porostome families from three (Phyllidiidae, Mandeliidae, Dendrodorididae) to four, i.e., Phyllidiidae, Mandeliidae, Dendrodorididae (containing only Dendrodoris) and a new family (containing only Doriopsilla). The revised taxa are redescribed based on anatomical features discovered by this analysis.

Vestibular glands in the reproductive system, and notal gland microanatomy in particular, were found to be of considerable phylogenetic value. The present study highlighted the need for histological investigation of such glands, since their positioning within the body wall or connective tissue can cause presence to be overlooked by dissection alone. In light of these results, previously described species will require reinvestigation by histological means before a genuine absence of such characters can be confirmed. The unexpected discovery of mantle dermal formations (MDFs) in the monospecific family Mandeliidae clearly supports its separation from other radula-less taxa. It also highlights the need for a broader study of relationships within Doridoidea, as these highly specialised notal glands have previously been found only in the radula-bearing doridoidean families Chromodorididae and Triophidae.

The current study has provided a substantial amount of new structural information about Dendrodoris and Doriopsilla. A broader investigation of the Doridoidea (a very diverse taxon) is now required to determine more precisely the relationship of these two families, and the Porostomata, to other doridoidean taxa.

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(Manuscript received 20.05.2004)

Thesis Abstract: Environmental Review of the Mary Kathleen Uranium Mine

MARINA THERESE COSTELLOE

Abstract of a Thesis submitted for the Degree of Master of Science
James Cook University, Townsville, Queensland 2003

The major aim of this project has been to investigate the current environmental status of the historic Mary Kathleen mine site including the open pit; D Stockpile, Crusher, Goldings West, West Tip, Southern Tip and North Waste Tip pile; evaporation ponds and tailings dams; tailings dam seepage and Cameron Creek. This study will provide data for an integrated assessment of the site and comparison to current ANZECC water, soil and stream sediment guidelines.

In the Mary Kathleen open pit, skarn type U-Th-REE mineralisation is hosted in amphibolite grade metamorphosed calc-silicate, mafic to intermediate igneous and sedimentary rocks. Elevated gamma-ray readings in the open pit correspond to exposed ore lenses (26 mSv/year) and the abandoned ore stockpile (10.7 mSv/year). Surficial oxidation of ore and adjacent sulphide-bearing calc-silicate rocks has led to contemporary precipitation of mineral efflorescences on the pit walls. The open pit lake contains saline (0.15%) surface waters which are Ca^{2+}, SO_4^- rich with elevated Cu (1170 μg/L), Fe (3230 μg/L), Mn (1050 μg/L), Ni (688 μg/L) and U (460 μg/L) at a pH of 6.11.

Waste rock piles are up to 30 m thick and several, which were only partly covered or ripped for seeding, have high radiation levels (25 mSv/year). Stream sediments accumulating below waste rock piles are acidic (pH 3.8–7) and results (mean values) show enrichment of Cu (323 ppm), Mn (945 ppm), Ni (90 ppm), Ce (806 ppm), La (531 ppm) and U (82 ppm) indicating active weathering and erosion of waste materials into the local drainage system. Biogeochemical analyses indicate that *Enneapogon lindleyanus* (grass), *Cymbopogon bombycinus* (grass), *Aerva javanica* (kapok bush), *Aristida longicollis* (poaceae) and *Acacia Chisholmii* (wattle) accumulate Cu, Mn, Ni, REE and U at mined and disturbed areas.

Gamma-ray measurements over the rehabilitated tailings dam demonstrate an intact cover. However, seepage of acid (pH 5.86), saline (0.31%) waters occurs from the toe of the tailings dam into the evaporation ponds and local drainage system. Seepage waters are Ca^{2+}, SO_4^- rich with elevated Fe (250 mg/L), Mn (328 mg/L), and U (303 μg/L). Abundant sulphate efflorescences and Fe-oxyhydroxide flocculants with elevated radiation (1300 cps), high REE (Ce 6840 ppm, La 3750 ppm) and U (901 ppm) levels precipitate at the seepage point. Thus radionuclides are mobilised into surface seepage waters, and are coprecipitated with Fe flocculants. Runoff from the mine area drains into Cameron Creek. Seepage of saline waters occurs from the tailings dam and evaporation ponds into Cameron Creek via surface and subsurface flows as indicated by salt-encrusted creek banks.

When sampled during the dry season, pools in the Cameron Creek system were shallow, saline (0.3–3%), alkaline (pH 8.3–8.6), and strongly enriched in SO_4 (25.8 mg/L) and U (5.1 mg/L) but fish and aquatic plant life were still sustained locally in lower salinity regimes. Elevated metal loadings of soils and sediments, radionuclide mobility, weathering and erosion of waste dumps and bioaccumulation of elements do not occur beyond the former mine site. Measured radiation levels are at or below Australian Radiation Protection Standards (20 mSv/year averaged over five consecutive years) in most areas. In contrast, seepage of

waters from the tailings storage area and evaporation ponds causes seasonal salinisation and impacts on the water quality of Cameron Creek during the dry season.

Acknowledgements

To Dr Bernd Lottermoser and Dr Paul Ashley for their tremendous contribution to the research project. Support for this project was given by the Australian Research Council, James Cook University and the Queensland Department of Mines and Energy. David Trezise (DME Qld) and Geoff Bradford (EPA Qld) are thanked for their assistance and support. Vegetation sample identifications were made by N.J. Beresford-Smith and the Queensland Herbarium.

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(Manuscript received 12.03.2004)

Thesis Abstract: Genetic Patterning at Austronesian Contact Zones

MURRAY P. COX

Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
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The advance of Neolithic culture was a defining process in human history. Chronicled by the distribution of Austronesian languages, one such expansion of Neolithic peoples swept through the Indo-Pacific region just 4,000 years ago. A record of this dispersal is carried in the genes of modern people. Yet human populations have a much older history in the region, and their genetic legacies also persist to modern times. Examination of the genetic patterns that resulted from contact between these Austronesian and non-Austronesian peoples forms a central focus of this thesis. Research was directed towards three geographical regions in which Austronesian languages are still spoken today: the island nations of Indonesia, Madagascar, and Vanuatu. Inherited genetic characters were examined from nearly six hundred individuals, and analysis focused on two genetic systems. Firstly, mitochondrial DNA, which is inherited through the maternal line; and secondly, the Y chromosome, which is inherited through the paternal line. Disengaging the genetic lineages of men and women allowed exploration of possible sex-specific structuring in the contact process. An examination of spatial patterning, and the application of novel genetic techniques for dating human population expansions, gave additional facets to the study. Four thousand years of human mobility have blurred prehistoric patterns in the genetic variation displayed by modern populations. No spatial or sex-specific patterning was detected. Yet it can be inferred that less than a fifth part of the modern populace carry genetic markers once diagnostic of the dispersing Austronesian speakers. It seems that non-Austronesian populations have contributed significantly to modern populations. Genetic analysis suggests that, at least in Vanuatu, adoption of a Neolithic economy triggered a period of population growth for non-Austronesian peoples. This was contemporary with the arrival of the first Austronesians. Thus, the spread of Neolithic society seems to have been driven in part by biological dispersal, and in part by cultural diffusion. The genetic data best fit a model of leapfrogging, whereby Austronesian populations crossed the Indo-Pacific region in bounds, each of which subsequently formed a staging ground for cultural diffusion. Although not reflected so clearly in the archaeological and linguistic records, non-Austronesian peoples were active players in the emerging Neolithic world. They encountered the dispersal of the Austronesians, adapted culturally to their changing situation, and biologically, they kept on going.

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(Manuscript received 08.06.2004)

Thesis Abstract: Studies in the Diversity and Evolution of Phalangeroid Possums (Marsupialia; Phalangerida; Phalangeroidea)

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Abstract of a Thesis awarded for the Degree of Doctor of Philosophy
University of New South Wales, Australia 2003

Keywords: Phalangeroidea, Miocene, Riversleigh, possum

Three new genera (*Onirocuscus*, *Illungalya* and *Caudipilosus*) of phalangerids are described from the Riversleigh World Heritage fossil property, northwestern Queensland. One previously described fossil species of *Trichosurus* and two of *Strigocuscus* and rediagnosed. These are referred to the new genera *Caudipilosus* and *Onirocuscus* respectively. In all, six new species of phalangerid are described in the three genera, and three species rediagnosed. Two phalangeroids are also described, one a miralinid (in the genus *Durudawiri*) and one that is unassigned to family.

Phylogenetic analyses of these and other phalangerids supports the division of the family as proposed by Flannery et al. (1987a) and George (1987). *Strigocuscus* is found to contain only one species, the extant *Strigocuscus* celebensis. The three new phalangerid genera form a monophyletic clade that is sister group to modern trichosurins, and described here as a new subtribe. Periotic morphology provides a basis for distinguishing the two subtribes. Phylogenetic analysis was also performed on the suborder Phalangerida. Tarsipedidae were generally found to be the most plesiomorphic family of possum. Superfamily Petauroidea *sensu* Aplin and Archer 1987 gained little support. Burramyidae often formed a sister group to Phalangeroidea (including Pilkipildridae).

In the Riversleigh deposits, the highest diversity of phalangerids occurs in the early Miocene, followed by diversity in the middle Miocene. By the late Miocene, only one species of phalangerid (genus *Trichosurus*) is known from Riversleigh. Today, *Trichosurus vulpecula arnhemensis* is the only phalangerid found in northwestern Queensland.

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(Manuscript received 15.06.2004)

Thesis Abstract: Adenovirus-medited Gene Transfer for Tendon Healing

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Abstract of a Thesis awarded for the Degree of Master of Science
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The delivery of therapeutic genes to injured tendon via an adenovirus vector is an attractive potential method for enhancing tendon healing. Genes encoding proteins that are important to healing can easily be incorporated into an adenovirus expression vector; which, following transfection into a tendon cell, allows the therapeutic protein to be transiently expressed. As a first step of developing gene therapy for tendon healing, we studied the feasibility and efficacy of adenovirus-mediated gene transfer in *vitro* and in *vivo*; and explored a novel method to enhance adenovirus transfection in *vivo* by immobilizing the virus with a gelatin sponge.

We investigated the transfection of Ad5CMVntLacZ, an adenovirus vector containing reporter gene LacZ, in human rotator cuff tendon cell in *vitro*, and in a rat Achilles tendon healing model in *vivo*. Ad5CMVempty, the adenoviral vector containing no inserted gene, was used as a control for adenoviral transfection alone. For the in *vitro* work, human rotator cuff tendon cells were obtained by primary cell-culture; and transfected with Ad5CMVntLacZ. Activity of β-galactosidase, the protein product expressed by LacZ gene, was measured through a β-galactosidase assay, to assess the efficiency of adenovirus transfection and study the duration of LacZ gene expression. Virus dose response was studied to obtain optimal transfection condition. Transfection was also visually detected by staining the cells with X-gal, a chromogenic substrate of β-galactosidase. After transfection, cell viability was measured by MTS assay, a colourimetric method for determining the number of viable cells. For the in *vivo* work, the right Achilles tendons of 350-gram Sprague-Dawley rats were transected surgically. Ad5CMVntLacZ was introduced during healing. Transfection was assessed by staining tendon tissues and frozen sections of tendon tissue with X-gal. 10^6, 10^8 or 10^9 plaque-forming units (PFU) of Ad5CMVntLacZ were used for studying virus dose response. LacZ expression duration was studied at a dose of 10^8 PFU, by harvesting and staining tendon tissues at 1, 3, 4, 10 and 17 days post transfection. We compared the transfection efficiency of two different virus delivery approaches: (1) injecting virus into healing tendon directly, (2) soaking virus in a gelatin sponge, which was then implanted into healing tendon. The in *vivo* biodistribution of adenoviruses was studied in the healing tendon, muscles peripheral to the tendon and distal tissues.

