A Tale of Two Privies: Techniques for the Recovery of Organic Remains from Australian Latrine Deposits

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# Table of Contents

Acknowledgments  
List of Figures  

<table>
<thead>
<tr>
<th>Section One: Introduction</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Two: Recovery of Other Organic Data from Latrine Deposits</td>
<td>7</td>
</tr>
<tr>
<td>Section Three: Recovery of Macrobotanical Remains</td>
<td>18</td>
</tr>
<tr>
<td>Section Four: Review of Literature on Parasite Eggs in Latrine Deposits</td>
<td>28</td>
</tr>
<tr>
<td>Section Five: Techniques for the Recovery of Parasite Eggs</td>
<td>37</td>
</tr>
<tr>
<td>Section Six: Physical and Chemical Examination of the Deposits</td>
<td>45</td>
</tr>
<tr>
<td>Section Seven: Conclusions</td>
<td>56</td>
</tr>
<tr>
<td>Bibliography</td>
<td>68</td>
</tr>
</tbody>
</table>
Acknowledgments

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List of Figures

Cover Picture: Two privies in an unidentified butcher's yard, Sydney 1900. From Max Kelly's *A Certain Sydney*

Figure 1.1: Plan of Regentville Latrine Complex 4

Figure 5.1: Egg of *Trichuris trichiura* recovered from the Jobbins Building Cess Pit 42

Figure 5.2: Size ranges of eggs of different parasite species 43

Figure 6.1: Results of the soils analyses 46

Figure 6.2: Soil textural classes showing the textural classes of the deposits studied 48

Figure 6.3: Schematic section of the Regentville latrine complex looking north 50
Section 1
Introduction

In 1991 the remains of a latrine structure from the site of Regentville were excavated by the University of Sydney's Centre for Historical Archaeology. The contents of this structure were excavated as several discrete deposits and the entire content of the outlet drain was retained with the idea of further investigation of it in mind. I began the course of this research with a fairly broad idea of investigating the contents of these deposits. The analysis of the artefact assemblages recovered from these deposits had already been completed and the results of the analysis indicated very clearly that two types of activities had occurred that related to the deposition of artefacts and the manner in which the latrine deposit was formed. The first of these conclusions was that the artefacts contained within the deposit were deposited throughout the entire period of the site's occupation. The second was that several cleaning episodes of this structure occurred. This result was a break with most previous interpretations of such deposits on Australian historic sites. The implications of these interpretations are discussed below.

In the light of the fact that the artefact analysis had already been completed, and that the entire latrine contents had been retained, it was felt that this was a perfect opportunity to conduct an examination of the organic components of these deposits. This choice was reinforced by the timely publication of Geismar's paper on the contents of the nineteenth century latrines from the Greenwich Mews site in New York. Geismar's study confirmed that periodic cleaning and continuous deposition of artefacts into latrines occurred. This study also raised a further issue - how do you identify a latrine deposit as distinct from the deposits contained within wells, garbage pits or cisterns? Difficulty in interpretation was not an issue with the Regentville latrine, as the surviving structural remains indicated clearly enough to the excavators that this was indeed a latrine and nothing else. However the problem exists that not all underground structures are so readily identified, for a variety of reasons, including the possibility that the original superstructure may no longer be intact and that the original function of the structure is ambiguous.

1 Judy Birmingham & Andrew Wilson 1994 Regentville Archaeological Project pp. 59-61
2 Joan Geismar 1993 'Where is night soil?' pp. 57-68
Thus the question that this thesis set out to answer was 'how do you identify a latrine deposit'? Having availed myself of some latrine contents, a survey of the international literature on the investigation of the organic contents of latrine deposits was conducted. This was carried out in three steps. The first step was to acquaint myself with the published material on the topic, the second was to establish contact with researchers who had conducted studies of similar deposits, and as a progression from this the third step was receiving and studying unpublished material on this topic. This review revealed that the range of organic materials generally recovered from these deposits falls into three categories, parasites, macrobotanical remains and other organic remains. The results of the review of the 'other' types of organic remains that it is possible to recover, such as pollen, insects, phytoliths and sterols are presented in Section Two of this thesis. The results of the review of the recovery of macrobotanical remains are presented in Section Three, and the results of the review on the recovery of parasite remains are presented in Section Four. Each of these sections summarises results of the previous research that has been conducted on the recovery of these remains from latrine deposits and documents the techniques used for their extraction as much as is possible.

As a result of conducting this survey it was decided that the focus of the current study would be upon the recovery of the eggs of intestinal parasites from these deposits. The reason for focusing upon this class of organic remains is twofold. The first is that while all of the classes of organic remains discussed above possess the combined potential to provide information on past human activities and upon the nature of these deposits and a site's surrounding environment, it was not possible to study all of these classes of organic remains in the course of this research as some (such as pollen) require specific facilities for their recovery that were not readily available, and that others (such as insects) required expertise in identification that was also not readily available. However the second, overriding reason is that the presence of parasites in a deposit is the primary indicator that this deposit had a faecal origin, and the identification of it as such allows for the positive interpretation of the structure that the deposit formed in as a latrine, and the allows for an understanding of how the other forms of organic evidence within the deposit were deposited also.

The issue of the positive identification of latrine deposits raised in Geismar's work is clearly also an important issue in Australian historical archaeology. Before going any further it is necessary to provide some background information on Regentville. The Regentville mansion, originally the focus of the Regentville estate near Penrith, west of Sydney, was built between 1823 and 1825 by Sir John Jamison, who at the time was one of the richest men in the colony. Jamison lived there until his death in 1844, and his family stayed on in the house until 1860. From 1860 to 1864 the house was used as a mental asylum, and in 1864 became a hotel, the Regentville Inn. It remained in use as a hotel until 1869, when it burned down in a
fire.

Figure 1.1 shows the plan of the Regentville latrine complex, with the hatched areas showing the sections of the complex from which the samples used in this analysis were taken. Two drains led into the latrine itself and one drain led out, presumably built so as to provide some flushing action and to cause the contents to move down the outlet drain and fall eventually into the main drain. The latrine was in use for the entire period of the site's occupation, from construction in 1823 to abandonment in 1869.

Before the study of the Regentville latrine artefact assemblage had been conducted, the general assumption was that the deposition of artefacts in below ground structures occurred only after these structures were no longer being used for their original function. There are naturally exceptions to this but most interpretations are based on the seemingly logical assumption that extraneous material was not deposited in these structures while they were being used simultaneously for another purpose. Two examples serve to illustrate this assumption. The first comes from the 1977 excavation of a structure presumed to be a well in the Sydney suburb of Rozelle. When discussing the deposition of the artefact assemblage in relation to the date of connection of municipal water supplies the report states:

> If 26/7/1901 can be taken as the terminal date for the use of the well as a water source, then it must also be regarded as the potential *terminus ante quem* of the well fill.\(^3\)

Clearly the inference is that the artefact assemblage could only have formed after the structure went out of use as a well. A second example of this comes from the report on the excavation of the Commonwealth Block in Melbourne. More than a dozen structures presumed to be cess pits were excavated on this site and the report states, when discussing the deposition of artefacts into one of these structures that:

> ... it is postulated that this pit was used as a rubbish pit after it went out of use as a cesspit, probably in the 1870s.\(^4\)

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3Dani Petocz 1984 *A Well in Rozelle* p. 19

Plan of the Regentville Latrine Complex
This interpretation is supported in the author's mind by the fact that no obvious nightsoil was present in this deposit, and also by the presence of a large and varied artefact assemblage, and in concluding his discussion of these features on this site he states that:

As with the other pits, it is believed that rubbish was deposited in the cesspits to fill them up after they went out of use.\(^5\)

In the light of the results of the analysis of the Regentville artefact assemblage, and Geismar's study in which it is demonstrated that these deposits were both periodically cleaned and were repositories for garbage during the period of their use, these earlier assumptions seem less logical, as these analyses have demonstrated that faecal material and rubbish were being deposited simultaneously in the structures studied.\(^6\) This then raises the issue of how it is possible to distinguish between a cesspit and similar underground structures such as revetted rubbish pits, on the basis of their contents in cases where structural remains provide insufficient information to allow for this distinction to be made. The successful interpretation of the artefact assemblages from such structures depends upon the successful identification of the deposition processes that led to their formation. The organic content of latrine deposits is the best means of determining this and, returning to the point made earlier, the presence of the eggs of intestinal parasites is the primary indicator that faecal material, and therefore cess, is present.

Because the presence of the eggs of parasites is the primary indicator of a deposit being faecal in origin, it was necessary in the course of this research to develop and test procedures for the recovery of parasites from Australian latrine deposits, as no previous studies of this type have ever been conducted on Australian material. This stage of the research is outlined in Section Five. On the basis of information gleaned by the review of the literature, recovery of eggs was initially attempted through flotation, and at this stage it was decided to introduce another sample as a control. This sample came from the cess pit of the Jobbins Building, a site excavated in 1992. The Jobbins Building, a terrace situated at 103-111 Gloucester Street in the Rocks area of Sydney, was constructed in 1857.\(^7\) The yard area of the terrace contained several outbuildings including the cesspit situated behind 111 Gloucester Street. The excavation of the cesspit, cut into bedrock to a depth of over three metres, yielded artefacts that link it with the period of tenancy of a Mrs Ann Lewis, a boarding-house proprietor on the

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\(^5\)Justin McCarthy 1990 *Archaeological Investigation of the Commonwealth Block*: pp. 134

\(^6\)Joan Geismar 1993 'Where is night soil?': pp. 57-68

\(^7\)Jane Lydon 1993 *Archaeological Investigation of the Jobbins Building* p. 23. Unfortunately the plan of the cess pit made at the time of excavation was not included in the report, and a copy of it was not able to be located, hence no plan of the cess pit structure is shown here.
site from 1861 to 1873. In 1865 drainpipes were installed, sealing the deposit, and the cesspit was converted into a fully serviced water closet. Lydon reached a similar conclusion to that reached in the interpretation of the artefact assemblage from the Regentville latrine made by Birmingham and Wilson; that the artefacts that made up the assemblage had been deposited during the period the latrine was in use.

Examination of the samples from Regentville and the Jobbins Building began with the application of flotation techniques. The variations of the standard flotation techniques used by other researchers to recover parasite eggs were so poorly described in the literature surveyed that it was necessary to develop my own variation. No eggs were recovered, by the application of this technique, even though it proved successful in recovering eggs from fresh faecal material. Another type of recovery technique, sedimentation, was developed and applied to samples from both sites. The presence of eggs was detected in the Jobbins Building material and thus positively identified it as faecal in origin, yet the result from the Regentville samples, taken from inside a structure whose function was known to be that of a latrine, proved to be negative.

This thus raised the question of why a negative result was achieved on the samples of the Regentville material when it was known to have come from a latrine. A clue was provided by the fact that the samples taken from the Regentville deposits were characterised by the complete absence of any of the organic remains that the literature reviewed indicated should be present if this deposit was indeed faecal in origin. The only way that an answer to this question could be provided was through the application of a suite of soils tests to the Regentville latrine matrix and the Jobbins Building cess pit matrix in order to establish exactly how the physical and chemical properties of these deposits had influenced the survival of their organic components. The results of this investigation are presented in Section Six. The conclusions reached from the soils analysis were that the Regentville matrix had been mobile and aerated, whilst in contrast the Jobbins Building matrix had been static and anaerobic.

The conclusion presents the results of this research in the form of a preliminary model of parasite deposition in latrine deposits and makes recommendations on how to sample and store these deposits as well as providing suggestions for future research.

8The use of the word 'latrine' when discussing the Regentville structure, as opposed to the word 'cesspit' applied to the structure from the Jobbins Building is not meant to imply any firm functional or structural differences between the two structures. These terms are used to distinguish between the two structures studied in order to avoid confusion.

Section Two
Recovery of Other Organic Data From Latrine Deposits

The review of the literature on the investigation of the organic contents of latrine deposits revealed that there is a wide array of organic material that has been found to survive in these deposits. Except for sterols, these organic remains are not restricted, unlike the eggs of intestinal parasites, to occurring only in deposits that are faecal in origin, and thus cannot be used as primary indicators of deposits that they are found in as being faecal in origin. The value of extracting these other organic remains from latrine deposits lies in the additional information that they can supply on such factors as the past vegetation surrounding the site, possible foods that were consumed by the occupants of these sites, and the environmental conditions that existed within the deposits themselves in the period that they were being formed. Researchers have identified several other types of organic remains in archaeological latrine sediments, such as the exoskeletons and pupal cases of various types of insects, pollen, bones, fabric and sterols. It was not possible to concentrate upon techniques for the extraction of these other types of organic materials from the Regentville and Jobbins Buildings deposits, and there was no certainty that all or any of these materials would have survived in these deposits. However the extraction of these materials from latrine deposits have yielded sources of information that would otherwise have been lost, and the presence of some of these, such as sterols and certain types of insects are important diagnostic tools that can be used in conjunction with parasite eggs in the identification of such deposits as faecal in origin.

Even though these other classes of material were not focussed upon as a part of the research for this thesis, it is important to discuss the techniques used to extract this material from latrine deposits, and the value of such information toward a better understanding of past human behaviour on the site (or sites) from which the material comes.

Insect Remains
Studies of insect remains from latrine sediments overseas have yielded a variety of insect species and have allowed researchers to draw certain conclusions from these deposits that they may otherwise have been unable to reach. The study of insect remains recovered from the contents of a medieval barrel latrine in Worcester revealed that the insect assemblage was dominated by two species, *Tipnus unicolour* and *Mycetaea hirta*, in a particularly good state of preservation. Greig notes that:
Occurring in such numbers and surviving in this particularly good state of preservation leaves little room for doubt that these two species were actually living and breeding in the contents of the barrel, whatever they may have been.\(^1\)

Both these species have been recorded as living among decaying organic refuse such as wood or straw, usually in enclosed conditions, such as would be encountered inside a latrine. The researchers were of the opinion that the contents of this deposit were highly organic, comprising mostly of vegetable material in an advanced state of decomposition. The possibility that this material may in fact have been an accumulation of animal dung is raised in this paper, but is dismissed on the grounds that a collection of dung beetles could thus reasonably have been expected to be present, and since only one specimen from this group was recovered, this does not appear to be the case. The author goes on to note that the insect fauna from this deposit, although not characteristic of a dung heap, is reasonably close to one recovered from a modern cess pit. Insect remains from latrine deposits are not restricted to those of animals that breed in the conditions present in the latrine environment. It has also been found possible to recover the remains of pests of stored grain. At Worcester the remains of *Orzaephilus surinamensis*, *Sitophilus granarius* and *Bruchus rufimamus* were recovered, the latter being a pest which infests broad beans. Greig notes that the presence of these insects could infer that kitchen refuse was being deposited in the latrine, but that having proved experimentally that at least the two former species can pass through the human digestive tract intact it would suggest that this explanation is not necessary and that the case for this deposit being the contents of a latrine is supported by this finding.\(^2\)

A paper by Kenward, Hall and Jones outlines in great detail a technique for recovering insect remains from archaeological sediments used at the Environmental Archaeology Unit at the University of York.\(^3\) The amount of detail given is laudable, considering the paucity of detailed instructions published in the literature that deals with the extraction of other kinds of organic remains from latrine deposits, in particular parasite eggs, an issue that is discussed further in Section Four. However as no attempt has been made in the course of this research to recover the remains of insects from the two deposits studied, it is not necessary to discuss this technique in great depth. It is sufficient to note that 1 kg samples of deposits are processed in order to recover insect remains, the first step being to wash these samples.

