

# PROCEEDINGS

of the  
1993

Postgraduate Student  
Association Symposium

held at the  
University  
of

Central Queensland  
1993



UNIVERSITY OF CENTRAL QUEENSLAND



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# Proceedings of the 1993 Postgraduate Student Associate Symposium held at the University of Central Queensland

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# Foreword

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The 1993 Symposium was held during the period 19–21 August, where UCQ postgraduate students gave papers on a range of topics. This Symposium had strong and generous support from the Vice-Chancellor and staff, as well as the Student Union. This publication highlights the diversity of research at UCQ.

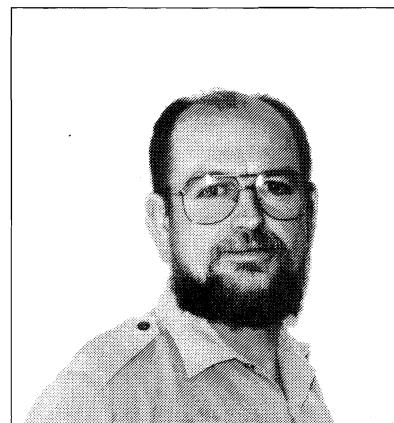
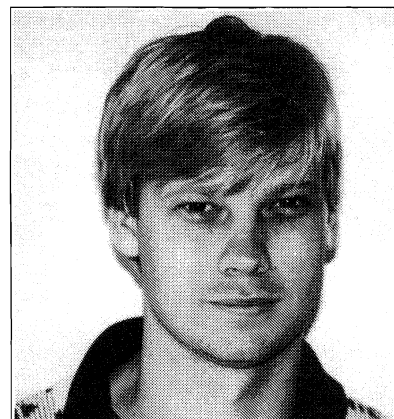
Antony Dekkers

The need to publish is fundamental to postgraduate students; not only to pass on the knowledge resulting from studies but also to enhance one's curriculum vitae. The process of doing so can be daunting, particularly to young and first-authors. This publication provides a venue for students to publish and to experience from the writing process. It also gives the opportunity for the publication of data that may not otherwise become available and for peer group review prior to moving into the wider world of publishing. It should be noted that the data presented is new and that the Proceedings are ISSN referenced.

Gary Wilson

One of the aims of the Symposium was to integrate the presentations so that people from diverse disciplines would be encouraged to listen to papers that were very different to their own specialised fields of study. The contents of the *Proceedings* intends to follow through with that aim. Authors have been placed in this particular order so that readers will be encouraged to explore the ideas set out in the papers between their chosen field of interest. For those of you who do, you may be surprised to discover that most papers are accessible and stimulating, at times amusing and challenging, but always displaying the diversity and innovation found in postgraduate research at UCQ. This publication, then, brings together some of the fine contributions postgraduate students make to University and Central Queensland life.

Gaylene Harris



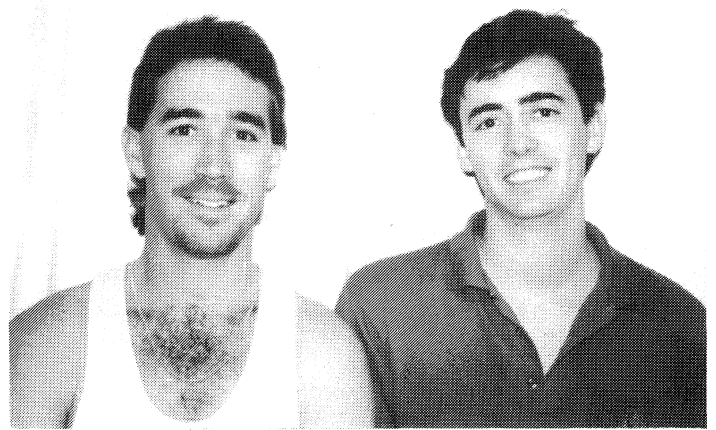
# Validity of detached breakwaters for Keppel Sands solution

**S. Keane**

GradIEAust, PEng, MEng Student

**P. Boswood**

GradIEAust, PEng, MEng Student



## Abstract

Recent approaches to coastal erosion problems are moving away from the more traditional methods such as groynes, which in many cases do not solve the problem, in favour of more “environmentally friendly” solutions. These solutions work in unison with the natural processes on the coast and by exploiting our knowledge of the coastal zone we may predict the future shape of a beach with regard to various coastal management strategies.

Keppel Sands beach, on the Capricorn Coast, is one such beach where traditional methods have been applied in the past with little or no success. The use of a detached breakwater would now seem a more feasible solution for this beach, under the guidelines of Silvester’s method. However, a requirement of negligible currents during swell conditions is applicable to this prediction process.

This paper will outline the situation at Keppel Sands and the validity of Silvester’s method for this case.

## 1.0 Introduction

The favourable climate and recreation opportunities which exist in the Central Queensland area, have encouraged extensive residential and commercial development. Often, this development has been located as close as possible to the beach itself to allow full advantage of our generous conditions to be taken.

For a long time, decisions made by the Livingstone Shire Council on the locations of these developments, and on beach protection matters along the Capricorn Coast, were made without the benefit of recorded field data or knowledge of likely allowances which should be made when dealing with the sea. In fact, many times residents and developers would themselves make decisions which could have long term effects on the coastline.

Today, however, field investigations are carried out by a number of bodies as well as there being more information regarding coastal strategies and their effects.

One area in which much more information is available today is that of breakwaters. Although these structures have been used frequently in the development and protection of harbours throughout the world, recent developments in detached or offshore breakwater technology have led to their successful incorporation in beach protection and enhancement projects. These structures have an advantage over groynes and seawalls in that they reduce wave energy and, as a result, allow the build-up of sediment (salient) over a long reach of the beach. This compares to groynes which have a very localised effect and seawalls which, whilst reducing the shorewards advance of the sea, often create further degradation seawards.