Human rotator cuff tendon cells were successfully transfected without impairing cell viability, maximal β-galactosidase activity was at the dose of 1000 PFU / cell, the duration of LacZ expression was six days with a peak value at 24 hours. A transfection rate of 100% was obtained at the dose of 5000 PFU / cell. X-gal staining of cells confirmed successful transfection.

1000 PFU / cell was determined as the optimal dose for efficient in *vitro* transfection. Successful in *vivo* transfection by Ad5CMVntLacZ was also obtained in healing rat Achilles tendon as confirmed by X-gal staining, 0.4% of tendon cells were transfected at the dose of 10^6 PFU, the rate rose to 2% with 10^8 PFU and 3% with 10^9 PFU. The duration of in *vivo* LacZ expression was 17 days. Transfection efficiency was enhanced threefold and localization improved using a gelatin sponge to deliver the adenovirus.

The results of this study demonstrate that adenovirus can be used to deliver a gene of interest to cultured human rotator cuff tendon cells in *vitro* and healing tendon in *vivo*, with sponge implantation enhancing transfection efficiency in *vivo*. This work provides a good base for further research into the use of gene therapy to assist the healing of injured tendon.

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Thesis Abstract: Ecosystem Change and Campylobacter in Freshwaters: Case Studies from the Taieri and Motueka River Catchments

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Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
University of Otago, Dunedin, New Zealand 2004

New Zealand has a history of rapid ecosystem change since the arrival of humans, resulting in a predominantly agricultural landscape. This thesis investigates the influence of ecosystem (land use) change and other environmental variables on the human pathogen *Campylobacter* in two distinct river catchments of the South Island, New Zealand.

The Taieri catchment is predominantly rural, with land use including farming, cropping, market gardening, and forestry. The distribution of *Campylobacter* in freshwaters was investigated at a variety of spatial scales in the Taieri river catchment. First, *Campylobacter* concentrations in second order streams within distinct land uses were investigated, and dairy and deer farms showed relatively high concentrations compared to sheep farms and ungrazed tussock. Secondly a range of stream sizes (from second to fifth order) within two small agricultural catchments that encompass a mix of land uses were used to investigate the relationship between catchment development, stream order and *Campylobacter* and faecal coliforms. No significant correlation was detected between catchment development and *Campylobacter*, but a significant correlation between stream order and *Campylobacter* suggested a cumulative impact of land use on *Campylobacter* concentrations. The relationship between ecosystem change and *Campylobacter* was further investigated at mainstem (sixth order) sites on the lower Taieri River. Longitudinal variation in *Campylobacter* at these sites was related to inputs from small tributaries and agricultural drains, and outputs such as settling and cell death. Median concentrations of *Campylobacter* in the lower Taieri River were highest during summer months, when recreational use of the river is most common.

Campylobacter concentrations in the Motueka River were investigated in relation to both time (seasonality) and place (stream size). Seasonal effects on *Campylobacter* concentrations were investigated in a region with distinct wet and dry seasons, and a range of stream sizes were included, from small streams to major tributaries and main stem river sites. *Campylobacter* concentrations in the lower Motueka River were relatively low compared to the Taieri River, despite higher concentrations in tributaries associated with specific land uses (sheep and dairy farming), suggesting that dilution of contaminants by relatively clean water from forested sub-catchments was occurring. *Campylobacter* was isolated more frequently in winter and less frequently in summer in the Motueka Catchment. Results from the Motueka catchment suggest that public health benefits can arise from limiting agricultural development in catchments and protecting forested areas, particularly with respect to maintaining the microbial quality of rivers for drinking water and recreational activities.

A comparison of isolates of *C. jejuni* from freshwaters and clinical cases of campylobacteriosis (from the Taieri catchment and nearby Dunedin City) was carried out using both a phenotypic technique (Penner serotyping) and a molecular genetic technique (pulsed-field gel electrophoresis of DNA restriction fragments). The degree of overlap in strain types between isolates of *C. jejuni* from freshwaters and clinical cases indicates that freshwaters probably

account for a significant proportion (10-20%) of sporadic cases of campylobacteriosis in the Taieri Catchment and Dunedin City.

Continuing ecosystem change through land use intensification in New Zealand may lead to further increases in microbial contamination of freshwaters, and an associated increase in waterborne enteric diseases such as campylobacteriosis.

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(Manuscript received 14.06.2004)

Thesis Abstract: Investigation of Immune-Suppressive Genes Expressed by the Cotesia rubecula Bracovirus (CrBV)

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Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
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The hymenopteran endoparasitoid, *Cotesia rubecula*, employs immune-suppression to overcome the internal defences of its host, *Pieris rapae*. Immune-suppressive activity arises from maternally secreted proteins and polydnavirus (PDV) particles, injected into a host larva with the parasitoid egg. The PDV associated with *C. rubecula* (CrBV) is unusual as it expresses only four genes (CrV1-CrV4) in *P. rapae* tissues and expression occurs only between approximately four and ten hours post-parasitisation (hpp). Previously, CrV1 was characterised and found to inactivate host haemocytes by causing disruption of their cytoskeleton, leading to abrogation of immune-associated processes. In this study, a cDNA library was constructed from parasitised *P. rapae* larvae and screened with CrBV DNA, leading to isolation of CrV2 and CrV3. Each gene was cloned and the resultant recombinant proteins used to produce anti-CrV2 and CrV3 antibodies.

CrV2 encodes a glycoprotein of approximately 40 kDa, which is secreted from infected haemocytes and fat body into serum. Comparison of CrV2 sequence with other known sequences revealed no significant homologies. CrV2 protein was detected in host larvae at 6 hpp, remaining in large amounts for a day and was declining by 48 hpp. A C-terminus coiled-coil region within CrV2 is suspected of involvement in formation of CrV2 trimers that were detected under non-denaturing conditions. CrV2 was visualised within haemocytes in large endosomes at 24 hpp. Although the function of CrV2 remains unclear, it appears to interact with haemocytes presumably to suppress their immune function.

CrV3 encodes a C-type lectin (CTL) homologue, also secreted from infected host haemocytes and fat body. Two CrV3 monomers (of approximately 14 and 17 kDa) were detected in parasitised larvae with the larger monomer being an N-glycosylated form of the smaller. CrV3 dimers and tetramers were also detected in *ivivo*. Recombinant CrV3 formed larger complexes and agglutinated ovine red blood cells, an activity that was Mn^{2+} and Mg^{2+} dependent but independent of $Ca^{2}+$. CrV3-mediated hemagglutination was inhibited by EDTA but not by biological concentrations of 29 potential ligands tested. Interestingly, CrV3 is similar to invertebrate CTLs associated with humoral defence but not with previously isolated viral lectins. Further, CrV3 homologues were recently detected in bracoviruses from *C. ruficrus* and *C. karyai*, indicating that a novel CTL family is expressed by some *Cotesia*-associated PDVs. CrV3 probably interacts with a host haemolymph component associated with humoral immune defences.

CrV1 and Crp32 (an immune-suppressive *C. rubecula* ovarian protein) were used to produce recombinant *Autographa californica* baculoviruses (AcMNPVs), pathogens with putatively enhanced virulence in *P. rapae*. Bioassays investigated pathogenicity of wild-type AcMNPV in *P. rapae* (previously unreported) and the effect of Crp32 insertion. Although the proportion of larval deaths due to wild-type AcMNPV was significant, the slow rate of mortality indicated that *P. rapae* is only semi-permissive to AcMNPV. Crp32 insertion proved insignificant in terms of the proportion and rate of mortality. Given the semi-permissive nature

of *P. rapae*, recombinant AcMNPVs expressing immune-suppressive and appropriate reporter genes may be useful for elucidating mechanisms of insect immunity and, more specifically, how CrBV acts to subvert these mechanisms in *P. rapae*.

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(Manuscript received 03.06.2004)

Thesis Abstract: The Role of Personal Values in Choice for Environmental Goods: Estimating Preferences for Non-Consumptive Use, Wildlife Viewing Among Student and Visitor Populations Segmented on their Personal Values

DAVID K. HOLDSWORTH

Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
University of Otago, Dunedin, New Zealand 2003

Preferences for wildlife viewing options were modelled for value segments among tertiary students and regional visitors to determine the relationship between consumer's values and their choices for environmental goods. Wildlife viewing was chosen as the choice subject, primarily as its complexity and nature should evoke personal values in the formation of choice criteria, and this product also exists under a range of management control reflecting both market and non-market non-consumptive use situations regionally.

A consumer's choice, characterised by the selection of a specific mix of product attributes was hypothesized to reflect that consumer's values, or motivational value types, described in Shalom Schwartz's, Universal Theory of Values. It was also surmised tourists [regional visitors] would maximise wildlife viewing by compensating access price and commercially managed site constraints for the certainty of viewing rare and endangered wildlife. The structure of personal values was postulated to be measurable and ordered the same across all populations, so student and visitor samples will have values structures similar in "explanatory power" for choices made by both.

Tertiary student and regional visitor samples were surveyed on their values and choice for options based on contingent and real wildlife viewing experiences existing around New Zealand. Their choices were analysed using conditional and mixed multinomial logic regression [MNL] to determine wildlife viewing preferences and preferences associated with particular motivational value types.

A significant interaction between values and choice for the wildlife viewing site attributes was found with respondents reporting particular types of values making characteristic choices for wildlife viewing sites. Science and environmental science students rating Universalism and Benevolence (Schwartz's Motivational Value Types) important in their lives, chose to visit a wildlife reserve, watch penguins, paying as little as possible. Commerce students rating Power, Achievement and Hedonism Motivational Value Types chose otherwise. Significantly different wildlife viewing site preferences were also found among visitors. A segment of middle aged and older women rating Universalism and Security values highly, preferred to visit a wildlife reserve site. Another segment of young Australians with Traditional values chose a coastal site.

Performance reversal of the survey choice model and associated values instrument was found from one sample to the other. The student conditional choice model used to analyse product attributes and choice explained less variance among the student's preferences, than did the visitor conditional model, Rho-squared of 0.1147 and 0.2489 respectively. The student ratings of values were consistent with Schwartz's Universal Structure of Values, while the visitor's ratings did not reflect that structure closely.