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1 James Greig 1981 'The investigation of a medieval barrel-latrine from Worcester' p. 269
2 James Greig 1981 'The investigation of a medieval barrel-latrine from Worcester' p. 269
3 Harry K. Kenward & others 1980 'A tested set of techniques for the extraction of plant and animal macrofossils' p. 8
through a 300 μm sieve, in order to separate them from their non-organic matrix, and, if the retent on the sieve is greater than a few cubic centimetres, to further process by paraffin flotation which allows for the separation of the light insect material from the heavier botanical material, and non-organic remains that may be retained on the sieve.

The authors report that this technique is suitable for extracting almost all types of insect and other arthropod remains with the exception of dipterous (fly) puparia, strongly calcified cuticle, such as woodlice, and charred or mineralised fossils. They recommend that if researchers wish to recover such remains then the same techniques used to recover macrobotanical remains from these deposits be used. Techniques for the recovery of macrobotanical remains are discussed and outlined in Section Three.

Faunal Remains
Faunal remains, specifically animal bones, are one of the major classes of artefacts recovered from excavations of historical archaeological sites. Their durability and the abundance that they are usually found in makes them an important source of information about past human activity on a particular site. Bones are frequently recovered from latrine deposits, where the possibility exists, in the case of very small bones such as some fish bones, that they were swallowed and passed through the digestive tract relatively intact. However the majority of bones recovered from latrine deposits appear to be the result of rubbish, rather than excrement being deposited in latrine pits. Faunal remains were recovered from the Regentville latrine deposit and from the Jobbins Building cesspit deposit. This material has been analysed by other researchers, and as techniques for recovering and interpreting faunal material from Australian historic sites are well established, it was felt unnecessary to concentrate on this class of organic remains within the scope of this project. For more detail on the faunal material from these two sites see the work of English and Steele.

Pollen
Pollen is perhaps the category of organic material that can provide archaeologists with the most information on the past human behaviour that has occurred on a site both in giving a picture of the past vegetation of a site, and, in the case of pollen recovered from latrine sediments, some idea of the plant foods consumed by the occupants of the site. Pollen is one of the most durable forms of organic evidence, surviving well in a variety of conditions, and

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4Judy Birmingham & Andrew Wilson 1994 Regentville Archaeological Project pp. 57-61

5Dominic Steele 1993 Jobbins Building: A Report on the Bone and Shell Assemblage, Anthony English 1991 This Muttonous Diet
is often present in large quantities in small samples. Shackley notes that the only environments where pollen does not survive well are oxidising or calcareous ones 'meaning that optimum preservation is achieved in acid waterlogged bogs, and minimum preservation in well-drained alkaline deposits'. This suggests that the Regentville latrine deposit would not contain pollen as it is both well-drained and alkaline, as is discussed further in section six. Shackley also notes that pollen grains are not always present in archaeological sediments even when environmental conditions are favourable. Pollen grains can be destroyed by oxidation, abrasion, or bacterial action, or be present in such tiny quantities that vast amounts of sediments have to be processed in order to recover a sample that is viable. Pollen analysis of latrine soils does have its drawbacks, which is why pollen analysis did not feature in this research. Firstly, if a sample of soil from an archaeological site is to be analysed for pollen the sample must be collected in such a manner as to avoid as much as possible contamination by modern pollen. Shackley gives good instructions on how to sample archaeological deposits, stating that clean tools for taking the samples with and clean containers in which to place the samples are necessary, as is taking the samples as quickly as possible from a freshly exposed surface. If these precautions are followed, the risk of contamination will be significantly reduced. As noted earlier, it is unlikely that pollen has survived in the well drained alkaline soil of the Regentville deposit, although there is the possibility that some may be present in the soil contained in bottles recovered from the deposit. It is also possible that pollen has survived in the Jobbins Building cess pit deposit. The main obstacle to attempting to extract pollen from these samples was that laboratory pollen extraction techniques can be quite dangerous. As Shackley states:

There are two cardinal rules for the preparation of pollen samples; firstly that it is only undertaken under appropriate supervision and secondly that the utmost care is exercised with the chemicals involved. The highest standards of safety must be observed. Ideal conditions are a sterile laboratory with an air-filtering system but these are not often available. A large and powerful fume cupboard which can cope with the fumes of acetone and hydrofluoric acid is essential, as is a sink not lined with lead ... Good supervision and great care with chemicals is absolutely essential ... The process is not difficult but it is finicky and time-consuming and requires the use of very noxious (and

6 Myra Shackley 1981 Environmental Archaeology p. 71
7 Myra Shackley 1981 Environmental Archaeology: pp 71-2
8 Myra Shackley 1981 Environmental Archaeology pp. 72-4
dangerous) chemicals. As there is only one laboratory in Sydney that has these facilities, and once pollen is extracted it requires a certain amount of expertise to identify, it was not feasible to analyse these deposits for pollen in the course of the present study, but there is no reason why in the future they could not be analysed for this material.

At least two studies of pollen from latrine deposits have been conducted in the USA, one on the privies from Queen Anne Square, Rhode Island and another on the privies from the Greenwich Mews site in New York. Reinhard and others note that investigating pollen is a proven method for examining diet, as pollen grains are able to pass through the human digestive system virtually intact. Humans ingest large quantities of pollen through the consumption of plant foods, but pollen assemblages in latrine deposits can represent both pollen introduced into a latrine through faecal material deposited in it, and pollen rain that has filtered into the latrine. Reinhard and others thus note that it is therefore important to distinguish between wind pollinated (anemophilous) and insect pollinated (entomophilous) types of pollen, noting that in most natural environments, anemophilous plants produce far more pollen than entomophilous plants, thus very little entomophilous pollen becomes incorporated in soil sediments unless human activity is involved, so high ratios of entomophilous to anemophilous pollens in latrine soils is most likely to have resulted from the consumption of entomophilous plants by the users of the latrine. Anemophilous pollens are of two types, long dispersal and short dispersal. Long dispersal pollen grains are very fine and can be dispersed over long distances, while short dispersal grains are larger and heavier, falling to the ground faster. Thus Reinhard and others note that:

Consequently, high percentages of long-dispersal pollen can result from natural pollen rain and/or human activity, whereas high percentages of short-dispersal pollen implicate only the latter.

The investigation of pollen recovered from the Queen Anne Square privies revealed the presence of abundant amounts of *Brassicaceae* and *Ligulafloreae* pollen types. *Brassicaceae* is the plant family that includes such vegetables such as cauliflower, broccoli and brussels sprouts, whilst one of the plants in the *Ligulafloreae* family is the dandelion which the authors note was an important plant in Colonial America for its use as a vegetable, for the use

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9Myra Shackley 1981 *Environmental Archaeology* pp. 74-5
10Karl J. Reinhard & others 1986 'Privies, pollen, parasites and seeds' p. 33
11Karl J. Reinhard, Steven A Mrozowski & Karl A. Orloski 1986 'Privies, pollen, parasites and seeds' p. 34
of its flowers to make wine, and its juice for medicinal purposes. The authors note that:

Their presence here presumably relates to the diet of the two households. This is surely true of maize (Zea mays) as well. Some of the other anemophilous plants might be dietary - but their low incidence argues for some caution in interpretation.\textsuperscript{12}

Interpretation of data such as this should be made with extreme caution, as it is not possible to say with any great certainty that these plants did in fact play an important dietary role in the lives of the users of these privies. Although the interpretation that these plants, which are seen as food plants today, did play a dietary role in the past is highly feasible, the temptation to speculate on the importance of these plants and their role as reflectors of socioeconomic status must be resisted, and this is true also for macrobotanical remains, as although they may be present within a latrine deposit, it is impossible to say whether they were consumed in food and passed through the human digestive tract, or were deposited in the latrine another way, such as in discarded food scraps. The great contribution that pollen analysis of latrine soils can make is to provide information on the type and variety of plants present on a site, not all of which possess seeds or durable parts and otherwise are invisible in the plant record. Because latrine deposits can act as concentrators of entomophilous and short-dispersal anemophilous pollen types, they have the potential to provide information on plant diversity on sites that may not be present in samples taken from other types of deposits.

The analysis of samples of latrine contents from the Greenwich Mews site in New York revealed the presence of a variety of pollen types, with a low arboreal to non-arboreal ratio noted by Reinhard, indicative of the area surrounding the site being largely deforested. However Reinhard notes that the percentage of Cheno Am pollen, an indicator of ground disturbance relating to habitation, is also relatively low. He states that:

\begin{quote}
Cheno Am plants commonly grow on trash mounds, ploughed ground, dirt mounds, paths, alleys, etc. Consequently it appears that although trees were not especially common in the area, there was a relatively stable environment with little building, land clearing, or other environmentally disruptive activities.\textsuperscript{13}
\end{quote}

The analysis of other types of pollen recovered from the latrine sediments revealed the presence of numerous types of dietary examples, in particular herbs and spices, including

\textsuperscript{12}Karl J. Reinhard & others 1986 'Privies, pollen, parasites and seeds' p. 34

\textsuperscript{13}Karl J. Reinhard 1989 'Parasite and pollen analyses' in Geismar's Greenwich Mews: p. 239
mint, cloves and parsley, and those of vegetables, including beans and potatoes.

Samples of latrine sediments to be analysed for pollen do not have to come solely from sediments held within the latrine structure. The well documented tendency of people in the past to discard empty bottles and jars into latrines means that it is often possible to recover these containers from latrine deposits filled with latrine contents and providing in effect a time capsule of pollen present in the deposit at the time the latrine was being used.14

**Phytoliths**

Phytoliths are another class of organic material that latrine deposits are likely to contain. Although none of the literature reviewed for this thesis discussed the recovery of phytoliths specifically from latrine deposits, their ability to survive in extremes of environmental conditions, as discussed below, indicates that they should be able to survive both passage through the digestive tract and deposition in a latrine environment. This durability may mean that it is possible to find the phytoliths of plants that do not possess durable seeds, outer coatings or pollen in latrine deposits, allowing for an increased knowledge of the plants both growing on a site and utilised by its occupants in the past. As with other types of botanical remains it is not possible to determine their dietary significance to the users of the latrine they are recovered from, this can only be inferred. Powers gives a clear definition and description of what phytoliths are:

> Opal phytoliths are literally "plant stones" ... formed from silica ... which occurs naturally in ground water, phytoliths can form in all parts of a plant but their deposition is not universal in terms of tissues, species and even ages of plants affected ... the silica adopts the morphology of the plant cell in which it is deposited and, therefore, phytoliths are formed whose average size is around 10 to 70 microns, approximately the same as pollen grains. Groups or "suites" of phytolith microfossils are studied because, unlike pollen, phytoliths are rarely species specific.15

Powers notes that most of the botanical and archaeological studies of phytoliths have tended to concentrate on one family of plants, the Gramineae or grasses because of their importance as domesticated cereals, although they are also known to occur in a wide range of plants including the shrubs, and temperate and exotic trees. The complete range of phytolith-

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14Michael Macphail, Research School of Pacific and Asian Studies, Division of Archaeology and Natural History, The Australian National University 1994 personal communication

15Alix Powers 1988 'Phytoliths: animal, vegetable and mineral?' in Slater & Tate (eds) *Science and Archaeology* Glasgow 1987 p. 460
producing species is not yet known. When a plant dies, the phytoliths within it are deposited either directly or indirectly into sediments, those that are eaten by animals being deposited in faecal material and ending up in archaeological sediments that way. The composition of phytolith suites recovered from faecal remains will vary depending upon the type of plants consumed, the seasonal availability and preference and the parts of the plants eaten. This process of selection will influence the phytolith suites recovered from the remains of faecal material, even when issues of differential preservation are not taken into account. Thus Powers cautions that when examining a phytolith assemblage from an archaeological sample all these issues need to be taken into account. On the issue of survival of these remains, Powers states that:

Once deposited within sediments, phytoliths are highly resistant to decay and decomposition by biological and chemical agents, and have been recovered from a wide range of sediment types, from acid peats through to calcareous sands with the pH of up to 9.8. The highly resistant nature of these plant fossils makes them an ideal candidate for ... the investigation of archaeological sites. Several of the particular advantages that phytolith studies might have over more traditional micro- or macro-palaeontological approaches follow from the fact that they are composed of silica, a substance that is relatively stable both chemically and physically. In consequence, it may be hypothesised initially that phytoliths, as compared with groups such as pollen and spores, will be preferentially preserved and hence more abundant in calcareous environments ... as a result of their comparative resistance to microbial attack and decomposition, oxidation and leaching and attrition.

The ability of phytoliths to survive in such environments as those discussed above means that they may emerge to be one of the most useful classes of botanical information that archaeologists can recover, not just from latrine deposits but from archaeological sediments in general.

As has been discussed earlier, pollen does not survive well in oxidised or calcareous deposits, but phytoliths do, and there is thus the possibility that they may have survived and be present in the Jobbins Building and the Regentville deposits. Phytoliths are very durable, but are not indestructible, and since they are identified down to species level through their characteristic

16 Alix Powers 1988 'Phytoliths: animal, vegetable and mineral?' in Slater & Tate (eds) Science and Archaeology Glasgow 1987 p. 460

surface sculpturing, damage through abrasion of this surface can render them unidentifiable, as these identifying features are easily worn, thus if movement of the Regentville deposit led to the phytoliths within it being abraded, it will not be possible to identify which plants they came from. An environment that is highly alkaline will also damage phytoliths, as they will dissolve in soils that have a pH of 10 and upwards, as although they are comprised of silica, they are not as stable as quartz grains. Such high pH levels are not likely to occur in natural soil deposits, but there are certain instances where this may occur as a result of human activity on a site, such as in a latrine deposit for a short period after it has been limed, as after a couple of months the lime breaks down and the pH levels are lowered again. Only those phytoliths that came into contact with the lime itself would be damaged, so if a deposit was extensively limed, but the lime was not incorporated thoroughly within the deposit, it is likely that areas of the deposit would contain organic materials, including phytoliths that were not damaged by this. A clump of lime was found in the Jobbins Building deposit, yet the botanical remains recovered were quite well preserved, so there is a good chance that phytoliths may have survived.

Sterols
Sterols are the only other form of organic remains apart from the eggs of intestinal parasites, that can positively identify a deposit as faecal in origin or not. Sterols are waxy, colourless solids, soluble in most organic solvents and virtually insoluble in water. They are components of virtually all plant and animal cells, with the notable exception of bacteria, where they are either totally absent or present in very small amounts. Cholesterol is the principal sterol of vertebrates, and its chief method of removal from the body is through excretion in bile, and is therefore only found in faecal material.

Knights and others discuss the examination of the contents of a second century AD ditch from a Scottish Roman fort, and note that bacteria, which frequently are unable to produce their own sterols, often possess the ability to modify conventional sterols produced by other organisms. They cite as an important example of this the formation of the 5β-dihydrosterol coprosterol from cholesterol by the intestinal microflora of animals, including humans. They note that:

This transformation is not often observed elsewhere and coprosterol has been considered therefore as a valuable marker for the assessment of sewage pollution in water ... The analyses of the coprolites found in the Lovelock Cave, Nevada, indicated that the sterols persisted in a well preserved

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18 Professor Peter Martin, Urban Horticulture, School of Crop Sciences, University of Sydney, 1994 personal communication.