Various methods have been developed to assist in the design and location of detached breakwaters, these methods generally being complex and requiring extensive nearshore details. Silvester et al. (1989) of the University of Western Australia, have developed a method which is relatively easy to apply and also allows the accurate determination of beach configuration after the construction of such structures. This method does, however, have a requirement that negligible longshore transport exists, due to the method being built around static equilibrium conditions.

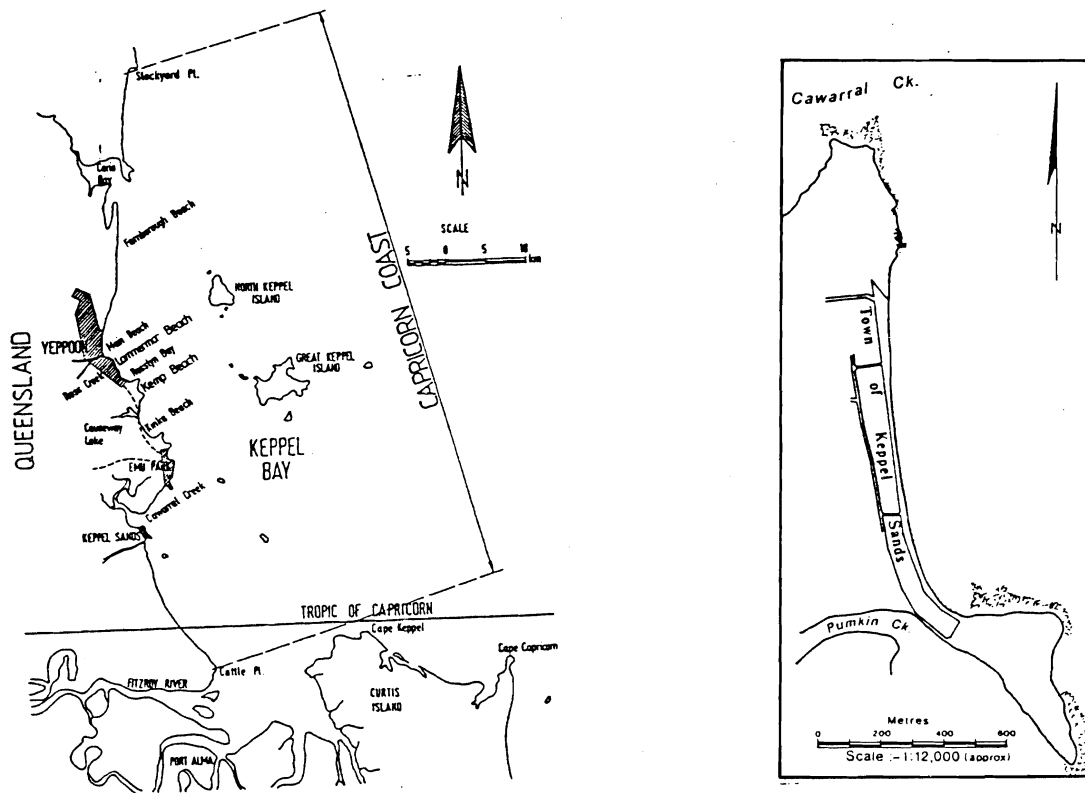
This paper will investigate the conditions at Keppel Sands and the validity of using Silvester's method for detached breakwaters as a possible means of assisting in the revitalisation and protection of the Keppel Sands beach.

## 2.0 Keppel Sands problem

Keppel Sands is a pocket beach of about 1100m in length situated on the Capricorn Coast. It is located approximately 20km north of Cattle Point (mouth of the Fitzroy River) (Fig. 1) in an area which is very much a large tidal flat. The beach is formed between two prominent headlands and is bound by two creek systems, Cawarral Creek to the north, and Pumpkin Creek to the south.

Along the entire length of Keppel Sands beach is a narrow foredune system upon which is placed an access road for residential properties. Due to the flat nature of the beach this means that, even with small changes in sea level, the tidal level approaches closely the level of the dunes. Because of wave action at this level there is continual erosion of this narrow dune system and a further flattening of the beach.

This caused the construction of rather crude railway sleeper walls and simple rock walls in an effort to protect the dunes, road and residential development at Keppel Sands. The most evident upgrade of this wall was after Cyclone David in 1976. However, some points which indicate the weakness of this structure are height of the structure and the possible horizontal recession accompanying cyclones.



**Figure 1:** Locality map (Piorewicz, Keane (1992)) and Keppel Sands plan (BPA 1979)

For a "design" cyclone with a probability of occurrence of 10% in 50 years it could be expected that (Beach Protection Authority 1979):

1. Surge together with tide may reach nearly 4.5m higher than mean sea level. This corresponds to only about 2.5m below the level of the road.
2. Waves of approx 2.2m in height will attack the dune at and above surge level, that is, above the level of protection.
3. The horizontal recession expected to accompany the "design" cyclone could be of the order of 20m.

### 3.0 Solution to the problem

Due to the weakness of this “seawall” and the threat to properties at Keppel Sands, there is a definite need for protective works to be carried out.

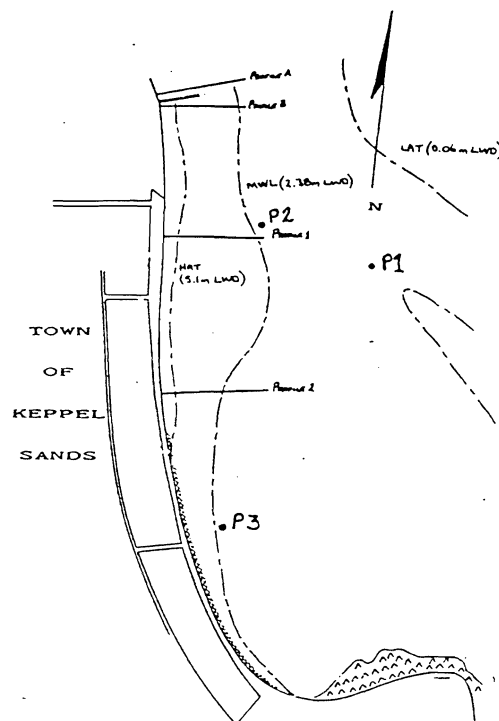
The Beach Protection Authority [BPA] (1979) recognised this and considered the various options available. These included upgrading the seawall, beach nourishment, and the construction of a groyne.