This pattern influenced the performance of the mixed choice models, where the interaction of the respondent values and the wildlife viewing attributes improved the explained variance. Explained variance improvement (Rho-squared increasing from 0.1147 to 0.1529) was relatively large 34% with the student's mixed MNL regression model. By comparison explained variance improvement through including the visitors' values in a mixed model, resulted in only 4% increase in Rho-squared from 0.2489 to 0.2583. An improved measure of the visitor's values to couple with their choices would provide a strong values choice explanation.

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(Manuscript received 12.01.2004)

Thesis Abstract: Environmental Ethics for the Future

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Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
University of Otago, Dunedin, New Zealand 2003

Mounting evidence suggests that the Earth is facing an environmental crisis unprecedented in its scale and causation. It manifests itself mainly in an unprecedented rate of species extinction, chemical pollution and climate change. It threatens the continued well-being of humanity as well as much of the biodiversity of the planet. The causes lie in the exponential growth and consumption of the global human population and the resulting overshoot. As for most populations in overshoot, the erosion of source and sink limits and the emergence of density-dependent biological mechanisms of population control lead to dire consequences.

The crisis stems from behaviour of *Homo sapiens* which is incompatible with the basic requirements of a sustainable global society. Underlying human behaviour are beliefs, values and structural constraints that shape people's concepts of progress. Our individual concepts of progress serve as norms that help us decide on our actions and to evaluate the decisions of others. The emerging global culture manifests a particular dominant concept of progress that is based on the beliefs and values of the Dominant Social Paradigm and that represents in many respects a mere extension of the *status quo* and its quantitative expansion.

On closer inspection the beliefs and assumptions that underlie the dominant concept of progress turn out to be neither empirically justifiable nor conceptually consistent. The transition to sustainability necessitates their replacement with a New Environmental Paradigm which gives rise to the four goals of efficiency, restraint, adaptation, and structural reform. The value base of the dominant concept of progress causes even more significant problems, reducable to some fundamental flaws in anthropocentric ethics. The precepts of anthropocentrism by themselves leave the concept of the flourishing of humanity ill-defined; and the pursuit of anthropocentric values leads to outcomes that are unintended and undesirable, even from the view of the anthropocentrist. Ecocentric ethics, in contrast, avoids those problems. I propose that a compromise acceptable to both anthropocentrists and ecoccentrists is provided by an environmental ethic based on the Gaia theory.

The required widespread and deep change in people's ethics must make use of the processes of enculturation by which people tend to acquire values and of the means by which existing values may be modified. Considering the alternatives, the most promising approach to accomplish a cultural change of such magnitude seems to be through educational reform. I argue that the adoption by the learner of ecocentric values through formal education is possible, desirable and practical. Analysis of current educational practices also suggests considerable culpability regarding the crisis at hand, involving both the transmission of harmful or counterproductive values, beliefs and attitudes and the failure to elicit more productive learning outcomes.

Based on those shortcomings, and contingent on the required changes to people's concepts of progress and values, I propose a blueprint for curriculum reform. It incorporates six general aims in the forms of groups of learning outcomes. They include a concept of progress founded on sustainability, an ecocentrist environmental ethic, remediation of skill gaps, vision for the future that includes change and sustainable solutions, a non-parochialist view of environmental values and academic inquiry, and empowering the learner to take action. The goal is to ensure that learners acquire the moral, scientific, interpretive and emancipatory knowledge to build a sustainable future for humanity and its home.

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(Manuscript received 12.04.2004)

Thesis Abstract: Trauma and Mental Health among Vietnamese Australians in South Australia

HOI CHRISTIAN MANUEL LE

Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
Flinders University, Australia 2002

Trauma and mental health are issues in the Vietnamese Australian community in South Australia. The aim of this study is to assess the trauma and the mental health status of Vietnamese Australian men and women in the Vietnamese community in South Australia. The objectives of the study were to: (1) assess and determine the current emotional and mental health condition of Vietnamese people in the Vietnamese community in South Australia; (2) identify the effects of trauma of violence, pre-migration, migration, post-migration, and resettlement issues on the emotional and mental health of Vietnamese people within the Vietnamese community; (3) identify and explore the attitude of participants towards violence and mental health problems or mental illness; (4) identify whether Vietnamese people seek professional help from counselling or mental health services; (5) identify any barriers Vietnamese people have to accessing counselling or mental health services; and (6) ensure that this study would be used to benefit those people who have experienced mental health problems or mental illness, trauma from violence, and the Vietnamese Australian community in general. The literature is extensively reviewed, appraised and discussed in regard to the history of violence, traditional Vietnamese values and culture, status of Vietnamese women, family violence in the Australian context, definition of violence and its effects on mental health and mental illness associated with violence. Attitudes of Vietnamese and Southeast Asians towards mental illness, the Vietnamese worldview, beliefs and practices are examined. Mental disorder (or mental illness), mental health problems and mental health are also examined and discussed. The study qualitatively explores focus group respondents' opinions, knowledge, attitudes and perceptions regarding the association between violence and mental health problems or mental illness, its impact on relationships and children, and social stigma factors which prevent people from seeking professional or psychiatric help. The study quantitatively examines the relationship between trauma from violence and mental health problems or mental illness. The study also assesses and determines the mental health status of Vietnamese Australian men and women in South Australia in general and its association with pre-migration, migration, and post-migration experiences such as trauma, loss of significant persons, life expectations, family issues, problems of adjustment and acculturation, community and emotional support, alcohol use and the post-traumatic stress disorder (PTSD) of those who experienced trauma from violence or abuse. Principal Component Analysis (Factor Analysis) of PTSD and psychological related symptoms was conducted and the association or correlation with traumatic experience such as the trauma of physical and emotional violence was examined.

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(Manuscript received 21.04.2004)

Thesis Abstract: Wetlands for Minewaters

Constructed Wetland Systems for Biological Treatment of Mining Wastewaters in Western Tasmania

MICHAEL J. LICHON

Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
University of Tasmania, Hobart, Tasmania 2000

Mining and lime-treated mineral processing wastewaters from the Hellyer Zn/Pb Mine in western Tasmania, bearing Pb after tailings dam treatment, pass through a series of pilot wetlands. This field-based study focusSes on identifying mechanisms behind wetland removal of residual Pb from wastewaters, performance improvement and catchment issues. The background, aims and significance of the industry-sponsored study are outlined. The study site for this applied research project is described and defined. Environmental uncertainties and practical challenges dictated the need for field-based observations supplemented by limited scope experimentation. Problems with sampling are identified and overcome by innovation.

Surprisingly, wastewater Pb sinks in wetlands almost exclusively in the form of PbS in the mud. The 50% suspended fraction of Pb uptake is removed from wastewaters by sedimentation, dependent on quiescent wetland residence time.

Several native emergent wetland plants suitable for treatment of mine wastewaters are identified using several criteria, and bulk and experimental plantings. These include *Eleocharis*, *Juncus*, *Restio* and *Triglochin*. The wetland plants contribute little to direct removal of Pb from wastewaters; rather, they provide structural stability and serve as *in situ* photosynthetic generators of organic matter. Falling into the mud, the organic matter maintains a decomposer-rich, low-Eh anaerobic mire, and fuels a microbial consortium including three genera of sulfate-reducing bacteria (SRB). By dissimilatory respiration, SRB reduce sulfate and thiosalts diffusing into the mud from the wastewaters to H_2S. The "dissolved" (filterable) 50% fraction of wastewater Pb uptake precipitates as PbS by chemical demand of sulphide acting on various complexed and colloidal forms of Pb present in the wastewater stream. This continues to a lesser degree downstream into the catchment with streambed colonisation by SRB consortia.

Wetland operating parameters are measured and evaluated. Key changes to mine site operation and wetland management, including optimising conditions for maximum SRB activity, waste co-treatment and improving wetland hydrology, are implemented or recommended to enhance wetland treatment performance. The river system affected by mine operations is examined by applying principles of total catchment management. Catchment areas need a multidisciplinary approach and cooperative, proactive management by stakeholders to minimise disturbance, degradation and water quality problems, and to apply remedial strategies.

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(Manuscript received 18.02.2004)

Thesis Abstract: The Influence of a Back Support Harness on the Spinal Movement and Force Profile of Sheep Shearers

STEPHAN MILOSAVLJEVIC

Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
University of Otago, Dunedin, New Zealand, 2004

The body of epidemiological data suggests that occupations with a heavy work classification carry risk of low back injury. Asymmetric movement coupling and repetitive loading in flexion are also considered to be components of undesirable functional working postures. Biomechanical analysis and literature guidelines suggest that occupational lumbo-sacral compressive forces exceeding 3400 Newtons and anterior shear forces exceeding 500 Newtons should be considered as indicators for a need for workplace intervention. The aim of this research was to investigate the 3D dynamic movement and force profiles in the lumbar spine of a sample of sheep shearers and to determine the influence of professional skill and the use of a back harness on these movement and force profiles.

A kinematic and kinetic analysis of the shearing tasks performed by twelve experienced shearers was undertaken in an industry standard shearing shed. Anthropometric, survey and 3D motion analysis data were gathered in order to construct the parameters for analysis. Surface mounted retro-reflective markers placed on sufficient trunk parameters defined three linked segments: pelvis, pumbar and pead, prms, prunk (HAT). A 3D, link segment, top down, inverse dynamics approach was used to construct the kinematic and kinetic profiles. Based on an expert driven qualitative assessment three specific shearing tasks were defined and prioritised for primary analysis.

Functional movement profiles demonstrate complexity and asymmetry of movement about three orthogonal axes identified at the thoracolumbar and lumbo-sacral joints. Flexion is not surprisingly a consistent movement during this task however lateral flexion and rotation couple with flexion in ways that suggest individual variability is a factor. A high level of professional skill appears to reduce the level of asymmetrical movement – particularly spinal rotation. The spinal force profile demonstrates considerable compressive and shear forces that are close to occupational health recommended action limits. The use of the back harness substantially reduces these forces.

The shearing occupation demonstrates complexity of movement coupling during a biomechanical analysis. An awareness of the potential for such task complexity should challenge the clinician to consider the manner in which we investigate spinal movement. Simplistic planar models may at times be insufficient and movements may need to be clinically coupled or combined in a manner that approaches the functional problem. The results of this study indicate that occupational skill is associated with reduced asymmetric movement and that a back support harness can substantially reduce spinal compressive and shear forces. Recommendations are made for the shearing industry, occupational health clinicians and for future research.

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(Manuscript received 16.06.2004)

Thesis Abstract: Do Transtheoretical Model Measures Predict Stage Transitions for Smoking Cessation? Studies of Callers to a Quitline

CATHY J. SEGAN

Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
La Trobe University, Australia 2003

The psychological question posed in this thesis is how do people move from being smokers with little interest in quitting, to exsmokers quitting for some time. Evaluation of a popular and influential health behaviour change model, the Transtheoretical Model (TTM), is used to examine this issue. Central to the TTM is the notion that individuals progress through a series of motivational stages of change in attempting to modify behaviour. These stages (and their definitions for smoking cessation) are precontemplation (not seriously considering quitting in the next 6 months), contemplation (seriously considering quitting in the next 6 months, or planning to quit in the next 30 days but has not made a quit attempt in the last year), preparation (planning to quit in the next 30 days, and has made a quit attempt in the last year), action (quit for at least 24 hours), and maintenance (quit for more than 6 months). Other model constructs including ten processes of change (which consist of five experiential and five behavioural strategies for change), the pros and cons of smoking, temptations to smoke and confidence to resist temptations are purported to predict transitions between the stages of change. Prospective tests of stage transitions provide better identification of the factors that cause people to move from one stage to the next, and can inform the debate as to whether behaviour change is better conceptualised as a stage or a continuum process.