19 Sybil P Parker (ed.) 1987 McGraw-Hill Encyclopedia of Science and Technology
condition. Few quantitative or qualitative differences from those of steroids from those of fresh faeces were found. In the present work, the sediment, subjected to a prolonged period of wet conditions, was devoid of any macroscopic resemblance to coprolites so that the possibility of the demonstration of a faecal origin for the organic matter ... could only be realised by identifying as many steroids as possible typical of those found in faeces and by showing these same compounds were not detectable in the upper layers of sediment.  

The sterols identified in the samples taken from this deposit could not be identified down to the species of the animals they came from, and it was impossible to determine whether they derived from a human or other animal source. However the authors state that:

It seems certain that part of the organic material from this level has been derived from faeces.  

As the authors note here, the data recovered from the sterol analysis of this material was not sufficient to prove conclusively that this deposit was originally contained human faecal material, but that the site location and history, together with other sources of biological information, in the form of plant and animal remains, do demonstrate conclusively that the deposit related to the period of Roman occupation of the site, and was most likely to have derived from the latrines in use on the site at that time.

This conclusion emphasises the fact that the positive identification of material in archaeological deposits as faecal in origin is difficult to make, and can border on mere speculation, except in the case of a very limited number of classes of evidence, such as sterols and helminth parasite ova, which can only derive from a faecal source. Even though these two classes of evidence, when found in archaeological deposits demonstrate irrefutably that all or at least part of these deposits are faecal in origin, it is again quite difficult to prove irrefutably that this faecal material has a human source. However, when this data is combined with other sources of data such as the remains of plant foods known to be consumed by humans, at least today, the interpretation is seen to be as conclusive as any archaeological interpretation can get.

The conclusion reached from the review of these previous studies is that although intestinal parasite eggs and sterols are the only classes of organic data that will allow for the positive

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20B. A. Knights & others 1983 'Evidence concerning the Roman military diet' p. 144

21B. A. Knights & others 1983 'Evidence concerning the Roman military diet' p. 149
identification of a deposit as faecal in origin, there is a variety of additional classes of data that can be recovered from these deposits that should not be overlooked, as they hold the potential to inform on the diversity of plant and animal resources being utilised by a site's previous occupants, information that may not be accessible through studying other classes of data. As is discussed further in Section Five, it is possible, through measuring the length of parasite eggs, to establish with reasonable certainty which species of animal faecal material in a deposit derived from.
Section Three
Recovery of Macrobotanical Remains

When conducting the review of the literature it became apparent that the most common class of organic 'artefacts' recovered from latrine deposits other than parasite eggs and faunal remains were macrobotanical remains, chiefly seeds. As is discussed further in section four, although the recovery of organic remains is the prime reason for studying latrine deposits, there is a lack of detailed information in the literature on the actual techniques used to recover these remains. As macrobotanical remains are not found solely in deposits that have a faecal origin, it was necessary to review the literature on the recovery of macrobotanical remains from archaeological deposits in general in order to come to a decision on the techniques best suited to recovering these remains from the Regentville and Jobbins Building deposits. The recovery techniques employed depends upon the manner in which the botanical material has been preserved because, as Holt notes, under normal soil conditions, macrobotanical remains, such as seeds will either decay or fulfil their reproductive function, thus for this material to be preserved in an archaeological context both the reproduction and the decay need to be prevented in some manner that also preserves the remains.\footnote{Cheryl A. Holt 1989, 'Floral analysis' in Geismar's Greenwich Mews pp. 217-8} The botanical remains which are most likely to survive in latrine deposits are the durable, inedible portions of plant foods such as seeds, cobs, and nutshells, and it should be noted that evidence for those plants also consumed on the site that do not posses durable parts are unlikely to be recovered from latrine deposits, thus any macrobotanical remains recovered from a deposit are unlikely to be representative of the full spectrum of plant foods utilised by a site's inhabitants. The variety of ways in which macrobotanical remains may be preserved and the techniques suitable for their recovery are discussed below.

There are four basic ways in which botanical material may be preserved in archaeological contexts, desiccation, carbonisation, waterlogging and mineralisation.

Desiccation of plant remains generally occurs in very arid environments such as those...
experienced in Peru and the Near East. There has been no discussion in the available literature on the possibility that botanical remains in latrine deposits may be preserved by desiccation although there is no reason why this should not be possible, particularly in earth closets. Coprolites preserved by desiccation have been recovered in caves in the USA, and have been found to contain botanical material.

Renfrew and others claim that carbonisation is the primary manner by which botanical material, usually seeds, is preserved in archaeological contexts. Carbonisation is a process where seeds are reduced to carbon while still retaining more or less their characteristic shape. Carbonised material floats well, and the flotation techniques and machines described below were developed with the aim of recovering carbonised, as opposed to waterlogged botanical material.

Waterlogging is the next most common form of preservation of botanical material after carbonisation. Organic material recovered from peat bogs in Europe exhibits exceptional preservation, as anaerobic conditions and the 'slow action of humic acid' combine to result in very slow rates of decay of this material, including very fragile material that usually decomposes quickly, such as the skin and flesh of animals and fruits. Botanical material in latrine contexts appears to survive mostly by waterlogging, where anaerobic conditions prevent, or at least slow down decay of organic material by halting or slowing microbial activity.

In Green's discussion of the occurrence of mineralised seeds in archaeological sediments he notes that it was originally thought calcium phosphate replacement of botanical material in archaeological deposits only occurred in chalk land areas where calcium-rich ground water was readily available, but that later research revealed that mineralised botanical materials preserved by calcium phosphate had also been recovered from sites situated on clay and gravel subsoils. He states that the calcium in mineralised material could originate from lime deliberately thrown in a pit as a sterilising agent, and then being dissolved by percolating ground waters and being carried in solution to react with sources of phosphate. He notes also that calcium and phosphate can also originate from human faecal material and that it is also possible that it might originate from mammal and fish bones, fish scales and that even plant materials might be a source of calcium and phosphate, concluding that:

It thus appears possible ... that preservation by mineralisation is likely

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2 Jane Renfrew & others 1976 First Aid for Seeds p. 3
3 Jane Renfrew & others 1976 First Aid for Seeds p. 4
to be dependant upon soil type, the type of organic refuse and the appropriate circulation of groundwater.4

When describing the nature of these mineralised seeds, Green states that seeds preserved by phosphate are made up of mineral infillings which reproduce the original in varying degrees of perfection, ranging from a 'mere pseudomorph of the whole' to cellular replacement.5

He notes that the information gained from mineralised seeds falls into two categories; the first, is that since most botanical material preserved by phosphate mineralisation is recovered from faecal deposits (in particular cesspits and latrines), he is of the opinion that this material gives researchers an idea of the range of plants used for food consumption on a particular site, and that woody seeds, those that pass through the digestive tract unharmed, are the ones most likely to be preserved by fossilisation. The second is that, because a wide range of species are rarely recovered from sites with aerobic soils, seeds that usually are preserved only in waterlogged conditions may by mineralisation be preserved in sediments which appear to have completely aerobic conditions.6

Recovery Techniques

Recovery techniques for botanical remains fall into two broad categories, field techniques and laboratory techniques. For some techniques the variation between methods used in the field and laboratory do not vary a great deal, the distinction between the two being that field techniques are designed with bulk processing of soil in mind, while laboratories are better equipped to manage finer work, such as examining a deposit for very small scale remains. Both categories have their advantages and drawbacks, and provide different types of data, the choice to process material in one way or another depends upon the nature of the material being dealt with and the questions that are being asked of it.

There are a range of botanical recovery techniques used by archaeologists in field

4Francis J. Green 1979 'Phosphatic mineralisation of seeds' p. 281
5Francis J. Green 1979 'Phosphatic mineralisation of seeds' pp. 282-3
6Francis J. Green 1979, 'Phosphatic mineralisation of seeds' p. 283
situations, but generally they come down to three types:

**Dry Sieving**
Dry sieving is the most common small-scale artefact recovery technique. The type of sediment and its moisture content are important factors in determining how the screening will be accomplished and what classes of artefacts will be recovered in an undamaged condition. Only the sandiest of soils can be sieved with ease, most other types, in particular those with a high clay content, need to be pushed through the screen. Only artefacts larger than the openings in the mesh and stronger than the abrading action will be recoverable, such as ceramics, lithics, and pieces of bone and shell. Thus dry sieving is not recommended as a technique for recovering botanical remains, either macro or micro, as remains are likely to either pass through the relatively large mesh sizes employed in this type of sieving, or be damaged by abrasion against the mesh.

**Wet Sieving/Water Screening**
It should be noted that in the literature on this topic there exists a degree of overlap in the use of these terms, and although they are used interchangeably by different authors from different countries, they are essentially two different techniques. In order to clarify this matter, the term wet sieving is used here to describe the use of water to wash soil through a series of nested sieves, whilst water screening is the process whereby soil is washed through a single layer of mesh. Wet sieving, as mentioned above, is carried out using a series of nested sieves. Soil is spread on the uppermost screen and sprayed with a fine mist of water, taking care to regulate the pressure in order that more fragile remains are not destroyed and that more robust ones are not damaged. Researchers can expect to recover lithics, well preserved bone and ceramics down to the size of the smallest mesh opening when this technique is employed. However shell and botanical remains are often lost or damaged when using this technique and the mesh size required in order to process large amounts of soil in a field situation needs to be quite large, often too large to recover small-scale botanical remains satisfactorily, so it is not recommended as a field technique for their recovery. Water screening is a variation of this technique, where soil is either placed into a bucket made of screen mesh and lowered into water and agitated, or soil is placed on a single screen and washed with a jet of water. Soil and artefacts smaller

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7 Gail E. Wagner 1988 'Comparability among recovery techniques' p. 18
8 Gail E. Wagner 1988 'Comparability among recovery techniques' p. 19
than the screen openings are washed away, artefacts larger than the screen openings are washed and retained. This technique is somewhat gentler on artefacts than both dry or wet sieving, and is useful for recovering bone, ceramic, and lithic material, but botanical remains are still lost through the mesh openings, which are necessarily of a larger size than those used in wet sieving in order to allow soil particles to escape.  

**Flotation**

Wagner claims that this is generally considered to be the only technique that produces satisfactory recovery rates for botanical remains. Pearsall notes that flotation techniques were first developed by archaeologists separately in Europe and America in the 1960s but that these initially parallel developments have converged in recent years, establishing three basic ways of conducting flotation, by hand in a body of water (manual flotation), by machine-assisted water pressure, and by compressed air with frothing agents. In its simplest form, manual flotation, soil from an archaeological deposit is added to a body of liquid, usually water. Objects with a specific gravity less than that of the liquid are suspended and can be skimmed, siphoned or floated off. This material is called the light fraction, or by British practitioners, the 'flot'. The soil matrix passes through a screen in the bottom of the container. Objects that are heavier than the liquid but larger than the screen mesh in the bottom of the container are caught by the screen. This material is the 'heavy fraction', or 'residue'. The advantage of flotation over water screening and sieving is that fragile and non-dense artefacts, such as seeds, are suspended in a liquid and can be removed without abrasion.  

Pearsall notes that fine sieving (wet or dry, depending upon the nature of the deposit) gives better results than flotation when dealing with certain types of deposits such as waterlogged or very dry material. Arid conditions may result in preservation of uncharred botanical remains that would decay on other sites. However desiccated remains may be damaged by wetting, making flotation inappropriate. It is also important to remember that when sieving, efficiency of recovery is based entirely on mesh size. Waterlogged soils also produce poor botanical recovery rates when subjected to flotation, as air spaces in plant tissues are filled with water, thus the material does not float well. Non buoyant remains end up in the heavy fraction,  

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9Gail E. Wagner 1988 'Comparability among recovery techniques' p. 19  
10Gail E. Wagner 1988 'Comparability among recovery techniques' p. 19  
11Deborah Pearsall 1989 *Paleoethnobotany* p. 79
Alwynne Beaudoin kindly provided me with precise details on the laboratory technique she uses to recover macrobotanical remains from paleo-sediments. She gives wet sieving as the preferred technique, stating that flotation does not recover some types of remains well. The method she uses to recover botanical remains is as follows:

As noted above, these techniques have essentially been developed for use in the field, but the laboratory variations are not that different, the emphasis simply being upon more detailed recovery, which does mean that it is not possible to process as large volumes of material as in the field, but the recovery rates of smaller remains and more fragile materials are greater than in a field situation. The techniques described below are those trialed in this study in order to determine the best manner in which to recover botanical remains from Australian latrine deposits in a laboratory situation.

**Techniques used to recover macrobotanical remains**

Alwynne Beaudoin, kindly provided me with precise details on the laboratory technique she uses to recover macrobotanical remains from paleo-sediments. She gives wet sieving as the preferred technique, stating that flotation does not recover some types of remains well. The method she uses to recover botanical remains is as follows:

**Beaudoin's wet sieving technique**

1. Measure out 100 ml sample of soil into a beaker
2. Wash sample through a series of nested sieves using a fine jet of cold water.
3. Once the sample has washed through the sieves and has been reduced to several fractions on the screens, transfer to beakers for sorting.
4. Transfer small amounts of the material to a gridded petri dish and sort under a standard binocular dissecting microscope while still wet. (Use a glass petri dish, not plastic as they cause problems with static) The finest tweezers possible should be used to sort this material, as standard laboratory ones are too harsh. Beaudoin notes that the other essential tool for this

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12See Pearsall pp. 83-4 for more detail on this technique
If a deposit has a very high clay content it may, as mentioned above, be necessary to disaggregate it prior to processing in order to release any macrobotanical remains trapped in the soil matrix. If the soil has an extremely high clay content it may be necessary to use a greater concentration of dispersant. The technique I developed in order to disaggregate the Regentville material which had quite a high clay content, is described below.

This is the basic technique but Beaudoin includes several tips that make processing easier, such as pre soaking clay-rich samples in water before washing them through the sieves, as this helps to break up the soil, noting that at this stage some macro remains may float to the surface which can be skimmed off before processing the rest of the material. She adds that if a sample is cemented, or very clay-rich, it may need to be disaggregated prior to screening, but that most material can be processed simply by washing with water, noting that:

This stage is quite time-consuming but that it is worth taking time to produce clean, well-sorted residue.13

Beaudoin suggests that using a variety of mesh sizes makes residues easier to sort, noting that it is a good idea to start with a relatively large mesh, such as 850μm, 1 mm or even 3.35 (depending on the size of other, extraneous material that is also present in a sample) and then have at least two more below this, such as 500μm and 250μm. She feels that its only really necessary to sort down as fine as 250μm, even though she advises placing a sieve with finer mesh, such as 100μm below this in order to retain sediments that would otherwise block the drain of the sink. It is not necessary to sort this fraction.

If a deposit has a very high clay content it may, as mentioned above, be necessary to disaggregate it prior to processing in order to release any macrobotanical remains trapped in the soil matrix. If the soil has an extremely high clay content it may be necessary to use a greater concentration of dispersant. The technique I developed in order to disaggregate the Regentville material which had quite a high clay content, is described below.

Deflocculation Technique

1. Place the 100 ml of soil sample in a 1 litre beaker.
2. Add 20 ml deflocculant (I used sodium polymetaphosphate) and enough water to make up 400

13 A. Beaudoin Palaeoenvironmental Research Officer, Archaeological Survey, Provincial Museum of Alberta, Canada 1994, personal communication
ml soil and water solution.
3. Stir gently to break up any lumps that may remain and to help release any seeds that may be trapped in the soil matrix.
4. Leave to settle overnight, and the next day process in the same manner as outlined above

If a deposit contains a large amount of carbonised plant material then flotation methods should be used. Mechanical flotation systems are useful for processing large quantities of material, but the initial outlay for purchasing one of these systems may be beyond the scope of some researchers, even though the saving in labour costs when compared to manual flotation are felt to be quite considerable.14 A technique for manual flotation is given below.