In considering these, it was recognised that, although a wall could be properly designed to protect development, it would still aid in eroding the beach immediately in front of the wall as well as being costly to construct. The beach nourishment option was considered to be of immediate benefit. However, permanent benefit would not be achieved as material could easily be removed once again by wave attack.

In considering placement of a groyne, it was reasoned that, due to the alignment of the headlands, the northern headland no longer had any ability to trap sand being transported along the beach. As a result, it was thought that construction of a groyne at this end of the beach would alleviate this loss of material and at the same time be of some benefit to the southern end of the beach. This option was considered by the Livingstone Shire Council and in 1981, using a rubble mound design, a groyne was constructed at the northern end of the Keppel Sands beach. (Although BPA concluded that the best option would be to combine beach nourishment and groyne construction, this was considered far too expensive.)

### 3.1 Effect of groyne

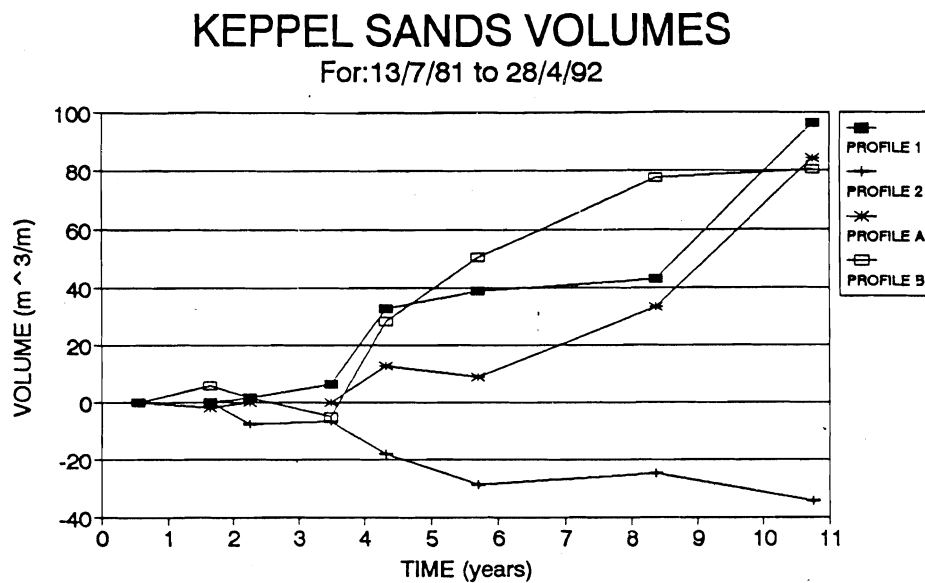
Since the construction of this groyne, there has been an ongoing study into its effects which has been carried out by Livingstone Shire Council and University of Central Queensland. This has consisted of surveying profiles regularly at a number of locations along the beach as shown in Figure 2. The result of this is the ability to determine changes in the volume of sand in these locations since the groyne's construction.



**Figure 2:** Profile and current meter locations

As can always be expected with groynes the only area which truly benefits from their construction is that area local to it (Fig. 3). With progression southwards along the beach, it can be seen that the conditions have not changed considerably, if at all. This shows that the groyne has not in fact had the desired effects and, as a result, other options need to be considered.

It is the belief of the authors that the most advantageous option available would be the construction of a detached breakwater.



**Figure 3:** Change in profile volume with time

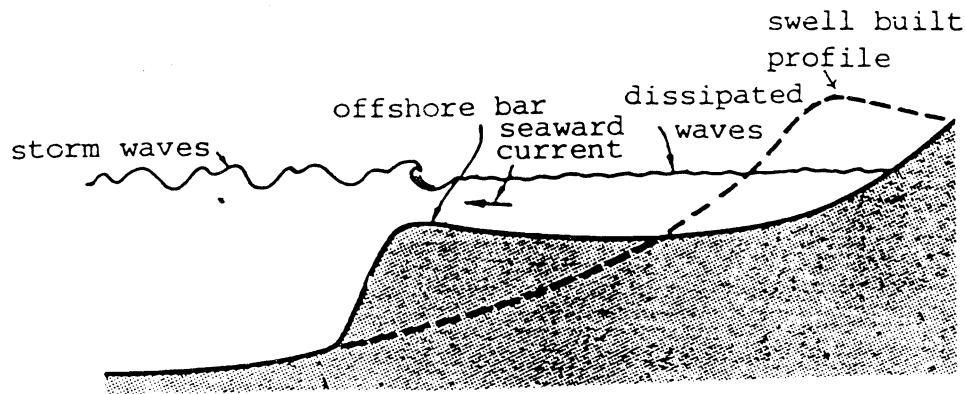
## 4.0 Details of authors' proposal

### 4.1 Theory—Silvester's method

Human beings have always had a tendency, when faced with a dilemma, to try to solve it in the easiest way possible. Unfortunately these solutions are often found to be in conflict with nature.

It is now widely recognised by the Coastal Engineer that, to achieve greatest results, it is more of an advantage to work with nature and if possible, to assist or duplicate its very effects. To do this, however, there must first be an understanding of the natural process of coastal defence. This is where widespread misunderstanding often occurs.

When storms occur, the waves created remove the beach berm and place this material seawards to form an offshore bar. This bar continuously builds up until such time as the incoming waves break over it, therefore decreasing the wave energy occurring on the beach and finally stopping further erosion (Fig. 4). This is when panic or fear quite often takes over communities with drastic measures, such as construction of seawalls, being implemented. The fact which is generally not known, or is overlooked, is that during subsequent swell conditions (arriving persistently from one direction) the material is returned to the beach over a period of several weeks.