There have been few prospective tests of stage transitions. This thesis aims to critically examine stage transitions, with a focus on transitions to and from the action stage of change. Four empirical papers are presented which stem from two independent studies of callers to a quitline. Three papers tested stage transitions. The findings demonstrated little support for the TTM's few clearly specified predictions regarding stage transitions and question the adequacy of the stage definitions themselves. Different factors predicted progression at different stages thereby supporting the notion of stages, or at least nonlinearities in the change process. The fourth paper highlights an important methodological issue in the testing of stage models, specifically the need to control for stage of change when examining whether the change processes predict cessation. Together, the findings raise concerns about the internal validity and predictive utility of the TTM, and thus its appropriateness as a framework on which to develop smoking cessation interventions.

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(Manuscript received 12.05.2004)

Thesis Abstract: The Development of Columnar Peds in a Texture Contrast Soil in the Pilliga State Forests, Northwestern New South Wales

PETER WALSH

Abstract of a Thesis submitted for the Degree of Master of Science (Research)
Macquarie University 2003

A common reaction among the number of scientists from whom I sought advice and opinion during my candidature for this degree was one of surprise upon learning of the nature of my research topic. These professionals all had one thing in common; they had at some stage in their careers conducted research in pedology, a scientific discipline devoted to the study of the genesis, distribution and composition of soils as they occur naturally. At first, I interpreted their reaction as being contemptuous of my study, insofar as why was I wasting my time in an area that no longer required research, as all the facts were known. Feeling somewhat defensive, I asked one of them to explain why discussion of my topic continually elicited this same response. Much to my relief it was not disdain that was being expressed, but simply an observation that studies of this kind are rare today due to the low status afforded pedology within contemporary Australian scientific and academic institutions. Whilst the level of research in pedology may have declined over the past few decades, the number of issues still to be resolved has not.

This thesis explores one of these issues, the genesis of columnar peds within a soil type commonly referred to as a soloth, a texture contrast soil that in this study has developed *in situ* from the weathering of a lithic facies of the Pilliga Sandstone. The relative importance of joint inheritance, shrink-swell and dispersion in a bedrock controlled environment was assessed, and it was found that a shrink-swell system is superimposed on top of a larger fracture system in the saprolite that is inherited from jointing in the underlying sandstone. As well as exerting a significant structural control on the development of columnar peds in the saprolite, the underlying sandstone also exerts a significant mineralogical control on the *in situ* weathered soil. Tentative models for the development of the fracture system which defines the sides of the columnar peds and the rounding of their tops are presented.

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(Manuscript received 07.06.2004)

Thesis Abstract: Transfers of Marketing Knowledge in Acquisitions

THORSK G. WESTPHAL

Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
University of Otago, Dunedin, New Zealand 2004

This study was motivated by, and responded to, two recent trends that have captured the attention of academia, business, and the public worldwide. The global shift towards a knowledge economy and the increasing importance of knowledge as an organisational asset and source of competitive advantage have set off an unprecedented wave of mergers and acquisitions that has spread across the globe over the last decade. Frequently undertaken to acquire know-how, many of these deals have failed to effect the post-acquisition knowledge transfers needed to achieve the desired knowledge-based synergies. However, despite these phenomena and the obvious importance of knowledge transfers to acquisition success, very little empirical research has examined the potential influences and outcomes of such transfers; none has studied both in conjunction.

It was, therefore, the primary aim of this study to develop an integrative framework of influences and outcomes of knowledge transfers in acquisitions. Specifically, this study focused on the transfers of marketing knowledge between the marketing departments of German acquiring firms and their German or overseas target firms.

Through the conceptual integration of the knowledge management, mergers and acquisition, and marketing literatures, this study developed a preliminary model of influences (i.e., knowledge characteristics, organisational characteristics, acquisition characteristics, and individual characteristics) and outcomes (i.e., transfer-related marketing synergies). This model was subsequently tested and modified through exploratory interviews with marketing executives of German multinational acquirers. The revised model, in turn, was then empirically examined through a large-scale questionnaire survey among German firms that had acquired other German or overseas acquisitions between 1996 and 2000.

Finally, statistical analysis of the survey data found that post-acquisition knowledge transfers are: a) hindered by the tacitness yet promoted by the specific and complementary nature as well as the perceived usefulness of the knowledge to be transferred; b) hindered by cultural and positioning dissimilarity between the firms yet promoted by their product-market dissimilarity; c) promoted by the prevalence of information-sharing norms in the firms' workplace as well as by the acquirer's establishment of group-based work arrangements and reward systems and the absence of managerial coercion, d) promoted by the acquirer's procedural fairness towards the target staff during the acquisition integration process as well as the target's post-acquisition resource dependence; and e) promoted by the individual staff members' professional respect and personal affinity for their new colleagues, their welcoming attitude towards the acquisition itself, their positive perception of the quality of the relationship between them and their new colleagues, and their relatively stronger identification with new, combined organisation than their old one.

As none of these variables had been empirically tested in the context of post-acquisition knowledge transfers before, this study's findings contributed to, and are expected to find application in, the bodies of literature from which these concepts were taken. In this respect, the study's contribution to the knowledge transfer and mergers and acquisition literatures are emphasised. These are discussed in the thesis.

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(Manuscript received 26.05.2003)

Thesis Abstract: Development and Perinatal Maintenance of the Neuromuscular System in Neurotrophin-3 null Mutant Mice

ADELE GLYN WOOLLEY

Abstract of a Thesis submitted for the Degree of Doctor of Philosophy
University of Otago, Dunedin, New Zealand 2003

The primary structure of the polypeptide neurotrophin-3 (NT3), a member of the neurotrophin family, was first identified in 1990 (Hohn, Liebrock et al. 1990). Transgenic mice without a functional gene for NT3 do not develop proprioceptive neurons within the dorsal root ganglia and thus lack both group Ia afferents and muscle spindles. Additionally, mice with a homozygous deletion of the NT3 gene have a significant reduction in the number of sympathetic neurons within the superior cervical ganglia. The number of alpha motoneurons is reported as being unaffected (Ernfors, Lee et al. 1994), and no other significant defects have been reported within the neuromuscular system. This thesis critically examines the development of the neuromuscular system in NT3 mutant animals. Using stereological analysis, we confirm an earlier report of gamma motoneuron loss within the ventral horn of the spinal cord in NT3 null mutant (-/-) animals (Kucera, Ernfors et al. 1995), but also establish that the size of the alpha motoneuron cell body is significantly reduced in the newborn (-/-) animals, while the number of alpha motoneurons is unaffected (Woolley, Sheard et al. 1999). Subsequent quantification of myofibre number in soleus and Extensor digitorum longus (EDL) muscles at birth (P0) using electron microscopic methods confirms that the target (muscle) size is also significantly reduced in these (-/-) animals, as compared to their wild type (+/+) littermates. The number of myofibres continues to increase postnatally in both the (-/-) and (+/+) animals, but the total number of myofibres at postnatal day seven (P7) is still significantly less in the (-/-) than in the (+/+) animals. Thus, the reduction in target size seen at P0 is partially due to a delay in development, but there is also a final deficit in the formation of the myofibres. At the neuromuscular junction, the number of small axon profiles found at each endplate is increased at P0, resulting in an increase in the overall total number of axon profiles per endplate. Furthermore, the occupancy of the postsynaptic membrane by the terminal axon profiles is significantly less in the muscles of P0 null mutant animals, as compared to their wild type littermates, suggesting a disturbance of the neuromuscular relations during this perinatal period.

Other morphological changes are described within the muscles of a small number of older (P3, P4 and P7) (-/-) animals. These include a failure of the neuromuscular junctions to be maintained postnatally. Neuromuscular junctions at P3 are sparse and appear to be confined to areas of the muscle in the immediate vicinity of large intramuscular nerve branches. The remaining junctions exhibit substantial abnormalities, including the degeneration of some of the terminal axon profiles. The total number of axon profiles per endplate is less than in the P0 null animals ($p < 0.05$) and the majority of axon profiles within the endplates are of medium size, suggesting that a progressive postnatal withdrawal of small motor nerve terminals from the muscle endplate has taken place. There is also evidence of both cytoplasmic darkening and degeneration of a significant number of terminal Schwann cells. By P4, and also within the muscles of the P7 null mutant animals examined, there is no evidence of any neuromuscular junctions within either EDL or so-

leus muscle, despite the continuing presence of peripheral axons at the point of entry into the muscle. The common peroneal nerve of the P3 null mutant animals shows gross abnormalities of the myelin, together with condensation of the axoplasm, and dense neurofilament.

This evidence suggests that NT3 is critical for the postnatal maintenance of the alpha motoneuron. Three possible mechanisms of action are discussed, the first being that NT3 is directly involved in the support of the motoneuron. The second possibility is that NT3 is directly involved in the support of the Schwann cell. Lack of primary support for the Schwann cell during the postnatal period would result in a secondary motor neuropathy and would explain the motor deficits seen within the (-/-) animals. The third possibility is that there is a reduction in the activity level of the neuromuscular system due to the absence of proprioceptive input, and that this reduced activity gives rise to the abnormalities seen.

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(Manuscript received 26.05.2003)

References

Ernfors, P., Lee, K.F. et al. (1994). "Lack of neurotrophin-3 leads to deficiencies in the peripheral nervous system and loss of limb proprioceptive afferents." *Cell* 77(4): 503–12.

Hohn, A., Liebrock, J. et al. (1990). "Identification and characterisation of a novel member of the nerve growth factor/brain-derived neurotrophic factor family." *Nature* 344: 339–341.

Kucera, J., Ernfors, P. et al. (1995). "Reduction in the number of spinal motor neurons in neurotrophin-3- deficient mice." *Neuroscience* 69(1): 321–30.

Woolley, A., Sheard, P. et al. (1999). "Alpha motoneurons are present in normal numbers but with reduced soma size in neurotrophin-3 knockout mice." *Neurosci. Lett* 272(2): 107–10.

Journal & Proceedings of the Royal Society of New South Wales, Vol. 137, p. 69–71, 2004
ISSN 0035-9173/04/010069–3 $4.00/1

The Clarke Medal 2003

LESLEY JOY ROGERS

The Clark Medal is considered for award annually for distinguished work in the natural sciences. The work must be performed predominantly in Australia or its territories.