Simple manual flotation in water

1. Fill a washing-up bowl with water.
2. Pour dry sample slowly and steadily into water, using one hand to stir the mixture and break up lumps.
3. Leave to stand for 10 minutes to allow the material to settle
4. Remove any carbonised flot, either by scooping it out with a sieve with mesh no larger than 1000μm or by pouring the water slowly through the sieve, and allow to dry slowly in the sieve. Do not allow the flot to stick to the side of the bowl while pouring off the water, this can be prevented by swirling the bowl gently while pouring.15

As has been noted above, seeds are also occasionally known to survive in deposits through mineralisation, and the fact that they are sometimes recovered from cesspit and latrine deposits is of relevance to this study. A technique for recovering this material is outlined below.

Green's Technique for recovering mineralised seeds

1. Disaggregate soil sample in water. If this proves difficult, as with soils with a high clay content, use 100 ml of 100 vol solution of Hydrogen Peroxide to 2500 ml of water to disaggregate 2500 ml of soil. Each sample usually takes between 10 and 15 minutes to disaggregate, although some heavier clays can take longer.
2. Wash sample through a 250μm sieve in order to remove finer particles of mineral soil and organic material.
3. Remove carbonised plant material and charcoal using simple manual flotation (uses Renfrew and others' technique).

14Deborah Pearsall 1989 *Paleoethnobotany* pp. 23-85
15Jane Renfrew & others, 1976 *First Aid for Seeds* p. 18
4. Sort 'flot' when charcoal sufficiently dry to examine without undue abrasion.

5. Sort residue wet immediately after flotation has occurred.

6. Once sorted, store mineralised seeds and other botanical material in alcohol, as prolonged exposure to the atmosphere causes disintegration.\(^{16}\)

This technique is essentially a combination of three techniques discussed previously; disaggregation, flotation and wet sieving. Although this technique was not trialed on either the Regentville or Jobbins Buildings deposits it appears to be a perfectly serviceable technique. The sieving stage is not dissimilar to Beaudoin's technique, but with ease of sorting of the residue in mind, I would recommend that a series of nested sieves, rather than a single sieve, be used. I feel that the flotation step is only necessary if one is interested in specifically recovering charcoal and carbonised material from samples. Again the technique used comes down to the type of deposit one is dealing with and the type of information one wishes to recover. It is felt that as the sieving stage of Green's technique is so similar to the wet sieving technique used in this study any mineralised seeds, if present, would have been recovered.

Both Beaudoin and Green recommend that the residue retained on the sieves be sorted while wet, and should be stored permanently in alcohol. This is an important point, as some researchers recommend drying botanical material prior to storage.\(^{17}\) A sample of seeds recovered from the Jobbins Building sample during sieving as a part of analysis for parasites were allowed to dry, in order to see what effect this would have upon them. These seeds, which prior to drying appeared perfectly preserved, exhibited large cracks after drying. It is thus felt that material from damp anaerobic deposits should be kept damp after processing and preserved in alcohol if long-term storage is required.

**Results of the analyses of deposits for macrobotanical remains**

When a sample of the Jobbins Building deposit was processed using the technique outlined by Beaudoin, numerous macrobotanical remains were recovered, including the seeds of grapes, melons (most probably watermelons), passionfruit or pawpaw, and poppy seeds, as well as some fragments of cereal straw (not the remains of cereal bran, as has been reported by other researchers studying the remains of faecal material). It is important to note that no very large fruit seeds were recovered from

\(^{16}\)Francis J. Green 1979 'Phosphatic mineralisation of seeds' pp. 281-2

\(^{17}\)Deborah Pearsall 1989 *Paleoethnobotany* pp. 15-102
this sample, although Lydon reports that the seeds of peach, grape, apricot, plum, loquat and citrus were recovered from another sample taken from the same deposit.\(^ {18}\)

When samples from the Regentville latrine deposit were analysed for botanical remains using Beaudoin's wet sieving technique, no seeds, only woody twig-like structures were recovered. Closer inspection revealed that they were not twigs but rather tree roots with the outer covering of bark still intact. Also present were some fragments of grass stems. It seemed unlikely, from the distinct absence of other types of macrobotanical remains in this deposit (such as the seeds of edible plants) that these remains dated from the period when the latrine was in use. In order to determine the age of this material, a test for the presence of lignin was conducted.\(^ {19}\) Lignin is a good indicator of the age of a sample of botanical material, and is usually not present in samples of material more than ten years old, the intensity of the colour being an indication of the amount of lignin present. A sample of woody root with its bark covering still intact taken from unit 425X15 from Regentville turned a very deep red, demonstrating that a high amount of lignin was still present in the sample. The presence of a high amount of lignin, and the fact that the bark covering was still intact indicates that this material was quite recent, certainly less than ten years old. The presence of this material in the deposit can be explained by tree roots growing into the drain at the time of excavation.

As noted earlier, flotation is the technique of choice for recovering large amounts of carbonised remains. Simple manual flotation was trialed on the Regentville deposit, as a number of black specks thought to be charcoal were present and flotation was felt to be the best technique to use when attempting to recover them. The charcoal in this material did float, although the other black specks were revealed to be particles of coke, as discussed in Section Six. Flotation also recovered some very fine modern root fragments. Flotation was not attempted on the sample from the Jobbins Building deposit, as no visible charcoal remains were present and the botanical material had been preserved by waterlogging and an anaerobic environment, rather than by carbonisation.

\(^ {18}\)Jane Lydon 1993 *Archaeological Investigation of the Jobbins Building* p. 23

\(^ {19}\)A 1% solution of Phloroglucinol is made up using 1 gram of phloroglucinol in 100 ml of ethyl alcohol. A small amount of this solution is applied to a freshly cut section of root or grass fragments, and then a small amount of concentrated hydrochloric acid is applied on top of this, and the samples are left for 30 seconds in order to allow the solutions to react. If after this stage the treated material turns red or pink, lignin is present.
Section Four
Review of Literature on Parasite Eggs in Latrine Deposits

As with the other forms of organic data that can be recovered from latrine deposits, a review of the literature on past studies of parasite eggs from latrine deposits was conducted in order to determine the types of parasite eggs most likely to survive in latrine deposits and the techniques used to recover them. It should be noted that the recovery of the eggs of parasites, as opposed to the actual bodies of the parasites themselves is the aim of all of these studies, as the bodies of parasites themselves are unlikely to survive in archaeological deposits, and it is the presence of their eggs that is the primary indicator of faecal material.

The first examination of an archaeological deposit for parasitological data was conducted by Taylor in 1955 on the contents of a wood-lined medieval pit in Winchester. Taylor described the material examined as:

a layer of consolidated material of a dark greenish-grey colour and a consistency approaching that of peat.\(^1\)

The eggs of three parasites, two nematodes and one trematode, were recovered from this deposit, *Trichuris trichiura* (whipworm), *Ascaris lumbricoides* (large round worm), and *Dicrocoelium dendriticum* (a liver fluke of sheep, deer, and very occasionally, humans). Because of the similarity in size and shape between the eggs of the species of *Ascaris* and *Trichuris* in humans, and those in pigs, Taylor found it impossible to establish whether the material contained within the pit represented the contents of a medieval latrine, or if the pit was a receptacle for pig manure, or both. Because no attempt was made to recover other forms of organic material, such as pollen or macrobotanical remains, the use of the pit and the origin of its contents remain uncertain.

The next report of the discovery of parasites in an archaeological context came in 1966, when eggs of *A. lumbricoides*, *T. trichura* and *D. dendriticum* were discovered in material excavated from another medieval wood-lined pit in Winchester, not far from the site of the pit previously examined by Taylor. Pike and Biddle describe the contents of the pit as being dark green-brown in colour, containing distinct layers and compacted into a solid mass. They

\(^1\) E. L. Taylor 1955 'Parasitic helminths in mediaeval remains' pp. 216-18
report that the layers readily separated to reveal the macroscopic remains of plant material, seeds, bones and insect pupal cases. Recovery of parasite remains was achieved by the use of a standard parasitological flotation technique, using an aqueous solution of zinc sulphate (specific gravity 1.3) as the flotation medium. Large numbers of eggs of all three parasites were recovered, all well preserved and easily recognisable. Again, the investigators were unable to identify them to species level, although it was felt that the presence of parasites along with edible plant remains was evidence enough to suggest the use of the pit as a cesspit, into which a wide range of refuse was deposited.

Most work on the recovery of parasite eggs from archaeological deposits attributes the survival of these eggs to the constant waterlogged condition of the deposits between the period of deposition and subsequent excavation. However, as Jones and others have reported, parasite remains may be recoverable from types of deposits previously thought unsuitable for their survival. They report the recovery of parasite eggs from Bronze Age deposits of wind-blown sand and colluvium in Scotland, and in dry, dusty sediments from a stone-lined latrine pit in York in use between the fourteenth and sixteenth centuries. Eggs of *Trichuris* sp. and *Ascaris* sp. were found in two of the thirteen samples taken from the contents of the pit, with the bulk of the fills being building rubble. As the authors note:

The analyses suggest that traces of human excrement were present in the pit but they became very diluted by the addition of a large volume of builders' rubble. What is more unexpected is that ova were present at all in dry, mortar- and rubble-rich deposits.

Numerous studies have, therefore been conducted upon medieval and even earlier material, but few upon material of equivalent age to the Regentville and Jobbins Buildings deposits. I encountered only two published accounts of investigations of nineteenth-century latrine deposits from the USA when conducting this review, one from New York and the other from Newport, Rhode Island. The latrine deposits discussed by Geismar were excavated from two mid to late nineteenth-century privy pits excavated in 1987 on the Greenwich Mews site, a development site situated in New York City's Greenwich Village Historic District. Although two pits were excavated, samples were taken and analysis conducted on the deposit from only one of the privies. The remains of pollen, seeds and *Trichuris* eggs were recovered.

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2 Alan W. Pike & Martin Biddle 1966 'Parasite eggs in medieval Winchester' pp. 293-96
4 At least one other has been studied from Colonial Williamsburg, but I know of no publication of the material, and attempts to contact the current director of the archaeological program there have proved unsuccessful.
5 Joan Geismar 1993 'Where is Night Soil?' p. 57
Karl Reinhard, who conducted the parasitological analysis of this deposit reported that the shells of the parasite eggs were well preserved, but the embryos within had decomposed. He suggested that the low concentration of eggs within these deposits indicates either that parasitism on the site was low at the outset, or that the eggs had been washed out of the coarse soil matrix. Ascaris and Trichuris have similar life cycles, are frequently found in association with each other in modern human populations, and are 'almost invariably recovered together' from historic period latrine deposits in Europe and North America. Reinhard states that the absence of Ascaris eggs from the Greenwich Mews material:

suggests that either vermifugic medicine were used that reduced Ascaris parasitism in Greenwich Village or that differential preservation allowed for the recovery of Trichuris eggs but not Ascaris eggs. Considering the excellent preservation of the parasite eggs, and microscopic remains in general, differential preservation seems to be an unlikely factor.

One major point stands in the way of this interpretation: that knowledge of intestinal parasites, and means of eliminating them was not available at the time that this latrine was being used and the deposit being studied was being formed. As Reinhard notes, Ascaris and Trichuris are often found in association in modern populations as they have similar life cycles and modes of transmission. It is more likely that the eggs of the two types of parasites were differentially preserved, especially as this result is not an isolated case, as no Ascaris eggs were recovered from the Jobbins Building cess pit deposit.

Reinhard suggests that the low numbers of helminth eggs present in the latrine soil could be due to three factors, either working separately or in combination. First, that parasite eggs in some latrines appear to be concentrated in certain levels of latrine deposits. In German medieval latrines, eggs appear to be more common in the upper levels, in the investigation of the Newport, Rhode Island latrines, they were largely found in the lower levels, while in soils from a prehistoric Amerindian latrine in Arizona, eggs were concentrated in the upper levels. The restricted sampling of the latrine levels at the Greenwich Mews site may have missed the levels in which parasite eggs were most concentrated. Thus it cannot be emphasised too strongly the need for excavators to take as large and frequent samples of these types of deposits as possible. This is an issue that will be discussed later in greater depth. The second

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6 Karl J. Reinhard 1989 'Parasite and pollen analyses (Appendix G)' in Geismar Greenwich Mews p. 235
7 Karl J. Reinhard 1989 'Parasite and pollen analyses (Appendix G)' in Geismar's Greenwich Mews p. 237
8 Henry Collins, Department of Veterinary Pathology, University of Sydney 1994, personal communication
9 Karl J. Reinhard 1989 'Parasite and pollen analyses (Appendix G)' in Geismar Greenwich Mews p. 237
factor could be that water percolating through the latrine soils may have dispersed the eggs into different levels and caused a reduction of total eggs in any given sample. Finally, there is the possibility that levels of parasitism on the site may have been low to begin with.

Reinhard states that evidence from the deposit lends support to the occurrence of the last two factors. Helminth eggs were found in samples from the lower levels of the latrine which were devoid of macroscopic remains, suggesting that downward water movement led to the displacement of eggs. He feels that the lack of *Ascaris* eggs suggests that parasitism was limited at the site with respect to species diversity, and that if diversity was limited, then it is also likely that over-all parasitism on the site was reduced, thereby resulting in low egg per gram count results. The processes by which parasite eggs are deposited within latrine sediments and factors that lead to their preservation or destruction are presented in the form of a model and discussed in greater depth in section seven.

The lack of *Ascaris* eggs in the Jobbins' Buildings deposit, and the complete absence of *Ascaris* and *Trichuris* eggs from the Regentville deposit may be due to one or more of these factors. However the lack of comparative material from other Australian deposits means that a similar situation can only be guessed at. It may emerge from later studies that *Ascaris* do not survive well, or at all, in Australian latrine deposits.

The other published study of historic-period latrine contents in the USA was conducted upon latrine soils excavated from two eighteenth century privies at Queen Ann Square in Newport, Rhode Island. *Trichuris* eggs were found in both deposits, but eggs of *Ascaris* were found in only one, while hookworm and taeniid eggs were found in the other.

The results of these two studies of American material of a date roughly contemporary with the deposit from the Regentville latrine and the Jobbin's Building cess pit, and those conducted on material of a much earlier date in Europe, formed a background for the present study.

Most researchers discussing the recovery of helminth eggs from archaeological latrine soils make reference to the techniques they used to recover parasite remains, but few actually describe the procedures used and the sampling strategy and chemicals that are needed. Some

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10Karl J. Reinhard 1989 'Parasite and pollen analyses (Appendix G)' in Geismar *Greenwich Mews* pp. 237-8
notable exceptions are Reinhard, Pike, Limbrey and Jones.\textsuperscript{11} This places newcomers to the field of archaeoparasitology at a distinct disadvantage, as without an experienced practitioner to turn to for advice, they are forced to resort to experimentation with procedures and quantities of materials in order to retrieve meaningful data from their material. Although no one technique can be guaranteed to be successful in all cases, detailed descriptions of several techniques and the reasoning behind their usage with suggestions on variations that may be necessary to suit certain types of material and recommendations on how to store material between the period of excavation and analysis and size of samples needed are an important first step.

The first detailed description of techniques for recovering helminth eggs from latrine soils comes from the work of Pike and Biddle in 1966, although a slightly more detailed description appears in Pike's 1967 work.\textsuperscript{12} The technique they used for recovering helminth eggs from a medieval latrine deposit in Winchester is as follows.