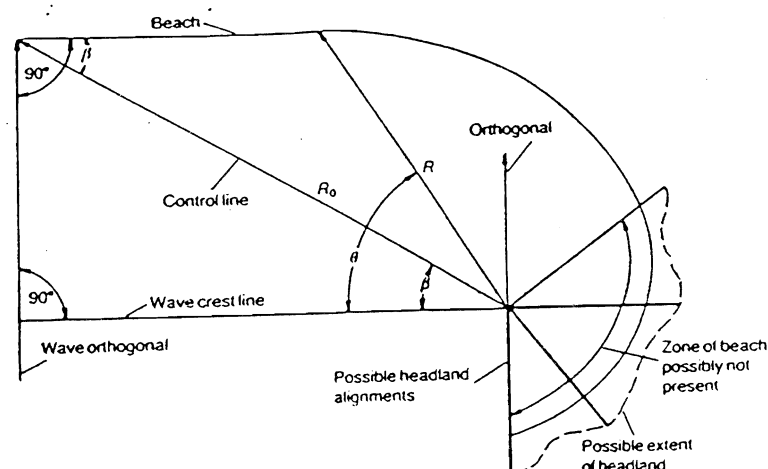


**Figure 4:** Storm versus swell built profile

If this swell occurs normal to the beach, then no long-term erosion is to be expected since the material removed is placed back in its original position. This process is essential as, if swell does not occur normal to the beach, then longshore transport of the material can occur.

The essence of the problem is for swell waves to maintain a reservoir of sand on the beach for offshore bar construction during storm conditions, and for the swell to approach normal to the beach such that no material is transported alongshore. This is the beauty of stable bays, where, due to refraction and diffraction of swell, the waves always approach normal to the beach. These bays, with their associated headlands or other controlling features, are the salvation of our coastline, as there is a limit to the erosion which can occur (this being when longshore transport is negligible). This is also the condition known as static equilibrium. If a source of sediment transport is still in existence along the coastline, then the bay can be said to reach a state of dynamic equilibrium.

It is the ability to predict the static equilibrium shape of the beach which is the essence of Silvester's method. From observation of static equilibrium bays (Fig. 5), it can be seen that they consist of a near tangentially straight segment downcoast, followed by a logarithmic spiral curve, and then connected to an almost circular section behind the headland upcoast. The line joining the upcoast and downcoast headlands, or the upcoast headland and downcoast tangent of the bay, is known as the control line and is given a length of  $R_0$ . This control line is at an angle of  $\beta$  to the line of wave crests. From the upcoast headland, radii can be drawn, of length  $R$ , to other points on the bayed beach, with these radii being at angle  $\Theta$  to the wave crest line.



**Figure 5:** Definition sketch of static equilibrium bays (Hsu, Evans (1989))

Hsu and Evans (1989) obtained a relationship between  $R$ ,  $R_0$ ,  $\Theta$  and  $\beta$  through observation of these variables in model and prototype studies of static equilibrium bays. The result of these studies was the development of the single equation applicable to the whole beach:

$$R/R_0 = C_0 + C_1 (\beta/\Theta) + C_2 (\beta/\Theta)^2$$

for which the coefficients  $C_0$ ,  $C_1$  and  $C_2$  are given in Table 1.

**Table 1:** List of required coefficients (Hsu & Evans (1989))

$\beta^\circ$	$C_0$	$C_1$	$C_2$
10	0.036	1.011	-0.047
15	0.050	0.998	-0.049
20	0.055	1.029	-0.088
25	0.054	1.083	-0.142
30	0.045	1.146	-0.194
35	0.029	1.220	-0.253
40	-0.000	1.326	-0.332
45	-0.039	1.446	-0.412
50	-0.088	1.588	-0.507
55	-0.151	1.756	-0.611
60	-0.227	1.930	-0.706
65	-0.315	2.113	-0.800
70	-0.409	2.284	-0.873
75	-0.505	2.422	-0.909
80	-0.600	2.520	-0.906

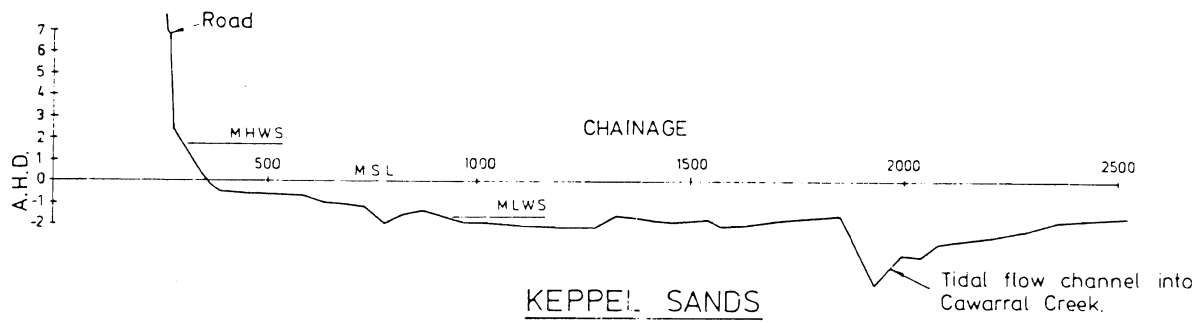
This method requires only that the angle  $\beta$  and the control line length  $R_0$  be determined prior to use. It is then possible, by selecting values of  $\Theta$  around the bay, to determine the value of  $R$  and thus the shape expected. This is made simpler again by incorporating the method into a computer numerical model allowing the user to change control points, by placing such structures as detached breakwaters or headlands at different locations, and see if this has the desired effect on the final outline of the beach.