Professor Rogers graduated BSc with first class honours in Zoology from Adelaide University and went on to be awarded a DPhil from Sussex University. She has since received a DSc from Sussex and more recently been elected a Fellow of the Australian Academy of Science. She holds a Personal Chair of Neuroscience and Animal Behaviour at the University of New England. The publication in 1979 of her discovery of lateralization in the chicken brain, at a time when it was believed that only human brains had functions centred in one or other side of the brain, was a major new development. The injection of cyclohaxamide to disable alternate brain hemispheres showed which hemisphere had dominant control of a particular function such as pecking behaviour. This work founded the new field of brain lateralization in animals which is now actively pursued internationally. Many birds, including kookaburras and magpies have been found to show lateralized eye use due to different visual functions being located in a specific hemisphere. Professor Rogers was the first to show that a shift in hemispheric dominance can occur as the chick develops. The most important aspect of this was the discovery of the effect of light shining through the egg shell before hatching. The chick embryo places its right eye next to the air sac and its left eye away from the light just when its visual system is starting to work. In a series of elegant experiments she showed that only two hours of light exposure at this stage establishes lateralization. This does not occur for eggs hatched in the dark. The lateralization can be reversed by occluding the right eye and exposing the left. She has used neuroanatomical methods to trace the visual projections to the forebrain and the effect of light.exposure on this process. These results raise interesting speculations on similar effects that may occur in other animals including humans. It is thought that brain lateralization developed early in evolution. It has now been found in lizards, frogs, fish, rats, dogs and primates. She has extended primate lateralization studies to orang-utans in the wild and to marmosets at the University of New England. Her work has been supported by numerous research grants for many years and its international impact is reflected in the large number of invited talks she has given at international conferences in a variety of fields and by her appointment to many significant university, government and scientific bodies. In addition to her extensive list of books and scientific papers she has made a major contribution in bringing science to the public through radio television and the print media. Lesley Joy Rogers is clearly an outstanding candidate for this award and it is with great pleasure that we award her the 2003 Clarke Medal for distinguished and original contributions to the fields of Neuroscience and Animal Behaviour

Jak Kelly

Edgeworth David Medal 2003

STUART ROBERT BATTEN

The Edgeworth David medal is awarded for distinguished contributions by a young scientist under the age of thirty five. It is for work done predominantly in Australia or its Territories or for contributions to the advancement of Australian science.

Stuart Batten graduated with first class honours in chemistry from Melbourne University and went on to obtain his PhD at the same university, working on coordination polymers under the supervision of Dr Richard Robson and Dr Bernard Hoskins. He has held postdoctoral appointments at the universities of Bristol, Melbourne and Monash and is at present an Australian Research Fellow at Monash University. He has recently been awarded the Rennie Memorial Medal of the Royal Australian Chemical Institute for his contributions to crystal engineering.

As a graduate student at Melbourne University his work on trigonal ligands contributed significantly to the establishment of the new, and now rapidly developing, field of coordination polymers.

He published the first comprehensive review of interpenetrating networks in which he reinterpreted a number of previous incorrectly described structures. It became one of the most widely cited reviews in Agnew. Chem. A further fruitful suggestion was the investigation of the structural and magnetic properties of coordination polymers containing the dca ligand. This has attracted considerable attention, a number of international collaborations and numerous publications world wide. Locally it has lead to a significant number of grants and higher degree projects. Dr Batten has presented this and other work at numerous international meetings many as an invited speaker.

His present research is on coordination polymers and supramolecular chemistry and has already led to the synthesis of supramolecular nanoballs. They have a hollow spherical shape, about 1.5 nm in diameter and he suggests they may be useful for catalysis.

With much of the scientific and technical world now devoting their efforts to nanostructures and nanotechnology it is difficult to believe that many scientifically interesting and technically valuable applications of these supramolecular nanoballa will not be devised in the near future.

We are happy to award the 2003 Edgeworth David Medal to Stuart Robert Batten for his distinguished and original contributions to the fields of supramolecular chemistry and inorganic crystal engineering.

Jak Kelly

The Society's Medal 2003

CLIVE WILMOT

Established in 1821 the Society, then known as the Philosophical Society of Australasia became the Royal Society of NSW on 12 December 1866. It was made up of people who were interested in all aspects of the natural world. They were often not professionals but inspired amateurs. In a civil society, institutions such as the Royal Society of NSW are the means by which interested people can participate in the scientific life which powerfully influences the modem world.

In the long life of this Society its fortunes have waxed and waned as social and economic changes have influenced its membership and its activities. It has survived because there have always been people of ability who were prepared to make outstanding efforts to help the society recover during its difficult times. Clive Wilmot is one such person who come to the aid of this Society at a time of critical need. He assisted in the establishment and development of the Southern Highlands branch, He has made and continues to make great efforts in promoting this highly successful branch, and ensuring that its activities reflect the very best in academic excellence. You have to be eminent, a communicator and approachable to get a speaking spot in the Southern Highlands.

As a member of the Council for a number of years, and in numerous other ways he has given of his enthusiasm, energy and organisational ability to ensure the Society continues to prosper. He has returned this Society to its venerable roots, where inspired amateurs and gifted professionals can mix and philosophise to their mutual benefit. This makes the Royal Society of NSW a uniquely Australian Institution and long may it remain so. We thank you Clive.

R.A. Creelman

Journal & Proceedings of the Royal Society of New South Wales, Vol. 137, p. 73–79, 2004
ISSN 0035-9173/04/010073–7 $4.00/1

Annual Report of Council

For the year ended 31st March 2004

PATRONS

The Council wishes to express its gratitude to His Excellency the Right Reverend Dr Peter Hollingworth AC, OBE, Governor General of the Commonwealth of Australia and Her Excellency Professor Marie Bashir, AC, Governor of the State of New South Wales for their continuing support as Patrons of the Society during their respective terms of office.

Regrettably, Council was advised in May 2003 that the vice regal patronage of Dr Hollingworth had ceased following the end of his term in Office. His replacement as Governor General, His Excellency, Major General Michael Jeffrey AC CVO MC (Retd) has graciously accepted the position of Patron of The Royal Society of New South Wales from the 25th March 2004.

Council wishes to extend their thanks to Her Excellency, Prof Marie Bashir AC for attending the Society's Annual Dinner on 12th March 2004 to give the Address and for presenting the 2003 Edgeworth David, Clarke and Royal Society Medals to recipients.

MEETINGS

Ten ordinary general meetings and the 136th Annual General Meeting were held during the year at various locations.

SPECIAL MEETINGS AND EVENTS

20th March 2004:
The President, Ms Karina Kelly, Professor Peter Williams and Professor Jak Kelly met with the Governor-General of the Commonwealth of Australia, His Excellency Major General Michael Jeffrey on the 20th March 2004. The Governor-General expressed great interest in the Society and his desire to further scientific understanding in our community. He also made an extremely generous offer for the Society to hold a function at Admiralty House. The Governor-General as indicated above, has graciously accepted the position of Patron of The Royal Society of New South Wales from the 25th March 2004.

4th February 2004:
The Society was a co-sponsor of the annual 2004 Joint Meeting of the Four Societies: Australian Institute of Energy; Australian Nuclear Society; Engineers Australia; and The Royal Society of New South Wales. The meeting, representing the 1122nd General Monthly Meeting of the Society was held in Harricks Auditorium, Ground Floor, Engineering House 118 Alfred Street, Milson's Point. The speaker was Fiona Melville who practices law as Special Counsel with Corrs Chambers Westgarth. She spoke on the topic of Carbon Credits, her talk entitled: 'Environmental Products'.

27th March 2004:
The Society took part in a combined afternoon meeting on this Saturday at the Powerhouse Museum with the Powerhouse Members representing the 1123rd General Meeting of The Royal Society of New South Wales. The theme was 'Science and Sport' to coincide with the Museum's excellent exhibition on Sport. Two guest speakers took part: Professor Kathryn North, Head of the Neurogenetics Research Unit at the Children's Hospital at Westmead and Professor of Paediatrics and Child Health in the University of Sydney's Faculty of Medicine spoke on the subject 'Genes in Sport'; and Dr Graham Trout, Deputy Director of the Australian Sports Drug Testing Laboratory, spoke on 'Drugs in Sport - The Race to Win: What? Why? Who and When?' Around 60 members and visitors attended.

12th March 2004:
The Annual Dinner of the Royal Society of New South Wales was held on the evening at

the Forum Restaurant, Darlington Centre, City Road, Sydney University. The after-dinner address was given by Her Excellency Professor Marie Bashir, AC, Governor of the State of New South Wales who later presented the Society's Awards for 2003 following the reading of Citations by Professor Jak Kelly.

MEETINGS OF COUNCIL

Eleven meetings of Council were held at the Society's Office at 6/142 Herring Road, North Ryde.

PUBLICATIONS

Journal

Vol. 135 (Parts 3 and 4) for 2002 was published late in April 2003.

This issue contained two peer-reviewed papers – one being the 33rd Liversidge Lecture delivered to the Royal Society of NSW ('Dietary Chemical and Brain Function') by Professor Graham A.R. Johnston and the other, on agriculture ('Ionic Combating Mechanisms and their Comparative Effects on Seed Hardening under Simulated Supra-Optimal Environmental Conditions'). The issue also contained citations for two awards for the year 2002 as well as a biographical memoir on the Society's former Patron, Sir Arthur Roden Cutler, V.C., AK, K.C.M.G., K.C.V.O., C.B.E., K. St. J., 1916–2002

Volume 136 (Parts 1 to 4) for 2003 was published in December 2003 as a combined issue of parts 1 & 2 with parts 3 & 4 due to the limited number of papers available.

This issue contained the Presidential Address for 2003 ('Publish and Perish') plus one peer-reviewed paper on agriculture ('Thermal Induction, Salt treatment and the associated Plumule/Radicle Growth Response of Sorghum at 42/19°C'). As well, an historical article on Tuberculosis in New South Wales ('The Celluloid Strip - Mass Screening for Tuberculosis in New South Wales, 1950–1975') was published. Volume 136 also contained the Annual Report of Council for the year ending 31st March 2003 along with biographical memoirs and the Financial Statements by the Auditors and Council for the year ending 31st December 2002, however the full financial details were not included. (Council has since decided that the full reports will be published in the next issue of the Journal).

There has been increasing interest on the part of MSc and PhD graduates wishing to have Abstracts of their thesis published in the Journal and a total of five Abstracts were published in Volume 136. Once published, these Abstracts are also published on our web site.

Council wishes to thank all the voluntary referees for their time and efforts and wishes also to thank Dr M. Lake for his voluntary assistance in preparing and typesetting the master pages for printing and for maintenance of the Society's web site. Council also wishes to thank the volunteer helpers who assisted in the production and distribution of the Journals

The Society received various requests for permission to reproduce material from the Society's earlier volumes of its 'Journal and Proceedings'.

Bulletin

Bulletin Nos 261 to 271 incl. were published during the period 2003–2004. Council extends its appreciation to the various authors of short articles for their contributions and to other voluntary helpers who assisted in the production and distribution of the Bulletin.