**Zinc Sulphate Flotation Technique**

1. Measure out 1-2 grams of sample and grind up in water.
2. Wash material several times in order to remove colouring matter.
3. Centrifuge when supernatant clear.
4. Mix sediment in centrifuge tube with zinc sulphate solution. (Specific gravity 1.3)
5. Place coverslip on top of surface film and then transfer to a microscope slide for viewing.\textsuperscript{13}

The brief instructions given for this technique assume some prior knowledge of 'standard helminthological techniques' and fail to provide important information on the time period required between washes of sediments in order to allow material to settle, and speed and time required for centrifugation. Small points perhaps, but important ones that influence the results of this type of analysis. Pike and Biddle note that most types of parasite eggs will float in zinc.


\textsuperscript{12}Alan W. Pike & Martin Biddle 1966 'Parasite eggs in medieval Winchester' pp. 293-96, Alan W. Pike 1967 'The recovery of parasite eggs from ancient cesspit and latrine deposits' in Brothwell & Sandison (eds) *Disease in Antiquity* pp. 184-8

\textsuperscript{13}Alan W. Pike 1967 'The recovery of parasite eggs from ancient cesspit and latrine deposits' in Brothwell & Sandison (eds) *Disease in Antiquity* p. 187
sulphate solution, but Pike adds in his later paper that as some more delicate eggs have a tendency to collapse in this solution, samples of soil should also be treated by simple sedimentation techniques in order to recover such eggs.\textsuperscript{14} Again, prior knowledge is assumed and no explanation of the technique is given. Pike notes that the zinc sulphate and sedimentation techniques worked because the soil was moist and appeared to have remained that way since deposition, and suggests that dried material such as coprolites would require some rehydration before eggs could be recognised with ease. He suggests that material be soaked in a 0.5 percent solution of trisodium phosphate for 72 hours or more, a technique derived from the work of Callen.\textsuperscript{15}

Limbrey addresses the issue of preservation of helminth eggs in latrine deposits, stating that they are unlikely to be found in a deposit where no macroscopic remains have survived. She suggests that if there is a possibility that helminth eggs may be present then the following technique may be used for their recovery.

Sodium Hydroxide Flotation Technique

1. Make up a solution of water softener or sodium hydroxide to a specific gravity of 1.3, and add to a sample of deposit. Limbrey notes that this solution disperses humus substances and releases surviving residues, with any floating material then accumulating around the edge of the container.

2. Skim off the scum that accumulates there with a fine paintbrush and transfer to a microscope slide for viewing.

Limbrey notes that this technique is simpler than the one used by Pike, and has the advantage that the soil does not have to be ground up in order to release the organic residues, and that the dispersal of humus substances (ie decayed organic matter, carbon etc,) leaves them in a clearer and more recognisable state.\textsuperscript{16}

The method outlined below is that used by Reinhard in his investigation of the Greenwich Mews latrine samples.

Zinc Bromide Technique

1. Measure out 50 ml of material from each soil sample and weigh it.

\textsuperscript{14} Alan W. Pike & Martin Biddle 1966, 'Parasite eggs in medieval Winchester' p. 294, Alan W Pike 1967 'The recovery of parasite eggs from ancient cesspit and latrine deposits' in Brothwell & Sandison (eds) Disease in Antiquity. p. 187

\textsuperscript{15} P. O. Callen 1969 'Diet as revealed by coprolites' in Brothwell & Higgs (eds) Science and Archaeology pp. 235-243

\textsuperscript{16} Susan Limbrey 1975 Soil Science and Archaeology p. 327
2. To each sample add one *Lycopodium* tablet.\(^{17}\)

3. Disaggregate soil samples with hydrochloric acid and distilled water.

4. Screen the acid, water and soil mixture through a 200 micron mesh screen to remove macroscopic debris.

5. Concentrate the sediments that pass through the screen by centrifugation and wash several times with distilled water.

6. Treat the concentrated sediments in 72% hydrofluoric acid for 24 hours. (This step acts to remove silicates that otherwise complicate microscopic analysis)

7. Remove sediments from hydrofluoric acid and wash several times in distilled water.

8. Float sediments in 77% zinc bromide (specific gravity 1.9) in order to remove heavy organics.

9. Subsample the sediments and examine for parasite eggs.\(^{18}\)

Again the problem arises that the precise details of this technique have not been adequately explained, such as the amount of hydrochloric acid required to sufficiently dis aggregate soil, the speed and length of time that the sediments must be centrifuged for and whether the sediments were rinsed after flotation in zinc bromide or subsampled directly.

Pike, Reinhard and Limbrey's techniques are variations upon standard clinical flotation techniques used by parasitologists in order to concentrate parasite eggs from faecal material. When investigating pit samples from one medieval and one Viking site at York, Jones employed a modified 'Stoll' technique (a quantitative test developed in order to calculate the number of eggs per gram in fresh faeces) in order to gain an indication of the number of eggs per gram present in each pit sample. The method for this is as follows:

**Modified 'Stoll' Technique**

1. Dissaggregate a 3 ml sample in 42 ml water.

2. Filter through a 250\(\mu\)m mesh to remove coarse particles.

3. Examine 0.15 ml aliquots of filtrate in their entirety for parasite ova.

4. Calculate the number of ova per gram by multiplying the number of eggs observed by 100

Jones advises that in samples where ova are particularly common, a 0.05 ml aliquot of the sample can be examined and the number of eggs counted multiplied by 300. This technique is designed for use in counting *Trichurid* ova, there is no reason why it could not be applied to *Ascaris* ova as well.\(^{19}\) Jones notes that once biological investigations had been completed on

\(^{17}\) *Lycopodium* tablets contain a known number of spores and are used for the purpose of quantification, by comparing the number of spores visible in a field of view to the number of parasite eggs.

\(^{18}\) Karl J. Reinhard 1989 'Parasite and pollen analyses (Appendix G)' in Geismar *Greenwich Mews* pp. 233-4

\(^{19}\) Andrew K. G. Jones 1985 'Trichurid ova in archaeological deposits' in Fieller, Gilbertson & Ralph (eds)
the samples from the pits, the remaining untreated sediment was examined carefully using field techniques. He reports that all samples contained large amounts of fine organic matter, but that none were distinguishable from adjacent samples on the grounds of colour, moisture content or texture, stating that:

This example demonstrates how difficult it is to tell the origin of a layer without the use of a microscope and illustrates the need for rigorous sampling.20

Some researchers have mentioned the occasional discovery of helminth eggs in pollen preparations, prompting them to investigate whether pollen recovery techniques could be used as a tool for also recovering parasite remains. Parasite eggs are noted for their durability, as the shells are composed of chitin, the same material as the exoskeletons of beetles. If well preserved, parasite eggs from archaeological contexts should be able to survive the rigours of palynological processing techniques. Reinhard and others report that palynological extraction techniques were applied to latrine soils from Queen Ann Square in Rhode Island, with good results. The pollen extraction process involves immersing sediments in sequential baths of concentrated hydrochloric acid, water, hot 40% hydrofluoric acid, water, glacial acetic acid, hot acetalysis solution, glacial acetic acid, water, potassium hydroxide and water. Using this technique Reinhard was able to recover sufficient numbers of eggs to allow for quantification and comparison between the soils of the different latrines from the one site, also noting that in a comparative study of *Ascaris* eggs recovered from these latrines, those recovered by palynological processing had rough coats with visible surface sculpturing, very similar to the appearance of *Ascaris* eggs when fresh.21 This indicates that if eggs survive palynological processing, they may also be 'cleaned' as part of the process.

In order to evaluate the durability of helminth eggs undergoing processing by palynological techniques, researchers treated a modern faecal sample containing the eggs of *A. lumbricoides, Clonorchis sinesis, Schistosoma japonicum* and *Taenia psiformis* by the process described above, with samples taken at the end of each stage. No reduction in overall numbers of eggs, nor a change in the ratios of the types of eggs present was noted until the acetalysis stage. This treatment destroyed all the eggs of *A. lumbricoides* and *S. japonicum*, and many of the *T. psiformis* eggs. Reinhard and others conclude that this experiment demonstrates that processing latrine sediments with palynological extraction techniques is not

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20Andrew K. G. Jones 1985 'Trichurid ova in archaeological deposits' in Fieller, Gilbertson & Ralph (eds) *Paleobiological Investigations: Research Design, Methods and Data Analysis* p. 109

21Karl J. Reinhard & others 1988 'Recovery of parasite remains from coprolites and latrines' pp. 226-7
the best way to recover helminth eggs. They attribute the survival of eggs in soils that have undergone pollen processing to a high cellulose and hemicellulose content of these soils, neutralising the acetolysis solution before complete destruction of helminth eggs occurred. They suggest that if this technique is used, as it can be beneficial in cleaning eggs and making surface morphological features more visible, another technique should also be applied to material from the same deposit in order to recover more fragile eggs that may be destroyed by this process.22 No mention is made of the effect that such processing may have upon *Trichuris* eggs.

As has been noted above, although previous researchers have discussed the techniques used to recover parasite remains from latrine deposits, they have failed to adequately describe in detail how to actually use these techniques to recover parasite eggs. As a result it was necessary to devise techniques of my own in order to attempt the recovery of parasite eggs from the latrine deposits discussed in this study. These techniques are covered in Section Five.

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22Karl J. Reinhard & others 1988 'Recovery of parasite remains from coprolites and latrines' p. 224
Section Five
Techniques for the Recovery of Parasite Eggs

As was discussed in Section Four, the current study has identified a gap in the literature relating to the field of archaeoparasitology. There is no clear, detailed, step-by-step technique published in any of the papers reviewed on the procedures for parasitological analysis of latrine soils. Naturally no one technique will prove suitable for use on all deposits or in all situations, but with an adequately detailed technique as a reference, researchers can alter the techniques they use to suit their needs and the material they are dealing with. So a major part of the work for this thesis has been in developing a technique suitable for the extraction of helminth eggs from Australian latrine deposits.

A protocol was devised and applied to a sample from the Regentville deposit. It was necessary to add an amount of fresh faecal material known to be infected with parasites to the sample in order to establish whether the actual process of sampling deposits for helminth eggs was destroying them or not.

**PROTOCOL FOR DETECTION & RECOVERY OF PARASITE EGGS**

The objectives that were sought to be achieved by the development and application of this protocol were first, to devise an efficient test for the detection of eggs of helminth parasites in latrine soils from historical sites, second to investigate the latrine deposit from Regentville for the presence of helminth eggs, and third, to examine similar material of equivalent age from the Jobbins Building cess pit, employing the technique developed here. The method employed is outlined below.

1. Take 70 grams samples of soil and add 30 grams of infected faecal material (10 grams of sheep faeces containing *Haemonchus contortus*, 10 grams of pig faeces containing *Ascaris suum* and 10 grams of dog faeces containing eggs of *Trichuris vulpis*).^1^ Divide the material into two 50 gram samples, samples A and B.

2. Place each sample in a suitable sized container (500ml beakers are a good size). To sample A add 20ml of the deflocculant sodium polymetaphosphate, to sample B add 10 ml of hydrochloric acid. Add enough distilled water to both samples to make up 400mls of soil solution. Stir each sample gently until no obvious lumps of soil remain. Leave for 5 minutes to ensure that each sample is thoroughly disaggregated.

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^1^These three types of parasite eggs are similar in size, shape and structure respectively to those of *Necator americanus* & *Ancylostoma duodenale* (human hookworms), *Ascaris lumbricoides* (large human roundworm), and *Trichuris trichiura* (human whipworm).
3. Sieve each sample through a 200μm sieve, saving the sediments washed through the sieve in a beaker.

4. Leave the sediments to settle out for 24 hours. Pour or vacuum off the supernatant liquid taking care not to disturb the sediments.

4A. Mix part of samples A and B with 1:10 distilled water and centrifuge at 2500 rpm for 5 minutes. Vacuum off supernatant liquid.

5. Treat parts of both samples A and B in 3 different ways:

5.1 Mix 1:10 saturated salt solution (specific gravity 1.2)

5.2 Mix 1:10 50 percent concentration potassium iodide (specific gravity c. 1.35)

5.3 Mix 1:10 100 percent concentration potassium iodide (specific gravity 1.7)

6. Perform standard flotation test - centrifuge at 2500 rpm for 5 minutes. Fill vials to the top with extra solution and place coverslip on top of the slightly positive meniscus, taking care not to let the vial overflow, otherwise any parasite eggs present will run down the sides of the vial and be lost.

7. Using a binocular microscope set at 40x magnification, count any eggs present in 5 fields of view

Several important results came from the application of this process to the deposit/infected material mixture.

First, *Trichuris* eggs survived processing in all of the different solutions. Second, no *Ascaris* eggs were recovered by flotation. It was later discovered that the sample of formalised *Ascaris suum* eggs used had been preserved in formalin for 20 years and had lost their ability to float. Third, no *H. contortus* eggs were recovered from the samples treated with hydrochloric acid, only from the samples treated with dispersant when sodium chloride solution was used. When flotation was attempted with potassium iodide, both at 100 percent and at 50 percent, *H. contortus* eggs were present only on the slides made up from the material treated with dispersant (as opposed to hydrochloric acid). When these slides were being viewed under the microscope, it was possible to see the eggs becoming bleached and gradually destroyed as time progressed, so much so that half an hour after the slides were made up, all the eggs initially present had been destroyed. This was attributed to the high specific gravity of the potassium iodide solution causing the eggs to distort and disturbing their internal structure. This can be a problem when using any solution of such a high specific gravity, while potassium iodide solution also contains a bleaching agent which removes most of the colour from the eggs.

The conclusion was reached that although solutions of high specific gravity may provide better chances of recovering eggs from infected material, the damage that may result, especially when using this solution, outweighs any benefits that this may have. Although eggs of a type such as *H. contortus* are generally considered too fragile to survive in an archaeological context, care must be taken with solutions used for the recovery of the eggs of any species of parasites, as eggs that do survive in archaeological contexts may become quite fragile over time and may be destroyed by the use of such harsh treatments. This has been noted also previously in section four in the discussion of the use of palynological extraction.
techniques for parasite recovery. The emphasis on recovering eggs from archaeological contexts should be just that, recovery, and the use of techniques that may in any way damage or destroy eggs should be avoided.

These experiments established that disaggregating soils with a dispersant such as sodium polymetaphosphate, and using a flotation agent with a relatively low specific gravity such as sodium chloride, would be the best manner in which to treat the samples from both Regentville and the Jobbins' Buildings. The modified technique is described below

Sodium Chloride Flotation Technique

1. Measure out a 50 ml sample of material.

2. Place sample in a suitable sized container (500 ml beakers are a good size). Add 20 ml of sodium poly metaphosphate and enough distilled water to make up 400 ml of soil solution. Stir gently until no obvious lumps of soil remain. Leave for 5 minutes to ensure that the material is thoroughly disaggregated.

3. Sieve soil, water and dispersant solution through a 200μm sieve, saving the sediments washed through the sieve in a beaker. Examine the material retained in the sieve for artefacts or macro botanical remains if desired.

4. Leave the sediments to settle out for 24 hours. Pour or vacuum off the supernatant liquid taking care not to disturb the sediments.

5. Pour about 3-4 ml of sediment into a centrifuge vial and top up with distilled water to within about 1 cm from the top and centrifuge at 2500 rpm for 5 minutes. Vacuum off supernatant liquid.

6. Add saturated salt solution (specific gravity 1.2) and fill vial to within 5 mm of the top. Centrifuge at 2500 rpm for 5 minutes.