## 4.2 Experimental analysis

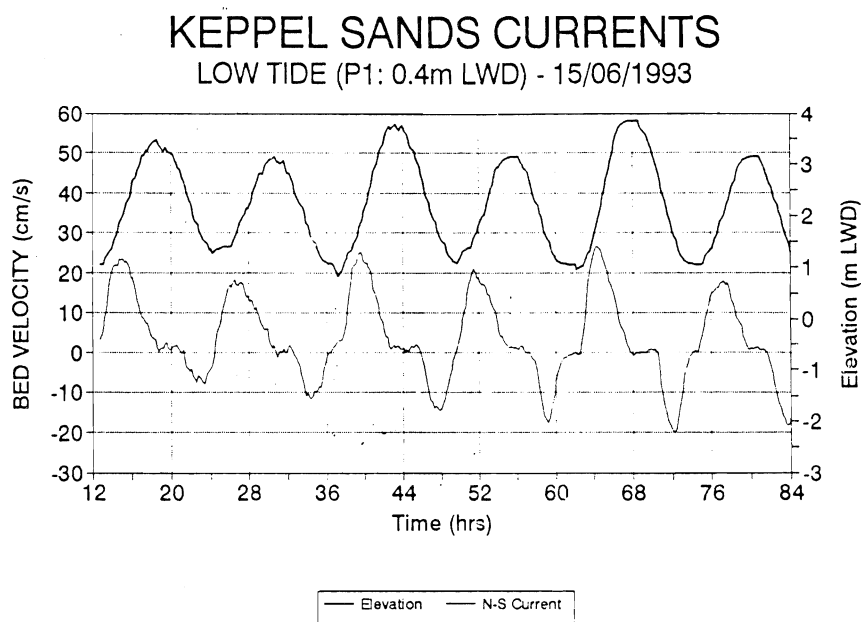
As previously stated, the use of Silvester's method has the limitation of negligible longshore sediment transport. To examine the system of currents at Keppel Sands, a Niskin winged current meter was set up at three locations (Fig. 2), to examine both the low and mid-tidal currents, and the distribution of the current along the beach at the mid-tide location. As the Capricorn Coast is a macrotidal region, this current can be expected to be a combination of both tidal and wave currents.

Statistical analysis of the raw data was performed over a 20 minute interval as this should give mean current conditions, whereas the elevation can be expected to be constant over this period. The method used is given in Massel et al. (1993), and will not be detailed here. The current measurements were converted to bed velocities assuming a logarithmic velocity profile as detailed in the proceeding section.

Due to the very flat bathymetry in the low tidal region, the meter was only partially immersed at low tide. (A typical profile is shown in Fig. 6.) Figure 7 shows the longshore currents for P1 for the period 15/06/93 to 18/06/93. As can be seen, the currents follow a cyclic pattern and hence there is negligible net longshore sediment movement. It should be noted that for the first day and a half there were strong winds which would have affected the currents, but as we are only interested in long term effects, these conditions shall not be considered. To obtain adequate water depth, the current meter was situated in a secondary channel of Cawarral Creek and this may have contributed to the large currents occurring around low tide. It should be noted that at low tide, the wave conditions are very calm (with the exceptions above), and this factor as well as the rippled bedforms suggest a strong tidal current influence at this location.

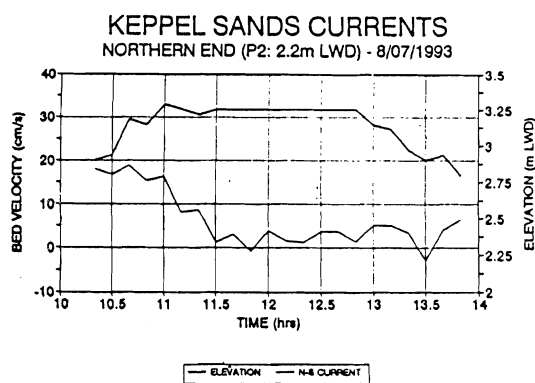


**Figure 6:** A typical profile for the Keppel Sands area (BPA 1979).

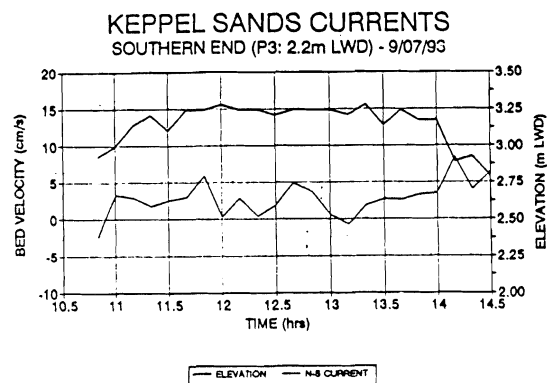


**Figure 7:** Longshore bed velocity for P1 from 15/6/93 to 18/6/93.

However, most sediment transport occurs in the mid to high tidal zones due to the higher surf zone energy caused by the steeper beach profile. Two locations in the mid-tidal zone were examined on consecutive days. Figure 8(a) shows the results for the 8/07/93 at the northern end (P2), and Figure 8(b) for the 9/07/93 at the southern end (P3). The northern end of the beach near the groyne is a steeper profile resulting in the higher energy due to wave breaking for the flood tide. The wave characteristics were 0.3 to 0.4m with a period of approximately 4 to 5 seconds. The wave height reduced to about 0.2m for the ebb tide.