AWARDS

Council made the following awards for 2003:
2003 Edgeworth David Medal: Dr Stuart Robert Batten of Monash University
2003 Clarke Medal (Zoology): Professor Lesley Joy Rogers of University of New England
2003 Royal Society of New South Wales Medal: Mr Clive Francis Wilmot, Vice President of the

Society and a founding member of the Southern Highlands Branch
The James Cook Medal, The Walter Burfitt Prize and The Archibald Olle Prize were not awarded in 2003

The 2003 Royal Societies of Australia Eureka Prize of $10,000 for Interdisciplinary Scientific Research was awarded to Professor Peter Robinson (School of Physics, University of Sydney; Dr Evian Gordon (Department of Psychological Medicine, University of Sydney); Dr Chris Rennie (Westmead Hospital, Sydney); and Professor James Wright (Mental Health Research Institute of Victoria) for developing the first successful model of generation of brain electrical activity. The award was made at the Eureka Awards ceremony at Fox Studio in Sydney on the evening of 12th August 2003.

MEMBERSHIP

At 31st March, 2004, Membership of the Society was Patrons 2 Honorary Members 9 Full Members 225 Associate Members 21 Total (incl. Spouse Members) 257

Unfinancial 14 (removed from membership) Resignations 13 New members admitted 17

LIBRARY

Acquisition of journals by gift and exchange has continued during 2003/4. Exchange material from overseas sources has been forwarded to the Dixson Library, University of New England in Armidale where it is available locally or on inter-library loan. Australian journals and other printed material are kept in the Royal Society's collection at the Society's Office where they are available to members and approved visitors.

Council thanks the staff of Dixson Library for their continuing maintenance of the Society's Collection. The Dixson Library advises the Society of any missing issues of overseas journals who then takes appropriate action. An accession list of literature received during the year has been compiled and appropriate notices will appear in the Society's Bulletin for the information of members.

The position of Hon Librarian is still vacant The past Honorary Librarian, Dr Erich Lassak has continued to assist on a periodic basis during 2003/4 to accession and forward journals to the Dixson Library. Dr Lassak has advised that after the Society moves to Sydney University, he will no longer be able to fulfil this role. It is therefore imperative that Council elect an Honorary Librarian to fill this vacancy.

ABSTRACT OF PROCEEDINGS

9th April 2003:
The 136th Annual General Meeting and the 1114th General Monthly Meeting were held in the Sydney Harbour Foreshore Authority's lecture theatrette, 1 Hickson Street, The Rocks, Sydney. The President, Mr D.A. Craddock was in the Chair. The Annual Report and Financial Report for 2002-3 were adopted. Graeme Green, Chartered Accountants were reappointed as Auditors for 2003. As reported in Volume 136 Parts 1–4, The President Mr David Craddock delivered his Presidential Address entitled 'Publish and Perish'. A vote of thanks was extended by Councillor Jak Kelly.

The Awards for 2002 were announced as follows:

The Edgeworth David Medal: Prof. Marcela Bilek of the University of Sydney The Clarke medal: (Botany): Prof Robert Hill of the University of Adelaide

The James Cook Medal and the Walter Burfitt Prize were not awarded in 2002

The following Members were elected to Council for 2003-2004:

President Ms Karina Kelly Vice Presidents Mr D A Craddock (immediate past President); Professor W E Smith; Mr C F Wilmot; (3 vacancies) Hon. Secretary (G) vacant Hon. Secretary (E) Professor P A Williams Hon. Treasurer Dr R A Creelman Hon. Librarian vacant Councillors Prof J C Kelly Mr M Wilmot; Mr J R Hardie; Mrs M Krysko v Tryst A/Prof W A

Sewell Prof M A Wilson Mr R W Woollett (5 vacancies) Southern Highland's Branch Rep.: Mr H R Perry

In July and August of 2003, Dr Michael Lake who in recent years has undertaken the typesetting work for the Journal, as well as Mrs (now Dr) A Binnie and Dr Eveline Baker were co-opted as Councillors.

7th May 2003:
The 1115th Ordinary General Meeting was held in Kirkham Room, Roseville College, 27 Bancroft Avenue Roseville. Professor Graham Johnson of the Department of Pharmacology, University of Sydney spoke on the subject 'The Effects of Chemicals on the Brain' — an updated presentation of his 33rd Liversidge Lecture 'Dietary Chemicals and Brain Function' delivered to the Society in 2002 and published in the previous issue of the Journal and Proceedings of The Royal Society of New South Wales. The lecture included the role of gamaaminobutyric acid in many neurological disorders and discussion on the future treatment of these disorders. The President, Karina Kelly extended a vote of thanks to Professor Johnson as well as to the Principal and Staff of Roseville College for the use of their facilities.

7th June 2003:
The 1116th General Meeting was held as a combined Saturday afternoon meeting with Powerhouse Members at the Coles Theatre, Powerhouse Museum, Ultimo. Over 100 Members and guests heard a fascinating presentation of the possibilities of time travel by Professor Paul Davies, Professor of Natural History at the Australian Centre for Astrobiology, Macquarie University. Professor Davies posed the question: time travel makes great science fiction, but can it really be done? and then went on to give a discussion on the physics involved with the universe such as black holes and the huge gravitational effects involved. Professor Davies was thanked for his presentation by the President of the Royal Society, Karina Kelly.

2nd July 2003:
The 1117th General Meeting was held in the Search and Discover Room at the Australian Museum, William Street, Sydney. Dr Fred Watson, Astronomer-in-Charge at the Anglo-Australian Observatory spoke eloquently on the current RAVE (Radial Velocity Experiment) survey which at present measures 600 stars per night by employing fibre optic bundles and which by the end of 2010 and with further developments planned, it is hoped will allow for 22,000 measurements per evening by electronic control. Dr Watson's enthusiastic presentation drew many questions from the audience and a vote of thanks was extended by Dr Michael Lake.

6th August 2003:
The 1118th General Meeting was held in the Search and Discover Room at the Australian Museum. The speaker for the occasion, Associate Professor Roland Fletcher of the Archaeology Department at Sydney University gave a talk entitled the 'Seeing Angkor — New Views of an Old City'. Professor Fletcher who conducts an excavation each year at Angkor Watt described that by using new imaging techniques of aerial radar surveys in conjunction with satellite imagery, a much larger ancient city than previously thought has been revealed and it now seems that the Angkor complex covered more than 1,000 square kilometres between the 12th and 16th centuries AD with many interesting features yet to be investigated. However, the failure of the civilisation seems to have been from environmental damage due to excessive forest clearing for rice cultivation in the upper valley. A vote of thanks was moved by Professor Jak Kelly.

3rd September 2003:
The 1119th General Meeting was held in the Search and Discover Room at the Australian Museum. The speaker for the meeting was Dr Peter Tyler, a medical historian who discussed the 'The Celluloid Strip – Mass Screening for Tuberculosis in Australia, 1950-75' Dr Tyler brought insight to the story of tuberculosis and its incidence in Australia leading to the introduction of the mass screening program.

His talk then covered the history and logistics of the mass screening program for tuberculosis in Australia. A vote of thanks was moved by Mr John Hardy.

1st October 2003:
The 1120th General Meeting was held in the Search and Discover Room at the Australian Museum. The guest speaker was Emeritus Professor Barry Boettcher, founding Professor of Biological Sciences at Newcastle University. Prof. Boettcher addressed the meeting with his talk entitled 'Azaria's Blood: Evaluating Forensic Evidence and the Azaria Chamberlain Case' He discussed the difficulties a lay jury had in choosing between opposing interpretations by experts of the forensic test results and whether these results could be taken as demonstrating the presence of foetal haemoglobin and therefore blood from an infant. A lively question time ensued following which a vote of thanks was moved by Mr David Craddock.

5th November 2003:
The 1121st General Meeting was held at the Search and Discover Room at the Australian Museum. Dr Philippa Uwins, Senior Research Fellow at the University of Queensland gave the lecture 'Nanobacteria – did they exist on Mars and is there evidence of them in Australia's Triassic and Jurassic sandstones?' Dr Uwins gave a stimulating talk with details of recent research work and electron microscope photographs to support her controversial belief in the existence of nano-organisms (nanobes). A lengthy question time and debate on issues followed the talk. A vote of thanks was moved by Associate Professor W.A. (Bill) Sewell and carried by enthusiastic acclamation.

7th April 2004:
The 1124th General meeting was held in Conference Room 1, Darlington Centre, Sydney University, combined with the 137th Annual General Meeting. The President, Karina Kelly delivered her Presidential Address entitled '2001 – Science past and Future' which looked at the history of The Royal Society of New South Wales since its foundation as the Philosophical Society of Australasia in 1821 and the contributions made by Douglass, Clarke, Liversidge and Hargrave. It considered the philosophies of Sir Francis Bacon whose ideas were the inspiration for the foundation of the Royal Society in England in 1661, and covered some of the changes that have taken place in science in the last fifty years – from the space race until now. She then briefly looked at the future of the society as a generalist organisation contributing to the intellectual life of Sydney and New South Wales - a society which will celebrate its bicentenary in 2021. A vote of thanks was moved by Dr Anna Binnie.

OFFICE

Appointment of Office Manager

In 2003, Council appointed Mr Alan Buttenshaw as Office Manager. His appointment commenced 3rd June 2003 on a part-time basis for 20 hours per week to carry out the day-to-day running of the Society's Office as well as to undertake some of the work formerly undertaken by the Honorary Secretary. Mr Buttenshaw who retired from the University of Technology, Sydney in early 2000, holds qualifications in both Chemistry and Metallurgy (Department of Technical Education) and has had extensive managerial and financial experience as well as experience in computing and networking.

Relocation of the Society's Office to the University of Sydney

In July of 2003 and with the future of the Society's existing Office premises in the student accommodation units at Macquarie University under threat from redevelopment, Council accepted an offer from the Vice Chancellor of Sydney University of premises at Sydney University for the Society's Office. Unfortunately the relocation was held up due to delays in the refurbishment of new premises for the incumbents.

This, together with a change in University priorities, resulted in an offer of alternative

premises at 121 Darlington Road, Darlington Campus, Sydney University in February 2004. Council at its meeting of 25th February 2004 unanimously passed a resolution to accept the new offer and arrangements are currently underway to finalise a lease agreement and prepare relocation cost estimates for presentation at the next Council meeting. Based on current assessments, the Society's Office should be relocated to 121 Darlington Road within the next few months.

SOUTHERN HIGHLANDS

The Southern Highland Branch held ten meetings (attendance around 60 to 65 members and visitors at each meeting). All meetings were held in the Lecture Room at Frensham School, Waverley Parade, Mittagong, New South Wales. The Branch has sent out 60 monthly Newsletters to members and about 150 notices of meetings each month to other interested people.

20th March 2003:
The 81st Ordinary General Branch Meeting was combined with the Branch's Annual General Meeting at which the Chairman's Report for the year to February 2004 was presented. The speaker for the evening was Professor Rod Cross from the Department of Physics, University of Sydney who spoke on the topic 'The Physics of Sport'. The meeting was attended by 42 members and friends.

The Branch Committee elected for 2003/2004 was:
Chairman: Mr H.R. Perry BSc
Vice-Chairman: Mr C.F. Wilmot
Hon. Secretary:
Commander D.J. Robertson C.B.E.
Hon. Treasurer: Ms Christine Staubner
Member: Miss Marjory Roberts

17th April 2003:
The speaker for the 82nd Meeting was Professor David Celermajer, Scandrett Professor of Cardiology, Royal Prince Alfred Hospital who presented a lecture entitled 'The Heart of the Matter – Why is Heart Disease so common and how can it be prevented'. The meeting was attended by 81 people.