7. Fill vials to the top with extra solution and place coverslip on top of the slightly positive meniscus, taking care not to let the vial overflow, otherwise any parasite eggs present will run down the sides of the vial and be lost.

7. Using a binocular microscope set at 40x magnification, count any eggs present in 5 fields of view

No helminth eggs were found in any of the samples taken from the Regentville or Jobbins Building deposits. At first it was felt that this was because no eggs had survived in this material, which was an acceptable explanation for the Regentville material where

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2Sodium polymetaphosphate is a standard dispersant used in soil science, 50 ml of dispersant is added to enough water to make up 1 litre of solution, which is sufficient for dispersing 50 grams of a sandy loam such as the Regentville latrine deposit. Heavy clay soils will require a greater concentration of dispersant in solution.
preservation of other types of organic materials was poor, but not for the Jobbins' Buildings material, where well preserved seeds and eggshell had been recovered. The possibility existed that parasite eggs had survived in this deposit but that for some reason their ability to float had been retarded, and were not being recovered by the sodium chloride flotation technique. The basic premise behind the use of clinical flotation techniques is that parasite eggs will usually float in solutions of high specific gravity, 1.2 or higher. However a problem emerges when eggs have been subjected to conditions that affect their ability to float. The use of only clinical flotation techniques upon deposits in which the parasite eggs have had their ability to float retarded may in these cases lead to a false conclusion that no parasite eggs have survived. Although flotation is simple, researchers are able to process several samples at a time and slides are relatively easy to view, if eggs are not recovered it may suggest that the technique does not work with a particular deposit, and not just that the deposit is devoid of eggs. As Reinhard and others state:

In general, clinical techniques have found to be insufficient for one primary reason: since eggs appear in various states of preservation, their specific weight is influenced in various directions ... in some cases, clinical techniques have been found to be completely ineffective in isolating parasite eggs from latrine soils.3

It is interesting to note that Reinhard and others have also experienced problems with eggs that do not float, but fail to provide any information on a technique, or techniques that can be used if flotation fails.

Because flotation failed to recover helminth eggs from either Regentville or Jobbins Building, the decision was made to try another type of technique; sedimentation. The value of using this technique lies in the fact that it is not reliant upon the buoyancy of helminth eggs in order for them to be recovered.

Standard Sedimentation Technique

1. Measure out 15 ml of soil.
2. Mix with enough water in a beaker to make up a soil solution. (If the soil has a high clay content it will be necessary to add dispersant to break up the soil during this process)
3. Sieve soil and water mixture through a 200μm mesh sieve.
4. Allow sediments to settle for 5-10 minutes and then vacuum off supernatant. Repeat this process until the supernatant is clear. Vacuum off final supernatant.
5. Pipette up a sample of sediment and make up a slide with it.

3Karl J Reinhard, Ulisses E Confalonieri, Bernd Herrmann, Luiz F. Ferreira & Adauto J.G. de Araujo 1988 'Recovery of parasite remains from coprolites and latrines': 224
When this technique was applied to a sample of the material from the Jobbins Building deposit, *Trichuris* eggs were recovered (see figure 5.1), although no *Ascaris* eggs were found. Even at this stage it was uncertain that the eggs recovered were actually human parasite eggs from this deposit, this finding could have been a result of contamination within the laboratory, through the use of sieves used previously to sieve faecal material that was known to be infected with parasite eggs. In order to rule out the possibility of contamination, the sedimentation test was run again on another 15 ml sample of the Jobbins Building deposit, with the 200μm mesh sieve being replaced by a fresh piece of window screen mesh (2 mm) that had not ever been used for screening faecal material. *Trichuris* eggs were found in this sample also, so the question of contamination was ruled out. The use of this larger mesh of course allowed coarser particles of sediment to pass through the sieving stage, making examination of the resultant microscope slide more difficult, and thus is not recommended for use in normal practice. Once it was established that the sieves used were not a source of contamination, another sample was tested, this time sieving through a 63μm mesh sieve. The use of this much finer mesh produces a much 'cleaner' slide when viewed, and allows for a greater concentration of microscopic material, but great care must be taken that this material is washed thoroughly through the sieve, and that larger quantities of soil are not used, as this mesh size is only 3μm larger than the largest of the size range of *T. trichiura* eggs, and smaller than the entire size range of *T. vulpis* eggs so there is the possibility that some eggs may not pass through the mesh. This is important if there is the possibility that a deposit may have also contained the faeces of other animals such as dogs. With this in mind it is recommended that 100μm mesh be the smallest size used when sieving material as part of a parasite recovery technique. The end result of these tests does demonstrate though that sedimentation can prove to be successful in recovering helminth eggs from latrine material when flotation fails.
Figure 5.1.
Egg of *Trichuris trichiura* recovered from the Jobbins Building cess pit deposit.
Figure 5.2: Size ranges of eggs of different parasite species

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Range of egg length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascaris lumbricoides</td>
<td>55µm (average fertilised)</td>
</tr>
<tr>
<td></td>
<td>90µm (average unfertilised)</td>
</tr>
<tr>
<td>Ascaris suum</td>
<td>50-75µm</td>
</tr>
<tr>
<td>Trichuris trichiura</td>
<td>50µm (average)</td>
</tr>
<tr>
<td>Trichuris suis</td>
<td>50-60µm</td>
</tr>
<tr>
<td>Trichuris vulpis</td>
<td>70-89 µm</td>
</tr>
</tbody>
</table>

Naturally the question arises of how it was possible to be certain that the *Trichuris* eggs recovered from the Jobbins Building deposit were of human origin and had not come from the faeces of other animals. As figure 5.2 shows, the difference in egg lengths between species of parasites can be quite marked, and this variation is the primary means by which it is possible to differentiate between certain species. As the table demonstrates, it is quite easy, by measurement to distinguish between the eggs of *T. vulpis* and *T. trichiura*. The eggs recovered from the Jobbins Building deposit had an average length of 51 µm, which ruled out any possibility that the faecal content of this deposit derived from a canine source. However there is a great similarity in size between the eggs of *T. trichiura* and *T. suis*, a similarity noted in the work of Taylor (as discussed at the beginning of section four) who felt unable to give a positive identification of the faecal material in a deposit from Winchester as either porcine or human in origin, as there existed the possibility that pig faeces may have comprised all or part of the faecal material in the deposit. Given that it is fairly unlikely that pigs were kept in the yard of the middle-class boarding house from which the Jobbins Building deposit came, and that the structure from which the deposit came has positively identified by the excavator as a cess pit, it is felt highly unlikely that the parasite eggs recovered from this deposit were any other than those of *T. trichiura* and that the deposit originated from human faeces.

There are many factors that can influence whether parasite eggs will or will not survive in latrine sediments, and this study has demonstrated conclusively that there is a very real

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danger of failing to recover eggs when relying only upon the use of clinical flotation techniques for recovery, even though eggs may be present. Awareness of these factors means that steps can be taken in order to reduce as much as possible any errors they may cause in interpretation and identification of these deposits. Issues of preservation and recovery of parasite eggs are central to the identification and interpretation of latrine deposits hence the real need for the development of a model that outlines the various phases of parasite deposition and recovery. A preliminary version of this model is presented in Section Seven.
Section Six
Physical and Chemical Examination of the Deposits

The deposits from the Regentville latrine failed to yield the macrobotanical, and more importantly, parasite remains that a latrine deposit (as can be seen from the survey of the literature discussed in Sections Two, Three and Four), would be expected to contain. As discussed previously, the surviving structural remains were sufficient to identify the actual structure these deposits were excavated from as a latrine, so clues were sought as to what bearing the physical and chemical properties of the deposits would have upon the preservation or destruction of the organic remains that they once contained. The same tests were also conducted on the sample from the Jobbins Building cess pit which did yield macrobotanical and parasite remains in order to provide a control sample. Testing of archaeological soils provides information on the nature of the deposits being dealt with. The archaeological interest of a soil sample taken from a site lies in to what degree it differs from the 'parent' soil on the site that it formed from. These differences can provide data on past human activity on a site that cannot be gained from any other source. The results of the soils analyses of the Regentville and Jobbins Buildings deposits are shown in Figure 6.1.

Most analyses of archaeological latrine soils have been conducted on medieval material from Britain. When these deposits are described in the literature, their greenish peat-like nature is almost invariably mentioned. This has come to be seen as the 'classic' nightsoil deposit, although it is not of course the only kind of latrine deposit that is ever recovered. Geismar noted in her paper that the latrines from the Greenwich Mews site did not contain any 'classic' nightsoil material, yet analysis of the latrine deposits yielded intestinal parasite eggs, pollen and macrobotanical plant remains. It is clear then that the nature of surviving latrine deposits can vary greatly, and thus it is necessary to conduct tests for analysing the nature of the soils that comprise these deposits in order to determine aspects of the physical and chemical characteristics of the soil that may have a bearing on whether organic remains survive or are destroyed in these deposits.

1Joan Geismar 1993 "Where is Night Soil?"
### Results of Soils Analyses

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Figure 6.1: Results of the soils analyses
Particle Size Analysis
If an actual soil is present within a latrine deposit, then it must have had a source other than the deposition of faecal material into the latrine. Particle size analysis allows for the determination of a soil's origin, the relevance of this to the latrine soils studied here is that it allows for a determination of whether the soils from these deposits originate from 'parent' soils on these sites, or if they have been introduced to the deposit from elsewhere. This test breaks a soil down to its basic components giving the proportions of silt, clay and sand present, allowing a soil to be classified into a type. The results of these tests on the Regentville and Jobbins Building deposits showed that the Regentville deposit derived from the 'parent' soil of the site, while the sand found to comprise the Jobbins Building deposit had been introduced to the site as a result of human activity and was in all likelihood builders' sand. The classification system used to determine these proportions was the International Standard rather than the Australian. Figure 6.2 shows the textural classes that soils are divided into on the basis of the size of the particles they contain, and the proportions of these present.

Types of soil present in Regentville latrine complex
Several discrete stratigraphic units made up the Regentville latrine matrix. The positioning of these units within the latrine complex are shown in Figure 6.3. The individual deposits were excavated within a 1 metre grid labelled with an alphanumeric code. The samples discussed here are labelled first by their stratigraphic unit identifier, then by their location on the site's alphanumeric grid, then by the number of the 10 litre subsample from which the samples were taken. For example, sample 528X19g was taken from unit 528, situated in quadrat X19 on the alphanumeric grid, and has come from one of six 10 litre sub samples taken from this deposit, sample 'g'. Figure 1.1 (Plan of the latrine complex) shows the position of the latrine structure on the site's alphanumeric grid.

425 Upper fill of outlet drain W14 and other quads: coarse sandy loam
426 Lower fill of outlet drain W14 and other quads: sandy clay loam
427 Construction fill, sandstone rubble over outlet drain: coarse sandy loam
428 Dark fill immediately over capping stones X17: coarse sandy loam
528 Lower fill main drain (drop from privy exit drain) X19: sandy loam
Figure 6.2
Soil textural classes showing the textural classes of the deposits studied
Reference Soil This was a soil reference profile taken at Regentville in 1990 and can be considered characteristic of an undisturbed soil from this site. Profile A1 is a loamy coarse sand, A2 a coarse sandy loam, and B2 a clay.2 As the soils from the latrine did not have a high clay content it was felt that they derived from the A1 and A2 horizons, not the B2.

Jobbins Building deposit

Unit 063 from the Jobbins Building is the cess pit deposit.

063 Fill of cess pit: coarse sand

The matrix of the Jobbins Building deposit was not a natural soil, rather it is a sand that has been introduced to the site. The hydrometer reading gave a figure of 7.24% clay but no silt. As hydrometers record the mass (both dissolved and suspended) of material in solution, the material recorded as clay was in all likelihood salt in solution.

Soil pH

Soil pH is be one factor that can influence the preservation or destruction of organic remains after they enter a deposit. A pH of 10 or higher will destroy any botanical remains present in a deposit, a reading of 8-10 will mean that a high level of decomposition of botanical material will have taken place and the only remains likely to be recovered are the most durable, woody parts such as seeds. A pH of 5-8 should ensure moderately good preservation of most botanical material, and from 3-5 the preservation is likely to be excellent, with even the most fragile material such as the skin and flesh of fruit surviving, as the more acid the deposit (down to a pH of 3 - any lower is too acid for material to survive), the better the preservation will be. pH readings of 3.5 to 4.5 are characteristic of peat bogs, and the excellent state of preservation of material recovered from these deposits is well known.3 The soils from the Jobbins Building cess pit and the Regentville latrine were both alkaline. The pH readings from the Regentville latrine deposit samples ranged from 7.44 to 8.84 (pH soil/water readings). In contrast the pH of the natural soil profile taken from another area of the site ranged from 5.30 to 5.99. The pH levels of the Regentville that were 8.3 and higher deposit indicate the presence of free lime.

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2School of Crop & Soil Science 1991 Soil Science in Historical Archaeology p. 56

3Jane Renfrew & others 1976 First Aid for Seeds p. 4
Figure 6.3
Schematic section of the Regentville latrine complex looking north

Schematic Section of the Regentville Latrine Complex
Looking North
Free lime is lime that is not chemically bonded to a soil, as the calcium carbonate it contains is still in its original form rather than being part of the soil's mineral fraction. Over time calcium carbonate in this form dissolves and is leached from the soil, and the pH of the soil is lowered. Lime does not survive well in soils over long periods of time, so the presence of free lime in the Regentville deposit indicates that carbonates were constantly seeping into the deposit, the most likely source of this being lime mortar in the demolition rubble present in the latrine pit. The pH levels of the samples taken from closer to the latrine pit are on average slightly higher than those from samples of material further down the drain, but not really enough to be significant.

The pH reading of the Jobbins Building deposit was 8.1, on the edge of the limit of alkalinity that botanical material can survive in. The botanical remains that were present were very well preserved. Because the pH of the Regentville latrine deposit was consistently higher than 8, it is not surprising that no botanical material has survived. The Jobbins Building deposit had a reading of 8.1, but the survival of botanical remains in this deposit at this pH can be attributed to the waterlogged conditions that it was preserved in. Breakdown of botanical material in soils with a high pH is a combination of direct chemical attack and microbial activity. Most of the microbes that break down vegetation in soils cannot function in waterlogged conditions, which appears to be the reason why some botanical remains have survived in the Jobbins Building deposit and not in the Regentville deposit which was very well aerated and thus provided an ideal environment for microbial activity. It should be noted that while the preservation of the botanical remains in the Jobbins Building deposit was excellent, only the most durable, woody parts of the original plants had remained, so the likelihood is that if the pH of this deposit had been lower, the less durable parts of these plants would also have been preserved. Although the high pH levels in the Regentville latrine deposit contributed to the destruction of any botanical remains that were present, they ensured that preservation of faunal remains in this deposit was excellent.

When examining the Regentville deposit for botanical remains, the presence of small particles of a black material was noted. This was at first thought to be charcoal but under microscopic examination it was revealed that although some specks of charcoal were present, the majority appeared to be fragments of coke or fritted material. An explanation for the presence of this material is that it is the remains of coke burned in a household context in the mansion, either for heating or cooking purposes. Before the advent of sewerage and modern flush toilets it was common practice not only to lime privies, evidence of this which was found in the Jobbins Building cess pit, but also to add ashes to act as a deodorising agent. It is

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4 Professor Peter Martin, Urban Horticulture, School of Crop Sciences, University of Sydney, 1994 personal communication
worth noting that wood ashes contain potassium carbonate, which has a pH of 8, which when added to a soil will raise its alkalinity. Thus a combination of lime and ashes thrown into a latrine pit, which was common practice in the past in order to deodorise the contents, would raise the pH to levels that would make it difficult for organic material to survive.