(a)

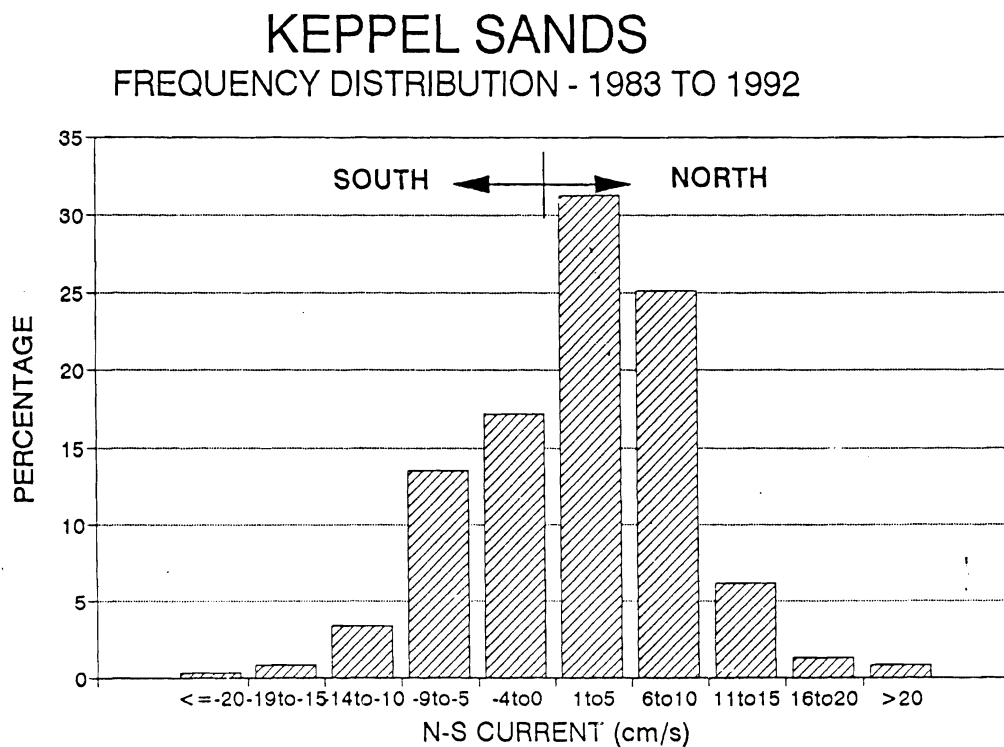


(b)

**Figure 8:** Longshore bed velocities for (a)P2 and (b)P3 for 8/7/93 and 9/7/93 respectively

The southern end of the beach is much flatter with a wider tidal zone. The average longshore current for this location is comparatively less than that for the northern end, with an average value of 3 cm/s. As the breakwater would be situated at this end, this location is of most interest. The wave conditions were also closer to ideal with a 5 to 6 second swell of approximately 0.2 to 0.3 m in height.

To examine the predominant range of currents at Keppel Sands, a further analysis of historical data, obtained from BPA for the period 1983 to 1992, is detailed. A frequency analysis of the longshore currents during this period (Fig. 9) shows that 87% of the total data falls within the range 0–10 cm/s, and 97% in the range 0–15 cm/s. The data from BPA is given as a single longshore current found at high tide, using dye tracing methods in the surf zone.



**Figure 9:** Frequency Distribution of BPA COPE Data 1983 to 1992.

### 4.3 Mathematical analysis

To examine the importance of these currents to the sediment entrainment process, we need to define the threshold velocity for sediment movement. Many semi-empirical and theoretical formulas are available in literature, all of which have their own advantages and disadvantages. None of the available formulae can be expected to have an accuracy of less than a factor of two.

For this analysis, three formulae will be examined to give a representative range of possible threshold velocities.

#### 1. Unidirectional steady flow

Using Shields' entrainment function and logarithmic velocity profile, the critical velocity at a specific height is given by (Raudkivi (1990)):

$$u_c = 5.75 u_{*,cr} \log z/z_o$$

where  $z_o$  is the elevation of zero velocity for a logarithmic profile; and  $u_{*,c}$  is the critical Shield's velocity such that:

$$u_{*,c} = (\tau_{b,cr}/\rho)^{1/2}$$

and the critical bed shear stress is given by:

$$\tau_{b,cr} = \Theta_{cr} (\rho_s - \rho) g d_{50}$$

where  $\rho_s$  and  $\rho$  are the densities of sediment and water respectively,  $d_{50}$  is the median sediment size; and  $\Theta_{cr}$  is the Shield's entrainment function.

Van Rijn (1989) summarised the work of Yalin who stated the Shield's parameter as a function of the dimensionless particle parameter:

$$\Theta_{cr} = 0.14 D_*^{-0.64} \quad 4 < D_* \leq 10$$

with

$$D_* = [(s - 1) g / \nu^2]^{1/3} d_{50}$$

where  $s$  is the specific gravity;  $\nu$  is the kinematic viscosity.

Using a depth of 0.01 m for bed load transport (Zanke 1980), the above equations were applied using  $s = 2.59$ , temperature = 20°C, and  $d_{50} = 163 \mu\text{m}$  (Woltman & Piorewicz 1993). The height of zero velocity has been related through literature to the Nikuradse concept of an equivalent grain roughness height. This method is based on laboratory results and does not predict actual conditions very accurately in the ripple regime. Therefore, for this analysis, the mid-tidal zone is assumed to have sheet flow conditions, giving:

$$u_{c,bed} = 11 \text{ cm/s}$$

#### 2. Oscillatory flow

For oscillatory flow, CERC (1984) has shown that the threshold flow velocity at the sediment bed can be evaluated using:

$$u_{c,bed} = (8 (s-1) g d_{50})^{1/2}$$

which gives a velocity of 14 cm/s.

#### 3. Further verification

Zanke (1980) developed the following model for predicting the critical bed velocity:

$$u_{c,bed} = A + B - \sqrt{AB}$$

where:

$$A = 2.4 (\rho_s gh)^{1/2}$$

$$B = 7.78 (\rho_s gv)^{1/3}$$

giving:  $u_{c,bed} = 16\text{cm/s}$ .

From the above analysis it can be expected that there will be an initiation of bed load sediment movement when the bed velocity is in the range 10–15 cm/s.

It can be expected that any significant sediment movement will occur when the sediment particles are transported through suspension. Applying the method of logarithmic velocity profile (in (1) above), the sediment will be initiated into suspension when the critical velocity exceeds the fall velocity of the sediment particle. For this case, the fall velocity  $w_s$  equals 1.9 cm/s (Van Rijn (1989)), giving a critical velocity,  $u_{c,sus} = 20\text{cm/s}$ .