15th May 2003:
The 83rd Meeting was held. Following the meeting, 53 people heard the guest speaker, Emeritus Professor John Mulvaney of the Australian National University speak on the topic: 'The First Tasmanian Garden – Recherche Bay'.

19th June 2003:
The 84th Meeting was attended by 78 members and friends. The speaker for the occasion was Emeritus Professor, Barry Boettcher, founding Professor of Biological Sciences at Newcastle University who gave a talk on the Azaria Chamberlain Case trial entitled: 'Azaria's Blood – Forensic Science and the Azaria Chamberlain Case'.

17th July 2003:
The speaker for the 85th Meeting was Mr Tony Wheeler, Project Director of the Spatial Business Unit of the Company, Sinclair Knight Merz and whose background is in the development of Surveying, Navigation and Information Systems. He spoke on the topic: 'Modern Techniques of Mapping, Analysis and Information Management'. The lecture was attended by 60 people.

21st August 2003:
The speaker for the 86th Meeting was Dr Fred Watson, Astronomer-in-Charge of the Anglo-Australian Telescope at Coonabarabran, NSW. The topic of his talk was 'The Folklore of the Sky'. The lecture was attended by 108 people.

18th September 2003:
The 87th meeting was attended by 51 people and the speaker for the evening was Dr John Smith of the Department of Physics, University of NSW. Dr Smith spoke on the 'The Science of the Voice'.

16th October 2003:
The 88th Meeting was attended by 66 people. The evening's speaker was Dr Alex Ritchie, Curator of Fossils at the Australian Museum in Sydney who spoke on the topic: 'Fishing with a Hammer in Antarctica and Australia'.

20th November 2003:
The speaker for the 89th Meeting was Professor Peter Curson, Professorial Fellow in Medical Geography at Macquarie University, Sydney. 55 people heard Professor Curson speak on the SARS epidemic outbreak: 'SARS, Emerging Infections and the Globalisation of Risks'.

19th February 2004:
The 90th Meeting was attended by 36 members. The speaker for the meeting was Professor Brendan Kennedy of the School of Chemistry, University of Sydney. He spoke on Synchrotron Science – An Australian Perspective'.

ACKNOWLEDGMENTS

The Council wishes to thank Mrs Maren Krysko v Tryst, Dr Erich Lassak, and Mr Edric Chaffer for their continued volunteer assistance during 2003.

The Chairman of the Southern Highlands Branch, Mr H.R. (Roy) Perry expresses his thanks and appreciation to the following people:

Ms Julie Gillick, Head of Winifred West Schools Ltd., and those members of her staff whose help throughout then year was a major factor in the success of the meetings; The lecturers who came to Mittagong to speak at the meetings – some at short notice and some from considerable distance; Council Members of the Society for processing new membership applications; and local branch committee members for their work and support.

Journal & Proceedings of the Royal Society of New South Wales, Vol. 137, p. 81–89, 2004
ISSN 0035-9173/04/010081–9 $4.00/1

The Royal Society of New South Wales

Financial Statements

for the Year Ended 31 December 2002

Council's Financial Report for 2002

Your Council Members submit the following financial statements of the Society for the year ended 31 December, 2002.

COUNCIL MEMBERS

Mr D.A. Craddock	Dr R. Woollett
Mr C.M. Wilmot	Mrs M. Krysko
Dr R.A. Creelman	Prof. J.C. Kelly
Mr M. Wilmot	Dr E. Lassak
Mr J. Hardie	Mr R. Perry
Prof. M. Wilson	Prof. W.E. Smith
Ms K. Kelly	Prof. P.A. Williams

PRINCIPAL ACTIVITIES

The principal activities of the Society during the year were: organisation of meetings and publication of the Journal & Proceedings and the Bulletin.

SIGNIFICANT CHANGES

No significant change in the nature of these activities occurred during the year.

OPERATING RESULT

The surplus for the year amounted to $6,190

Signed in accordance with a resolution of the members of the Council.

President

Hon. Treasurer

Dated this _____ day of March 2003

[Original signed & dated.]

Statement by Members of the Council

In the opinion of the committee the financial statements:

1. present fairly the financial position of The Royal Society of New South Wales at 31 December, 2002 and the results for the year ended on that date in accordance with Australian Accounting Standards and other mandatory professional reporting requirements.

2. at the date of this statement, there are reasonable grounds to believe that the Society will be able to pay its debts as and when that fall due.

This statement is made in accordance with a resolution of the council and is signed for an behalf of the Council by:

President

Hon. Treasurer

Dated this _____ day of _____ 2003
[Original signed & dated.]

Compilation Report

On the basis of information provided by the Council of The Royal Society of New South Wales we have compiled, in accordance with APS 9 "Statement of Compilation of Financial Reports", the special purpose financial report for the year ended 31 December, 2002.

The Hon. Treasurer is responsible for the information contained in the special purpose financial report and has determined that the accounting policies used are consistent with the financial reporting requirements of The Royal Society of New South Wales and are appropriate to meet the needs of the members.

Our procedures have been limited to the classification and summarisation of information to compile this special purpose financial report from the information provided to us by the Hon. Treasurer and do not include verification or validation procedures. No audit or review has been performed and accordingly no assurance is expressed.

Neither the firm nor any member or employee of our firm undertakes any responsibility or accepts liability in any way whatsoever to any person other than the Hon. Treasurer in respect of the special purpose financial report including any errors or omissions in the special purpose financial report however caused.

Graeme Green
Chartered Accountant

Dated: _____ [Original signed & dated.]

Independent Audit Report to the Members

SCOPE

I have audited the financial statements, being the Statement of Income and Expenditure, Balance Sheet & Notes to and forming part of the financial statements of The Royal Society of New South Wales for the year ended 31 December, 2002. The Council is responsible for the financial statements. I have conducted an independent audit of these financial statements in order to express an opinion on them to the members.

My audit has been conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the financial statements are free of material misstatement. My procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial statements and the valuation of accounting policies and significant estimates. These procedures have been undertaken to form an opinion as to whether, in all material respects, the financial statements are presented fairly in accordance with Australian Accounting standards and other professional reporting requirements so as to present a view which is consistent with my understanding of the Society's position and the results of its operations.

The audit opinion expressed in this report has been formed on the above basis.

AUDIT OPINION

In my opinion, the financial statements present fairly in accordance with Australian Accounting Standards and other mandatory reporting requirements the financial position of The Royal Society of New South Wales as at 31 December, 2002 and the results of its operations for the year then ended.

G.M. Green
Registered Auditor No. 15169

Signed in Sydney on _____ [Original signed & dated.]

Statement of Financial Performance at 31 December, 2002

	2002 $	2001 $
INCOME		
Membership subscriptions	11 299	12 019
Journal subscriptions	3 864	6 409
Reprints & other publications	16	455
Investment income	5 423	8 347
Profit on sale of bookshelf	-	7 500
Annual dinner	(417)	112
Other	1 120	165
TOTAL INCOME	21 305	35 007
EXPENSE		
Accounting & auditing fees	1 400	500
Bank charges & govt duties	1	40
Bulletin	1 870	3 257
Depreciation	461	576
Insurance	1 037	703
Journal & proceedings	8 347	4 746
Miscellaneous	111	84
Monthly meetings	-	279
Office	590	1 611
Provision for doubtful debts	-	(1 684)
Relocation cost	-	1 240
Rent	-	1 636
Travelling	863	-
Telephone	435	464
TOTAL EXPENSES	15 115	13 452
SURPLUS FOR THE YEAR	$ 6 190	$ 21 555
Balance at 1 January	159 961	138 406
Balance at 31 December	166 151	159 961
Accumulated Funds	166 151	159 961

Statement of Financial Position at 31 December 2002

	Note	2002 $	2001 $
ASSETS			
Current Assets			
Cash	2	26 479	27 001
Investments	3	-	5 926
Receivables		4 653	3 373
Total Current Assets		31 132	36 300
Non Current Assets			
Investments	3	161 578	149 340
Property & equipment	4	15 444	15 905
Total non-current assets		177 022	165 245
TOTAL ASSETS		208 154	201 545
LIABILITIES			
Current Liabilities			
Other	5	1 154	2 811
Total Current Liabilities		1 154	2 811
Non-Current Liabilities			
Creditors & accruals		-	-
Total Non-Current Liabilities		-	-
TOTAL LIABILITES		1 154	2 811
NET ASSETS		$ 207 000	$ 198 734
MEMBERS' FUNDS			
Accumulated funds		166 151	159 961
Library fund	6	14 931	13 844
Trust funds	7	24 870	24 222
NSW Centenary of Fed. Fund	12	(98)	(98)
Studentship fund	13	1 146	805
TOTAL MEMBERS' FUNDS		$ 207 000	$ 198 734

The accompanying notes form part of these accounts.

Notes to and Forming Part of the Accounts for the Year Ended at 31 December 2002

1. Statement of Accounting Policies

These financial statements are a special purpose financial report prepared for use by the Council and Members of the Society, the council has determined that the Society is not a reporting entity.

The statement has been prepared in accordance with customary accounting practices on an accruals basis and on historic costs, taking no account of changing money values, or, except where specifically stated, current valuations of non-current assets.

Where required, comparative figures have been adjusted to conform with changes in presentation for the current financial year.

Council determined that the Society be registered for the GST with the ATO. The ATO's reporting requirements necessitated changing the accounting method to a full accrual system. Late dues are retained as Receivables, when previously they had been written off as Doubtful Debts at year end. Only sums owing by members who have resigned or died or who have been removed from the membership list under Rule 5(b) are expensed under Provision for Doubtful Debts.