During the excavation of the Jobbins Building cess pit deposit, a clump of pale yellow, compacted material was recovered from inside the deposit itself. Testing of this material revealed it to be a clump of lime that had turned to calcium hydroxide. Carbonates do occur naturally in some soils, but they have a very hard consistency, and it was obvious that this material had been introduced into the deposit as it was very soft and crumbled easily. Three types of lime exist that are possible sources of the lump of lime found within the Jobbins Building deposit:

1. 'Quicklime' - Calcium Oxide \([\text{CaO}]\)
2. Hydrated Lime - Calcium Hydroxide \([\text{Ca(OH)}_2]\)
3. Agricultural Lime - Calcium Carbonate \([\text{CaCO}_3]\)

Quicklime and hydrated lime are the most alkaline of the three types and will, when added to soil, break down into calcium carbonate over time, and if added to a deposit in large enough quantities, will form clumps, with an outer covering of calcium carbonate, and the internal material still in its original form. Agricultural lime, which already consists of calcium carbonate does not behave in this manner, so it appears that the clump of lime found in the Jobbins Building deposit was originally either quicklime or hydrated lime, but had become a pseudomorph of the original material as it had converted to calcium carbonate.  

**Organic Carbon**

Because no macrobotanical remains and parasite eggs were found within the soils from the Regentville latrine, it was not possible to determine from these tests alone that this deposit had once contained the remains of faecal material, even though the interpretation of the surviving structural remains demonstrated that the structure itself was that of a latrine. The analysis of the ceramic assemblage from this deposit demonstrated that rubbish was being discarded constantly into the latrine throughout the period of its use, but the examination of this material for macrobotanical remains and parasites yielded no remains that would distinguish this deposit from ordinary soil, so there was the possibility that this deposit may have been simply ordinary topsoil that had been washed into the latrine or soil that was deposited in there on purpose. The only way to determine whether this soil had been present

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5Professor Peter Martin, Urban Horticulture, School of Crop Sciences, University of Sydney, 1994 personal communication
in the latrine during its use and thus represented a highly decayed organic deposit or not was to test for the presence of organic carbon. Two tests for determining the amount of organic carbon present were conducted on the latrine/cess deposits from both sites. The Walkley Black technique detects and gives a figure for the amount of unstable carbon (the type that give soils with a high organic content their characteristic rich brown-black colour) present in a given sample, while the Tinsley technique detects and gives a figure for the amount of stable carbon present in a soil, the type that is not soluble, in that it will not leach out easily in water, and which is not immediately visible when looking at a soil. A figure for the proportions of organic matter present in a soil is derived from the results of the Tinsley test. These tests do not give a figure for the amount of fresh organic matter present in a soil, this can only be determined by establishing the loss by ignition for a soil, noting of course that some water will also be lost, along with all of the organic matter. The percentage loss by ignition as compared to the percentage organic matter is not radically different in any of the soils tested, which means that there was very little fresh organic matter present in the soil, that the majority of the organic matter present had been there for some time.  

The percentage of organic matter present in most of the samples from the Regentville latrine deposit is on average 1-2 percent higher than that of a sample of undisturbed soil taken from another part of the site. This is quite significant as it would generally be expected that topsoil with grass growing on it would have a higher proportion of organic matter than a soil found in a drain. This increase is too large to have come from natural plant activity, and represents a high concentration of organic matter. Latrine contents can only have been the source of this material, so even though no macrobotanical or parasite remains had survived in this deposit, the high amount of organic carbon present demonstrates that the soil in the outlet drain of the Regentville latrine still contained some of the original organic content from the period of the latrine's use, and this soil must thus have been present when the latrine was in use and had not been introduced at a later date. The percentage of organic matter in the Jobbins Building deposit was also very high, indicating a concentration of organic matter felt likely to have been faecal in origin.

**Electrolytic Conductivity**

Another factor that was felt to have contributed to the lack of organic remains within the Regentville deposit was the fact that the action of water coming down the latrine outlet drain was washing this material down and out of the system. If this leaching of the deposit had

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6 Some anomalies in the results have been noted in samples from Jobbins Building 063a, 528X19g, 425X19b, 425X15d, 427X17, & 428X17, in that the percentage of organic matter in these samples appears to be higher than the percentage of organic matter and water lost by ignition.
occurred it would also be expected that the soluble salts present within the deposit's matrix would also have been leached from the deposit. Electrolytic conductivity is a measure of the soluble salts present in a soil, and readings are expressed in terms of micro siemens per cm (EC μS/cm). The readings from the Regentville latrine deposit indicate that the soluble salts present are moving down and out of the deposit as a result of water flow, the average reading from unit 528 of 34.1 EC μS/cm is much lower than the readings from any of the other latrine units, where for example unit 425 had an average reading of 100 EC μS/cm, and unit 426 an average reading of 81.2 EC μS/cm. The high reading of 235 EC μS/cm in the Jobbins Building deposit is a factor of the presence of slaked lime (calcium hydroxide). This high reading after a period of more than 130 years suggests that no leaching of this deposit occurred.

**Phosphate**

Another means by which to determine the degree to which the Regentville latrine soils were mobile and leached was to test for the levels of phosphates present in each deposit excavated from within the latrine drain and also those deposits not actually excavated from within the drain, but found in association with it. (See Figure 6.3) The phosphorous readings of the natural soil profile at Regentville ranged from 32 to 70 parts per million. These low readings contrast with the readings from the latrine samples where units 425 & 426 in the Regentville material contained very high levels of phosphates, over 1000 parts per million in some of the samples tested. The distribution of phosphate levels within each latrine deposit seems quite random as samples 425X15a & 425X15e both contained 1060 parts per million of phosphate, yet another sample taken from the same quadrat, 425X15d contained only 215 parts per million. The overall pattern that emerges is that the levels of phosphorous are much higher in the deposits that were gradually working their way down the outlet drain than those that were related to the latrine structure, but not within the structure itself and which had remained static from the time they were deposited. These mostly high levels of phosphate in the material sampled can only have bone as their source, so the varying levels of phosphate within quadrats is attributed to differing bone distribution within the deposit. Certainly all the bone recovered from this deposit was in excellent condition which can be attributed to the high pH. The soil samples that did not come from the drain system but which are still related to the privy system do not, on the other hand, show high phosphate readings, as low as 35 parts per million in 427X17 and 21 parts per million in 428X17. The samples from the main drain deposit 528X19 varied from 0 to 250 parts per million. The reason for this difference between these deposits could be that as the 528 material is not necessarily solely latrine material, and thus the levels of phosphate could have become diluted, and another is that because the main drain is likely to have had more water passing through it, it is likely that this material may also have been leached of phosphates over time. The Jobbins Building deposit
had quite a low reading of 23 parts per million, even though a quantity of bone was recovered from the deposit when excavated. The explanation for the wide variation in the levels of phosphorous present in the Regentville latrine matrix is that although all visible bone recovered from the latrine deposits appeared in excellent condition to the naked eye, attrition of the bones present in the outlet drain of the latrine had occurred as a result of the deposits in the drain having been mobile, that water had been passing through this deposit has already been explained in the discussion of the electrolytic conductivity tests results.

**Conclusions reached from the soils analysis**

The results of the soils analysis conducted on the deposits from both these sites were fairly conclusive. It was possible to demonstrate that the soil that comprised the Regentville deposit derived from the topsoil that was already present on the site, that it had not been brought from elsewhere and thrown into the latrine, in contrast with the Jobbins Building deposit which was comprised of builders sand that had been deposited in the structure. The pH of both deposits was very high as a result of lime having been present within the deposits. The results of the tests for phosphates and electrolytic conductivity demonstrated that the soils in the outlet drain of the Regentville latrine deposit had been leached by the action of water running through the drain and that the deposit itself had been mobile, slowly moving down the drain to the point where it dropped into the line of the main drain, the soils excavated from which exhibiting an even higher degree of leaching than those in the outlet drain.

The combined information gained from this suite of soils tests is that the physical (mobile and leaching) and chemical (high pH) characteristics of the soils within the Regentville latrine structure led to the destruction of any macrobotanical or parasite remains that the soils had once contained, even though the residual organic carbon was sufficient to demonstrate that this material had once been highly organic. The results of the same tests when applied to the Jobbins Building cess pit deposit demonstrated that this deposit, while also highly alkaline, had in contrast remained static and had never suffered any significant leaching, instead staying waterlogged. These contrasts in the nature of the soils from the two deposits and the environmental conditions that existed within them provides the key to the differential preservation of their organic contents and thus why no eggs of helminth parasites were recovered from the Regentville latrine soils, even though these deposits were known to have originally contained faecal material.

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7Dominic Steele 1993 Jobbins Building Yards Report on the Bone and Shell p. 25
Section Seven
Conclusions

In conclusion it is necessary to come back to the question posed in the introductory section of this thesis - How do you identify a latrine deposit? The review of the literature and the analysis carried out as a result, provided the answer to this question. The presence of eggs of intestinal parasites is the primary indicator of a deposit's faecal origin. This is not to say that the other types of organic data that can be recovered from latrine deposits are therefore not worth analysing as although parasite eggs identify the deposit's source, macrobotanical remains and all the other types of organic remains discussed in Section Two have the potential to inform on past species diversity of plants and animals on the site from which a deposit comes, and the interpretation of these remains can yield information on the past inhabitants' diet and activities on the site, although as noted in Section One, the development of an appropriate methodology for recovery rather than the interpretation of this data was the aim of this particular study.

Although the question of how to identify a latrine deposit was answered with relative ease, as it became obvious in the quite early stages of this research that the eggs of intestinal parasites were the primary means of identifying a latrine deposit, the major problem faced was how to actually recover these eggs from a latrine deposit, as the literature reviewed did not discuss in detail techniques for recovery. As has been mentioned earlier the major part of the research for this thesis was in developing a fail safe technique for the recovery of parasite eggs from latrine deposits. As is demonstrated in Section Five, clinical flotation techniques have proved successful in recovering eggs from latrine deposits, but the application of a flotation technique to the two deposits studied here failed to recover any eggs. The subsequent development and application of a sedimentation technique proved successful in recovering parasite eggs from the Jobbins Building deposit, but the Regentville latrine sediments still failed to yield any eggs and the conclusion was thus reached that parasite eggs were no longer present in this material.

If the presence of intestinal parasite eggs was to be seen as the primary indicator of a latrine deposit, then reasons needed to be sought as to why no parasite eggs had been recovered from the Regentville material, even though the structure from which it had been excavated was unquestionably a latrine. The only way a solution to this problem could be reached was through the application of soils tests to the deposits from both sites. The application of a suite
of tests, as opposed to one or two was necessary in order to determine the full variety of factors that can contribute to the preservation or destruction of organic material within latrine deposits. The results of these tests demonstrated that a combination of high pH, leaching and movement of the sediments within the Regentville latrine had led to the destruction of the two types of remains that this study had sought to recover, macrobotanical remains and parasite eggs. The results of the same tests applied to the Jobbins Building deposit on the other hand, demonstrated why macrobotanical remains and parasite eggs had survived in this deposit. Unless these tests had been conducted, the reasons for the differential preservation of the organic contents in the deposits from these two sites would have remained enigmatic.

When reviewing the literature on parasite recovery from latrine deposits it was revealed that other researchers had also encountered deposits with low or negative parasite recovery results. When examining these researchers explanations and their interpretations of why parasite eggs were or were not present in these deposits it became obvious that some of these interpretations were flawed as they were not based on an understanding of parasitology.¹

An example of this comes from a study of latrine contents excavated from two eighteenth century privies at Queen Ann Square in Newport, Rhode Island. *Trichurus* eggs were found in both deposits, but eggs of *Ascaris* were found in only one, while hookworm and taeniid eggs were found in the other. Because of the proximity of the two privies to one another, the absence of *Ascaris* in one of the privies was attributed to differences in living conditions between the two households rather than to differing environmental conditions within the deposits. The authors suggested that the differing proportions of eggs present within the latrine deposits of the two households was related to poorer sanitation practices in one household as opposed to the other, and ultimately to socioeconomic differences between the two households who formed these deposits. The assumption is also made that as the faecal deposits in the latrine from one household are less concentrated than those from the other household that the users of the one with the least concentrated deposits must have been using their latrine less frequently and instead using faeces as fertiliser.² They provide no data to back up these assumptions and fail to note that differences in concentration of faecal material in these deposits may be a product of differential preservation or partial removal of these deposits during period cleaning of the latrines. It is impossible to recreate past living conditions and determine the health and well-being of a site's occupants from examining the parasite eggs found in their latrines. The authors state that the proximity of the two latrine structures to each other means that the deposits within them must have encountered similar

¹Henry Collins 1994 Department of Veterinary Pathology, University of Sydney, personal communication

²Karl J Reinhard & others 1986 'Privies, pollen, parasites and seeds' p. 35
environmental conditions, yet provide no data to back up this statement. The reader is given no information on the physical or chemical properties of the two deposits. Too little is known of the environmental variations that parasite eggs can and cannot endure for these researchers to state confidently that environmental conditions did not contribute to the absence of *Ascaris* eggs from one of these deposits.

This example is not an isolated case, the archaeoparasitological literature is filled with examples of misinterpretation of parasitological data and assumptions made on the health and sanitation of the users of latrines in the past that are pure supposition and cannot be supported. Much of this appears to stem from ignorance as to how humans acquire parasites and the manner in which they end up in latrine deposits and then in the archaeological record. Having become aware of this problem existing in the literature it was felt that the development of a preliminary model of the phases of parasite deposition and recovery from latrine deposits was necessary as a first step in refining the interpretation of this class of data. This model is presented in Figure 7.1.

**Phase one**

Phase one of this model covers the period in which the host becomes infected by intestinal parasites, and thus the manner by which parasite eggs end up in faeces. In order for parasite eggs to be recovered from latrine deposits it is necessary for them to have been deposited in the first place, it is thus necessary for the user or users of a latrine deposit to be infected with parasites. Although there is nothing that can be done to recover eggs from deposits that never contained any in the first place, or contained faeces from a host or hosts who were so lightly infected that the chances of recovering any eggs is small, an awareness of the processes of parasite infection and breeding cycle can aid in interpretation, allowing the researcher to reach the conclusion when faced with a result of no eggs recovered from a deposit whose environmental conditions were otherwise favourable for the eggs' survival, that no eggs were present in the deposit at the outset.
Figure 7.1.
Phases of parasite deposition and recovery in latrine deposits

Phase One
Acquisition of parasites by host
Parasites lay eggs
Eggs present in faeces

Phase Two
Faeces deposited in cesspit/latrine Organic material
either destroyed or preserved

Phase Three
Latrine goes out of use
Stabilisation of the deposit
Time elapses

Phase Four
Excavation
Egg recovery and identification
Phase Two

Phase Two covers the period of deposition of faecal material into a latrine, and the immediate effect of the conditions this material is subjected to. When faecal material containing parasite eggs is deposited in a latrine environment, the prevailing environmental conditions within the latrine deposit itself will determine whether the organic materials within the faeces, including parasite eggs, are preserved or destroyed. If parasite eggs were present at the time the latrine deposit was formed, a number of processes may contribute either to their preservation, destruction or removal. Periodic cleaning of latrines was required by law in Sydney, at least for the later half of the nineteenth century, so it is quite likely that the Jobbins Building cess pit was periodically cleaned. Although Regentville's rural location means that it was not subject to these regulations, there is evidence that more than one major cleaning episode occurred during the period of its use.\(^3\) The effect that the practice of adding lime or ashes to privies (effectively raising the pH levels, as discussed in Section Six) has upon the preservation or destruction of parasite eggs is still not completely clear. *T. trichiura* eggs, as noted above, were recovered from the Jobbins Building deposit, which had a pH of 8.1, and in which lime was present. The passage of time and the latrine environment are also factors that can influence the preservation or destruction of eggs. The only parasite eggs likely to survive in latrine deposits from archaeological sites are those with reasonably durable shells, and this has been borne out in the previous works on material overseas mentioned previously. The relative durability of the shells of eggs of particular parasites is a product of the parasites' life cycle, in that those parasites whose reproductive cycle requires the eggs to spend a period of time outside of the host (such as *Trichuris* and *Ascaris*) have by necessity more durable shells than those whose reproductive cycle occurs entirely within the host. It is also because transmission of these parasites occurs outside of the host through contact with faeces that they are more likely to occur in latrine deposits than other types whose life cycle/breeding cycle does not require this. In summary, the presence of parasite eggs in latrine deposits is a function of their physical characteristics. Durability of eggs aside, the environmental conditions that existed within a latrine deposit at the time parasite eggs were deposited in it has a bearing upon whether they survive or are destroyed. Liming, decomposition of the faecal material and removal of latrine contents as a result of cleaning are important factors that bears heavily on whether any eggs initially present in a deposit will survive.