Zanke (1980) also gives a model for the initiation of suspension which produces similar results. Dyer (1986) suggested that approximately 75% suspension occurs when  $u_{c,sus} \approx 3u_{*,cr}$  which results in  $u = 30\text{cm/s}$ .

Therefore, from the experimental analysis for the surf zone it can be seen that there would be negligible sediment movement for the southern end (under normal conditions), whereas the northern end shows bed load movement during the flood tide, but will not be significant enough to affect the use of Silvester's method. Examination of the BPA data shows only 10% within the range 10–15 cm/s, and only 1% greater than 20 cm/s (required for suspended transport). It should be noted that due to the expected accuracy of the above equations, there could be very minor sediment movement at lower velocities. Therefore, from the above discussion it can be stated that Silvester's method for detached breakwaters is applicable for the Keppel Sands case.

## 5.0 Conclusion

At Keppel Sands, houses are located on narrow but relatively high dunes with only a residential access road between the allotments and the beach. The rubble mound seawall constructed several years ago is not capable of preventing further serious erosion during extreme conditions and the groyne at the northern end of the beach is not having positive effects on the south end of the beach.

It is believed that a detached breakwater will solve this situation and from experimental/field analysis, it has been shown that there is no reason why Silvester's method for detached breakwaters cannot be applied to Keppel Sands.

Therefore, the proper design of the detached breakwater should now be undertaken.

## 6.0 Acknowledgements

The authors wish to express their thanks to the Beach Protection Authority for supplying the Keppel Sands Cope Data and for their kind assistance, and to Dr Piorewicz for his valuable knowledge and guidance.

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# Reproductive ecology of populations of the northern brown bandicoot, *Isoodon macrourus*, in Central Queensland

**Susan Attard**  
BAppSc(UCQ)

**Supervisor: Stephen McKillup**  
BSc(Hons) PhD(Adel)

**Veterinary Adviser: Gillian Swarbrick**  
BVSc(Qld)



## Abstract

The reproductive ecology of free-living populations of the northern brown bandicoot, *Isoodon macrourus*, has only been studied at a few locations. This species exhibits either seasonal or year-round breeding. Photoperiod, rainfall and temperature have been suggested as likely cues controlling reproductive patterns. The species has not been studied in Central Queensland, nor does the climate here resemble that of other study sites.

Four populations were chosen: one unwatered site, one mulched site with trickle irrigation, one with adjacent sprinkling and one heavily watered and mulched. This allowed testing for two separate effects: rainfall and soil moisture. Sprinkler output was measured with a rain gauge. Soil samples were dried to a constant weight to calculate soil moisture. Each of the four sites were trapped for three nights each month, using rigid wire cages. Adult bandicoots were marked, weighed, their body measurements taken, and reproductive condition noted. Pouch young head lengths were taken and their developmental stage recorded.

Preliminary analysis indicates that females at the unwatered or lightly watered sites weigh less, are less likely to breed, produce smaller litters and are less successful in weaning young. At the heavily watered and mulched site the females are relatively heavier, continue to breed through winter, produce larger litters and are more likely to successfully wean their offspring. Lighter females at this site produce larger litters than females of similar weight at other sites. This site apparently contains only a small established population, which is isolated from other groups. The destination of offspring raised here and their adult size will be points of future research interest.

## Introduction

This study was done in response to the lack of information on the reproductive ecology of *Isoodon macrourus*, the northern short-nosed bandicoot, in Central Queensland. This solitary, crepuscular or nocturnal marsupial is semi-fossorial, feeding on soil-litter invertebrates and small fruit. Males typically weigh about 1–1.5 kg [maximum recorded 3.1 kg], and females about 0.6–1.2 kg [maximum recorded 1.7 kg], depending on their age, the season of the year and the locality. Their length including tail is about 57 cm in males and about 48 cm in females. The range covers the coastal areas from the Kimberleys through the monsoonal tropics of the Northern Territory, and from Cape York to the Hawkesbury River in New South Wales.

Breeding in this species appears to be seasonal in the northern and southern extremities of the range while in the central parts breeding is year round with some evidence of seasonality. Near Newcastle, seasonal breeding occurred from July to April and this correlated strongly with bandicoot body weight increases and less strongly with rainfall patterns. Most rainfall in this region occurs in autumn/mid-winter but, because breeding can continue despite lack of rain and fail early despite good rains, Gordon (1971) suggested rainfall was a modifying influence through food source. Variation in commencement of breeding both temporally and spatially was presented as evidence against photoperiod being a primary cue. Termination of breeding correlated with poor rainfall and subsequent food shortage.

Gordon (1974) trapped near Brisbane and found no seasonality in breeding activity with one female reported to have produced six litters in 13 months, an average of one litter every 56 days. No information on possible breeding cues was offered.

However, also near Brisbane, Gemmell (1982) reported a lack of wild bandicoot breeding from April until June. Year-round breeding was reported in captive colonies kept in outside enclosures but births peaked from August to October and were at their lowest from March until June (Gemmell 1988). There was little definition of seasonality in breeding. Gemmell (1990, & Barnes 1984) has suggested either temperature or photoperiod as the primary cue initiating breeding in the Brisbane region.

Finally, Hall (1983) also trapped around Brisbane and reported year-round breeding with a peak number of litters produced in August after a low in June. Hall found no statistical evidence for periodicity in breeding activity and no cues were suggested.

Kemper et al. (1990), on the Mitchell Plateau, found births occurred from September to April with a peak in January. No breeding cues were suggested in this paper. Friend (1990), near Darwin, found *I. macrourus* births occurred from late August until mid-April with a peak between October and March. Both these studies were done in the monsoonal wet-dry tropics where about 80% of total rain falls from November or December through until March. Friend suggested rainfall as a major determinant of seasonal breeding in these regions. Since daylength varies little in the tropics and temperatures are high throughout the year, neither of these factors is a likely cue to trigger breeding. However, rainfall is highly seasonal and this affects the density of invertebrates, the bandicoot's primary food. This in turn influences bandicoot body weights and body weight is a major determinant in mammalian breeding (Widdowson 1981).