	2002 $	2001 $
2. Cash		
Cash on hand	850	731
Cash at bank	25 629	26 270
	26 479	27 001
3. Investments		
Current		
Deposits at call	-	5 926
Non-Current		
St George 551555467	161 578	149 340
4. Property		
Office equipment & furniture at original valuation of	12 400	12 400
Less accumulated depreciation	(10 556)	(10 095)
	1 844	2 305
Library at 1936 valuation	13 600	13 600
	15 444	15 905
5. Liabilities		
Current - Other		
Journal subscriptions pre-paid	1 684	1 931
GST tax payable	(530)	880
	1 154	2 811

	2002 $	2001 $
6. Library Fund		
Balance at 1 January	13 844	13 754
Donations & interest	1 087	90
	14 931	13 844
Library purchases & expenses	-	-
Balance at 31 December	14 931	13 844
7. Trust Funds		
Included in Trust Funds are		
Clarke Memorial Fund 8	3 800	3 642
Walter Burfitt Prize 9	7 755	7 817
Liversidge Bequest Fund 10	3 553	3 406
Olle Bequest Fund 11	9 762	9 357
Total Trust Funds	24 870	24 222
8. Clarke Memorial Fund		
Capital	5 000	5 000
Revenue		
Income	158	218
Expenditure	-	(18)
Surplus (Deficit)	158	200
Balance at 1 January	-1 358	(1 558)
Balance at 31 December	-1 200	(1 358)
Total Fund Capital & Expenditure	3 800	3 642
9. Walter Burfitt Prize Fund		
Capital	3 000	3 000
Revenue		
Income	338	490
Expenditure	(400)	(400)
Surplus (Deficit)	(62)	90
Balance at 1 January	4 817	4 727
Balance at 31 December	4 755	4 817
Total Fund Capital & Expenditure	7 755	7 817
10. Liversidge Bequest Fund		
Capital	3 000	3 000
Revenue		
Income	147	203
Expenditure	-	-
Surplus (Deficit)	147	203
Balance at 1 January	406	203
Balance at 31 December	553	406
Total Fund Capital & Expenditure	3 553	3 406

	2002 $	2001 $
11. Olle Bequest Fund		
Capital	4 000	4 000
Revenue		
Income	405	558
Expenditure	-	-
Surplus (Deficit)	405	558
Balance at 1 January	5 357	4 799
Balance at 31 December	5 762	5 357
Total Fund Capital & Expenditure	9 762	9 357
12. Centenary of Federation Fund		
Revenue		
Income	-	-
Expenditure	-	(5 098)
Surplus (Deficit)	-	(5 098)
Balance at 1 January	-98	5 000
Balance at 31 December	(98)	(98)
13. Studentship Fund		
Revenue		
Income	341	319
Expenditure	-	-
Surplus (Deficit)	341	319
Balance at 1 January	805	486
Balance at 31 December	1 146	805

Journal & Proceedings of the Royal Society of New South Wales, Vol. 137, p. 90–98, 2004
ISSN 0035-9173/04/010090-9 $4.00/1

The Royal Society of New South Wales

Financial Statements

for the Year Ended 31 December 2003

Council's Financial Report for 2003

Your Council Members submit the following financial statements of the Society for the year ended 31 December, 2003.

COUNCIL MEMBERS

Mr D.A. Craddock
Mr C.M. Wilmot
Dr R.A. Creelman
Mr M. Wilmot
Mr J. Hardie
Prof. M. Wilson
Ms K. Kelly
Dr R. Woollett
Mrs M. Krysko
Prof J.C. Kelly
Dr E. Lassak
Assoc Prof. W.A. Sewell
Mr R. Perry
Prof. W.E. Smith
Prof. P.A. Williams

Co-opted Council Members
Dr Michael Lake
Ms Anna Binnie
Dr Eveline Baker

PRINCIPAL ACTIVITIES

The principal activities of the Society during the year were: organisation of meetings and publication of the Journal & Proceedings and the Bulletin.

SIGNIFICANT CHANGES

No significant change in the nature of these activities occurred during the year.

OPERATING RESULT

The surplus for the year amounted to $4,518 (2002 - $6,190)

Signed in accordance with a resolution of the members of the Council.

President

Hon. Treasurer

Dated this _____ day of April 2004

[Original signed & dated.]

Statement by Members of the Council

In the opinion of the committee the financial statements:

1. present fairly the financial position of The Royal Society of New South Wales at 31 December, 2003 and the results for the year ended on that date in accordance with Australian Accounting Standards and other mandatory professional reporting requirements.

2. at the date of this statement, there are reasonable grounds to believe that the Society will be able to pay its debts as and when that fall due.

This statement is made in accordance with a resolution of the council and is signed for an behalf of the Council by:

President

Hon. Treasurer

Dated this _____ day of _____ 2004
[Original signed & dated.]

Independent Audit Report to the Members

SCOPE

I have audited the financial statements, being the Statement of Financial Performance, Statement of Financial Position & Notes to and forming part of the financial statements of The Royal Society of New South Wales for the year ended 31 December, 2003. The Council is responsible for the financial statements. I have conducted an independent audit of these financial statements in order to express an opinion on them to the members.

My audit has been conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the financial statements are free of material misstatement. My procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial statements and the valuation of accounting policies and significant estimates. These procedures have been undertaken to form an opinion as to whether, in all material respects, the financial statements are presented fairly in accordance with Australian Accounting standards and other professional reporting requirements so as to present a view which is consistent with my understanding of the Society's position and the results of its operations.

The audit opinion expressed in this report has been formed on the above basis.

AUDIT OPINION

In my opinion, the financial statements present fairly in accordance with Australian Accounting Standards and other mandatory reporting requirements the financial position of The Royal Society of New South Wales as at 31 December, 2003 and the results of its operations for the year then ended.

G.M. Green
Registered Auditor No. 15169

Signed in Sydney on _____
[Original signed & dated.]

Statement of Financial Performance at 31 December, 2003

	2003 $	2002 $
INCOME		
Membership subscriptions	14 283	11 299
Journal subscriptions	3 596	3 864
Reprints & other publications	75	16
Investment income	5 187	5 423
Donations	13 600	-
Eureka award	4 000	-
Annual dinner	668	(417)
Other	79	1 120
TOTAL INCOME	41 488	21 305
EXPENSE		
Accounting & auditing fees	1 500	1 400
Bank charges & govt duties	-	1
Bulletin costs	2 047	1 870
Depreciation	369	461
Eureka prize	10 000	-
Insurances	886	1 037
Journal & proceedings publication	4 599	8 347
Monthly meetings	1 777	-
Office expenses	2 133	701
Provision for doubtful debts	1 366	-
Salaries & wages	11 200	-
Superannuation	576	-
Travelling	-	863
Telephone	517	435
TOTAL EXPENSES	36 970	15 115
SURPLUS FOR THE YEAR	4 518	6 190
Balance at 1 January	166 151	159 961
Accumulated Funds at 31 December, 2003	$ 170 669	$ 166 151

Statement of Financial Position at 31 December 2003

	Note	2003 $	2002 $
ASSETS			
Current Assets			
Cash	2	46 989	26 479
Investments	3	-	-
Receivables	4	6 551	4 653
Total Current Assets		53 540	31 132
Non Current Assets			
Investments	3	148 542	161 578
Property & equipment	5	15 075	15 444
Total non-current assets		163 617	177 022
TOTAL ASSETS		217 157	208 154
LIABILITIES			
Current Liabilities			
Creditors and accruals	6	2 845	1 154
Total Current Liabilities		2 845	1 154
Non-Current Liabilities			
Creditors & accruals		-	-
Total Non-Current Liabilities		-	-
TOTAL LIABILITES		2 845	1 154
NET ASSETS		$ 214 312	$ 207 000
MEMBERS' FUNDS			
Accumulated funds		170 669	166 151
Library fund	7	16 082	14 931
Trust funds	8	26 036	24 870
NSW Centenary of Fed. Fund	13	(98)	(98)
Studentship fund	14	1 623	1146
TOTAL MEMBERS' FUNDS		$ 214 312	$ 207 000

The accompanying notes form part of these accounts.

Notes to and Forming Part of the Accounts for the Year Ended at 31 December 2003

1. Statement of Accounting Policies

These financial statements are a special purpose financial report prepared for use by the Council and Members of the Society. The council has determined that the Society is not a reporting entity.

The financial report has been prepared in accordance with customary accounting practices on an accruals basis and on historic costs, taking no account of changing money values, or current valuations of non current assets. Sums owing by members who have subsequently resigned or died or who have been removed from the membership list under Rule 5 (b) have been expensed under provision for doubtful debts.

	2003 $	2002 $
2. Cash		
Cash on hand	815	850
Cash at bank	46 174	25 629
	46 989	26 479
3. Investments		
Current		
Deposits at call	-	-
Non-Current		
Term deposit - St George a/c no. 551555467	148 542	161 578
4. Receivables		
Membership fees	5 510	4 653
Provision for doubtful debts	(1 366)	-
Eureka prize receivable	2 200	-
Journal subscription in arrears	207	-
	6551	4653
5. Property		
Office equipment & furniture at cost	12 400	12 400
Less accumulated depreciation	(10 925)	(10 556)
	1 475	1 844
Library at 1936 valuation	13 600	13 600
	15 075	15 444

	2003 $	2002 $
6. Liabilities		
Current - Creditors and accruals		
Membership fees prepaid	65	-
Journal subscriptions pre-paid	2 113	1 684
Sundry creditors	1 584	-
GST payable/(refundable)	(917)	(530)
	2 845	1 154
7. Library Fund		
Balance at 1 January	14 931	13 844
Donations & interest	1 151	1 087
	16 082	14 931
Library purchases & expenses	-	-
Balance at 31 December	16 082	14 931
8. Trust Funds		
Included in Trust Funds are		
Clarke Memorial Fund 9	3 978	3 800
Walter Burfitt Prize 10	8 119	7 755
Liversidge Bequest Fund 11	3 719	3 553
Olle Bequest Fund 12	10 220	9 762
Total Trust Funds	26 036	24 870
9. Clarke Memorial Fund		
Capital	5 000	5 000
Revenue		
Income	178	158
Expenditure	-	-
Surplus	178	158
Balance at 1 January	(1 200)	(1 358)
Balance at 31 December	(1 022)	(1 200)
Total Fund Capital & Expenditure	3 978	3 800
10. Walter Burfitt Prize Fund		
Capital	3 000	3 000
Revenue		
Income	364	338
Expenditure	-	(400)
Surplus (Deficit)	364	(62)
Balance at 1 January	4 755	4 817
Balance at 31 December	5 119	4 755
Total Fund Capital & Expenditure	8 119	7 755

	2003 $	2002 $
11. Liversidge Bequest Fund		
Capital	3 000	3 000
Revenue		
Income	166	147
Expenditure	-	-
Surplus	166	147
Balance at 1 January	553	406
Balance at 31 December	719	553
Total Fund Capital & Expenditure	3 719	3 553
12. Olle Bequest Fund		
Capital	4 000	4 000
Revenue		
Income	458	405
Expenditure	-	-
Surplus	458	405
Balance at 1 January	5 762	5 357
Balance at 31 December	6 220	5 762
Total Fund Capital & Expenditure	10 220	9 762
13. Centenary of Federation Fund		
Revenue		
Income	-	-
Expenditure	-	-
Surplus (Deficit)	-	-
Balance at 1 January	(98)	(98)
Balance at 31 December	(98)	(98)
14. Studentship Fund		
Revenue		
Income	477	341
Expenditure	-	-
Surplus	477	341
Balance at 1 January	1 146	805
Balance at 31 December	1 623	1 146

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Papers, other than those specially invited by the Editorial Board on behalf of Council, will only be considered if the content is substantially new material which has not been published previously, has not been submitted concurrently elsewhere nor is likely to be published substantially in the same form elsewhere. Well-known work and experimental procedure should be referred to only briefly, and extensive reviews and historical surveys should, as a rule, be avoided. Letters to the Editor and short notes may also be submitted for publication.

Three, single sided, typed copies of the manuscript (double spacing) should be submitted on A4 paper.

Spelling should conform with "The Concise Oxford Dictionary" or "The Macquarie Dictionary". The Systéme International d'Unites (SI) is to be used, with the abbreviations and symbols set out in Australian Standard AS1000.

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The Abstract should be brief and informative.

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DATE OF PUBLICATION August 2004