Phase Three

Phase Three covers the period in which a latrine deposit goes out use, microbial activity ceases, and time between deposition and excavation of the deposit elapses. Once a latrine has

\(^3\)Judy Birmingham & Andrew Wilson 1994 *Regentville Archaeological Project* pp. 57-61
gone out of use, providing the physical conditions within a latrine remain constant, any microbial activity should eventually cease and the deposit should become stable. The optimum conditions for the preservation of parasite eggs are, most importantly, constant ones. Eggs are known to survive well in waterlogged conditions, as they have been found in waterlogged latrine deposits overseas, and also in the Jobbins Building deposit. Eggs are known to survive desiccation when entire coprolites survive, as mentioned previously, so it is possible that they could also survive deposition in very dry latrine environments, their survival is noted in 'dry, dusty sediments' from a latrine in York. Fluctuating environmental conditions, in particular an inconsistency in the water content of a latrine soil, can be very damaging to organic remains, an example of this is noted by Reinhard and others when discussing the poor preservation of *T. trichiura* eggs from the latrines excavated at Queen Anne Square, Rhode Island. Some of the eggs recovered were either cracked or fragmentary, and the authors note that:

fragmentation of the eggs possibly resulted from mechanical stress such as freezing-thawing episodes.

In the case of the Regentville latrine, the electrolytic conductivity test results (as discussed in Section Six) revealed that the physical conditions within the latrine deposit did not remain constant and that the deposits were leached over time by the action of water flowing through them. This is felt to have contributed greatly to the destruction of any parasite eggs that would have been present in these sediments at the time they were deposited. The physical conditions within the Jobbins Building cess pit in the period between the sealing of the deposit and its excavation, on the other hand appear to have remained constant, hence the good preservation of organic remains in this material. The Regentville latrine ceased to be used in 1869 when the mansion was destroyed by fire, and the Jobbins Building cess pit went out of use in 1865 when drainpipes for a water closet were installed, sealing the deposit.

**Phase Four**

Phase Four covers the stages of excavation of a deposit and the recovery and identification of the eggs within it. Poor sampling strategies can result in parasite eggs being missed during excavation. As is discussed in greater detail below, consideration of sampling strategies before excavation occurs is necessary, not only for parasite material, but other organic

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5. Karl J Reinhard & others 1988 'Recovery of parasite remains from coprolites and latrines' p. 218
remains as well. Reinhard and others note that different levels sampled from medieval latrines in Germany contained different concentrations of parasite eggs. Although the value of conducting egg per gram counts on latrine soils can be considered dubious due to an inability to conclude the level of infection of a host, as it is impossible to determine whether material was deposited over a period of days or months, and the numbers of users of a latrine, knowing that varying rates of concentration of eggs may occur within a latrine deposit means that the excavator should take samples from various levels of a latrine deposit in order to have the greatest chance of recovering any eggs present. One sample is not sufficient, as it may come from a level that contains little or no eggs.

The manner in which samples are stored prior to analysis can also have a bearing upon whether eggs survive or not. This is discussed in greater detail below. Finally, when it comes to the analysis stage, as has been discussed previously, the use of clinical flotation techniques on deposits where the eggs within cannot float (for whatever reason) may lead to a false conclusion that the deposit contained no eggs, either now or in the past also. This is a fairly grave problem if parasites are being used to indicate the presence of faecal material, although this is an example of why it is not good to base conclusions on the information provided by the presence or absence of one class of data. It may emerge from further studies of Australian latrine deposits that flotation does not work, and that sedimentation, although slightly more tedious, is the only technique worth using for a fail safe result.

This model is of course only preliminary, but it is a step toward explaining the reasons behind the presence or absence of parasite eggs in latrine deposits, meaning that any interpretations of parasite data made using this model as a guide will have a basis in parasitology, rather than relying on mere supposition and speculation as has sometimes been the case in the past.

**Sampling Strategies for Latrine Deposits**

If parasite eggs are to be recovered successfully from latrine deposits, it is necessary to ensure that eggs that have survived through the first three phases of the model outlined above are not overlooked or destroyed in the fourth and final phase. In his report on the pollen and parasite analyses of the Greenwich Mews latrine sediments, Reinhard notes that it is absolutely necessary to establish a regular sampling strategy for latrine materials in order to optimise the organic data that can be retrieved from these deposits. He suggests that a vertical stratigraphic sampling scheme be employed when excavating latrines, allowing for the identification of levels in which pollen, parasite eggs, macrobotanical remains and faunal

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7Karl J Reinhard & others 1988 'Recovery of parasite remains from coprolites and latrines' p. 229
material are most common. He feels that samples taken every 100 mm in a vertical column through a privy's depth is ideal, and that it should be remembered that intact or nearly intact bottles or other vessels may contain organic remains that flowed in at the time of deposition, providing a 'time capsule' of organic material present in a latrine. This is an important point to be remembered for any future analyses of the Regentville material, as bottles filled with soil were recovered during the excavation of the latrine. Reinhard recommends quantities of soil required to conduct analyses of latrine soils, stating that:

The soil samples should be large enough to apply a battery of tests. One cup of soil is sufficient for pollen and parasite analysis. For analysis of macroscopic remains, a flotation sample of 3-5 cups of soils is usually sufficient. For pollen wash of bottles or ceramics, very small amounts of soil can be used ... Soil immediately adjacent to the interior sides of containers are most productive in pollen washes.8

I feel that it is impossible to say with absolute certainty how much deposit is required for conducting analyses of a latrine's organic content, except that it is far better to err on the side of retaining too much material than too little, as once a deposit has been fully excavated it is impossible to go back and obtain more material for analysis. It is not always feasible to retain very large samples of material, especially when limited storage space is a consideration, but samples of at least 1 kg are essential for conducting a battery of tests for parasites, pollen, macrobotanical remains, soil chemistry and for determining the physical and chemical characteristics of the deposit. Naturally the weight of a sample is affected by its water content, so waterlogged samples will weigh more than their dry counterparts for the same volume of material sampled.

The entire contents of the outlet drain from the Regentville latrine excavated in 1991 were retained providing a very large amount of material on which to conduct analyses, in excess of 300 litres. It was naturally desirable to employ a sampling strategy that would give as unbiased, representative samples from these deposits as possible. In most cases, it is possible to obtain a fairly representative, random sample of a soil deposit by running a sample through a riffle box (also called a sample splitter). Riffle boxes consist of a metal frame with a series of slots of different dimensions according to the approximate particle size of the material that is to be divided. Shackley discusses their use, and notes that:

They are especially suitable for coarse and medium-sized pebbles, although they may also be used for dry sand. The dry sediment is poured in at the top of

8Karl J Reinhard 1989 'Parasite and pollen analyses' p. 243
the apparatus, in one smooth movement along the length of the box. This ensures that each particle has a theoretically equal chance of falling down any of the slots which lead alternately into two metal boxes ... The method is more accurate than 'quartering', useful for coarser samples and less 'messy'. It is still liable to quite substantial sampling errors.9

As Shackley notes, this method of sampling works well on dry soil samples, and was thus useful for dividing the bulk of the Regentville latrine deposit into more manageable proportions and in eliminating sample bias as much as possible. This worked precisely because the bulk of this material was dry, but a problem arises when damp or waterlogged material needs to be sampled, as was the case with unit 528 from Regentville and unit 063 from the Jobbins Building. The only feasible course of action that could be taken when attempting to sample these units was to gather composite or 'pinch' samples of the material, that is small amounts of soil gathered from all over a context combined in a sample bag.10 It is necessary to bear in mind that these samples were in all likelihood not representative of the units as a whole. For most archaeological soils, the answer would of course be to dry the soil out and then pass it through the sample splitter. However the reason for investigating latrine sediments is to recover organic remains that may be present within these deposits. As has been discussed previously, preservation of the organic contents of latrine deposits, such as plant remains and parasite eggs, is dependant upon favourable and constant environmental conditions, which in the majority of cases means waterlogged and anaerobic. It is perfectly acceptable, once a portion of a deposit has been chosen for soils analysis, to dry this material out, but in terms of obtaining a representative sample from the entire deposit, it is not feasible to dry out the entire deposit, which is to be investigated for organic remains, solely in order to obtain a 'representative' sample for soils analysis. Drying out waterlogged plant remains can lead to considerable damage or even complete destruction.11 This was observed in the present study when samples of seeds from the Jobbins Building were allowed to dry out, and visible cracks appeared on these surface of the seeds. No similar discussion in the archaeoparasitological literature exists on the ability of parasite eggs to survive desiccation in latrine soils that were previously damp, although their presence has been recorded in coprolites preserved by desiccation, intact but with some damage having occurred as a result.

9Shackley, Myra 1975 *Archaeological Sediments* pp. 35-6

10Deborah Pearsall 1989 *Paleoethnobotany* p. 96

11H. N. Jarman & others 1972 'Retrieval of plant remains from archaeological sites' in Higgs (ed.) *Papers in Economic Prehistory* p. 45
of the drying process. A test run on a sample of the material from the Jobbins Building which had yielded *Trichuris trichiura* eggs when tested wet, failed to yield any after oven drying. The conclusion reached was that desiccation in this manner had destroyed the eggs that previously had been present.

No guidelines exist for the management and storage of latrine deposits as distinct from other types of archaeological deposits, as this does depend upon the types of analysis that these deposits are to be subjected to after excavation. As the survival, or potential for survival, of organic materials is often the reason for the investigation of latrine soils, it is desirable to employ a storage method that reduces the possibilities of these remains being damaged or destroyed in the period between excavation and analysis.

Renfrew and others advise that samples containing organic material taken from waterlogged or anaerobic deposits should not be dried out. They advise that these samples should be kept in their original condition and to contact a specialist in dealing with these deposits to come and take samples. They note that this is not always an option and state that:

> If the sediment has to be removed without specialist supervision this should be done with clean tools and bagged up in clean polythene bags ... It may be necessary to add a drop of fungicide (e.g. Formalin or Topane) to the organic sediment if it is to remain in store before processing. This, hopefully, will restrict the action of fungi that may have entered the sample during its excavation.

Whatever the method of recovery chosen, it is advisable to keep the environmental factors that the organic material is exposed to as a result of processing as constant as possible, which means ensuring that wet material is not allowed to dry out, and that material be handled as little and quickly as possible. As Jarman and others note:

> repeated wetting and drying of the remains can result in their total destruction.

They illustrate this by providing the results of a test conducted on a sample of 500 archaeological charred seeds which showed that although only 4 percent of the sample were

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12 Karl J. Reinhard & others 1988 'Recovery of parasite remains from coprolites and latrines' p. 219

13 Jane Renfrew & others 1976 *First Aid for Seeds* pp. 24-5

14 H. N. Jarman & others 1972 'Retrieval of plant remains from archaeological sites' in Higgs (ed.) *Papers in Economic Prehistory* p. 45
damaged by a first treatment that involved wetting and drying, a further 56 percent of the sample was destroyed when this was repeated, so that only 15 percent of the sample remained whole and undamaged. When this final lot of seeds were wetted and dried for a third time, all were destroyed. Pearsall comments that decisions to use chemical flotation (which involves the rewetting of charcoal both in the heavy liquid used to make it float, and the subsequent rinsing with water to ensure that all traces of chemical adhering to the material are removed) must be considered carefully in the light of these results.\textsuperscript{15}

Once samples of a deposit have been taken, it is essential to ensure that they are stored in such a manner that their organic content will not deteriorate before analysis takes place. For optimum recovery during analysis it is desirable to analyse this material as soon after it is excavated as possible, although this is not always a practicable solution. If it is impossible to analyse samples soon after excavation, and that they may have to wait for a period of months or even years before analysis takes place, there are a number of measures that can be taken in order to prevent samples from deteriorating. The first and most important of these is to maintain a constant environment as close as possible to the one experienced by these samples prior to their excavation. This means that storage in sealed plastic bags, or in jars is necessary. Dry material should not be allowed to get damp, and waterlogged, or moist material should not be allowed to dry out. With waterlogged samples from anaerobic deposits, there exists also the possibility that bacterial action may start to take place, destroying all or some of the organic remains previously present. This can be prevented by adding a quantity of reversible fungicide, such as Formalin, which can be washed out later when analysis takes place.\textsuperscript{16}

If these guidelines are followed, the risk of damaging, destroying or failing to recover parasite eggs and other organic remains from latrine deposits should be minimal.

**Future Directions**

This study has by no means covered all of the available research angles relating to the recovery of organic material from Australian latrine deposits. There are many aspects of this topic that could be covered in the future, such as the effect that the design and construction of a latrine structure has upon the preservation or destruction of the organic remains deposited in it. The differences in construction of the two latrine structures from which the deposits in this study came from were touched upon in section one, and it is felt that the differing designs of

\textsuperscript{15}Deborah Pearsall 1989 *Paleoethnobotany* pp. 51-2

\textsuperscript{16}Jane Renfrew & others 1976 *First Aid for Seeds* p. 29
the two latrines studied had a bearing upon the differential preservation of organic materials in their deposits.

The variety of organic remains that it is possible to recover from Australian latrine deposits is another avenue of enquiry that warrants more attention in the future. This study restricted itself to the recovery of parasite eggs and macrobotanical remains from these deposits. Sterols in particular are a class of data that may prove to be a very useful tool to use in conjunction with parasite eggs as indicators of a deposit's faecal origin, and the issue of the difficulty in determining whether parasite eggs in certain deposits are of human or porcine origin, may be solved in the future by identifying the eggs down to the level of their DNA, although as noted in Section Five, this was not felt to be an issue in the case of the eggs recovered from the Jobbins Building deposit.

Although recovery, rather than interpretation of the organic remains found in latrine deposits was the focus of this study, it is hoped that in future researchers will be able to devote more attention to this aspect of research, having been able to easily recover organic remains using the techniques developed in the course of this study. Naturally the interpretations of this material, in particular the parasite data, will need to be based on reality, and not on supposition and speculation as some studies have in the past, and further development of the preliminary model of parasite deposition and recovery proposed here can only serve to aid these interpretations.
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