Data are needed on animals living in natural surroundings around Rockhampton. There is no information on the ecology or reproductive biology of local populations of *Isodon macrourus* in the literature and the climate in Central Queensland does not resemble that of the previous study sites. Additionally, evidence is strong for rainfall as the major determinant of bandicoot breeding due to its effect on soil-litter invertebrate numbers. Bandicoots which are living at artificially watered sites may exhibit different reproductive patterns from those in natural settings.

The foci of this study are to monitor wild populations and to compare populations at sites which receive "rainfall only" with those which receive "rainfall and sprinkler" input. Is there seasonality of wild bandicoot breeding in Central Queensland? Can a comparison of "rainfall only" versus "rainfall and sprinkler" watered populations indicate cues used to initiate breeding in the central part of the range? Is there a significant difference between the populations regarding reproductive patterns?

## Methods and materials

Animal Experimentation Ethics Committee approval has been gained for all procedures used in this study. The data has been collected by a trap/mark/release/recapture method over 3 nights per site at 4 sites per month using treadle or hook activated Sherman traps baited with rolled oats and peanut butter. The four sites studied were as follows. One site received only natural rainfall. A second site received rainfall and some sprinkler input, but the sprinkled area was small and only partly mulched. The third site, small in area and not sprinkled, was trickle irrigated and thickly mulched. A fourth site not only received rainfall, but was heavily and widely sprinkled and thickly mulched. The third site was used as a control for the effect of soil moisture but without the cue of rainfall.

Rainfall at all sites was deemed to be that recorded by the Bureau of Meteorology in Rockhampton. Sprinkler augmentation was measured by a rain gauge. Readings were taken from two locations at each site each month and then averaged, where possible. With reduced sprinkling in colder months, this was not always possible and one reading was then used to calculate the month's record. Soil moisture content was analysed by taking triplicate samples from all sites each month, weighing the fresh sample, drying it to a constant weight, then calculating the percentage weight lost. The samples were taken from diverse locations in each site.

Initially all the animals were to be anaesthetised for examination, but concerns were raised as to both the necessity for and the dangers involved in this procedure. Some of the larger males have been anaesthetised using a simple vaporiser, in which compressed oxygen is passed through an air flow regulator and vaporises the anaesthetising agent, contained in a glass bottle. This then passes to a muzzle where the vaporised anaesthetic is inhaled by the animal. This method has not been used on most occasions.

Identification of all adults has been by ear marking with a leather punch following a standard code. Measurements of all adult individuals have been recorded to compare with earlier work (i.e. weight, pes, manus, ear, head and tail lengths). Head lengths of pouch young have also been recorded to allow estimation of their age, from which the birth date and hence the month in which their parents bred, can be estimated. Hall (1990) found that head length was a reliable indicator of the age of pouch young and the equation presented in that paper was used in this study. Since Hall (1990) also presented a table of developmental stages in the growth of pouch young of *I. macrourus* which were stated to occur with “small variations in timing” (p. 124), this table was used to generate a checklist of characteristics for additional estimation of age.

## Results

The following data are for five months of trapping at each of four sites. The sites were: (1) the UCQ Ecological Reserve, (2) the Limestone Creek Environmental Reserve, (3) the UCQ Biology Compound and (4) the Kershaw Gardens. It is recognised that this study was pseudoreplicated but this was unavoidable due to time and trap limitations. Also the small sample size obtained prevents statistical analysis of the results. Weights graphed were monthly mean weights where a female’s weight varied between captures.

In the UCQ Ecological Reserve a total of four females and six males were trapped, but one of these females and three of the males were subsequently trapped more frequently in the Biology Compound. One female was carrying a litter about one week old in late March but these were not present (and had apparently been ejected) when trapped a month later. None of the three remaining females bred. Tracks of an adult and at least one juvenile observed in late April may indicate that a female produced a litter at this site in late February. Graph 1 on page 21, shows that these females were all below 1.2 kilograms and their weight remained constant or decreased throughout the study.

At the Limestone Creek ER, (which included a small lightly sprinkled area) two females and four males were trapped. Neither of the females had pouch young, or pigmented nipples indicative of a suckling litter. However they were not caught frequently and this may reflect the availability of an alternative feeding area. Infrequent trapping may prevent detection of a litter. Graph 2 on page 22 gives the weights of these females; none exceeded 1.1 kilograms and again weights remained relatively constant for the period of the study.

At the Biology Compound (which was trickle irrigated), two females and six males were trapped although some males were only recorded once at this site. One female moved into this area from the first site and did not produce a litter here until late July when four pouch young were found. The second female produced a litter of three in early May but ejected that litter in late May when the young were developmentally retarded. This female produced a litter of one male in late June which grew successfully until five weeks of age. The fate of this offspring is unknown. Graph 3 on page 23 shows the weights of females at this site; these ranged from 1.15 to 1.7 kilograms. Females at this site are heavier than at the previous two sites, and gained weight around mid-July. The second female continued to gain weight during the second lactation, in contrast with the previous litter.

In the Kershaw Gardens (which was heavily watered and mulched), four females and four males were trapped. All females trapped were either carrying a litter or showed signs of suckling a nested litter. These females were trapped frequently and development of their young followed closely. Graph 4 on page 24, documenting their body weights, clearly shows the much heavier weight of Number 6 throughout the earlier part of the year, and the subsequent decrease in weight over winter. This female weighed 2.0 kilograms in April and this is the heaviest wild-caught female of this species ever recorded. The other females weighed less throughout the year, and were similar to those from the trickle irrigated site, but bred regularly throughout the study period in contrast to females of other sites. Females at this site produced between three and five offspring per litter in eight litters. Four litters were known to be raised to within a week of pouch independence.

Rainfall data are shown in Graph 5 on page 25. Although incomplete, this demonstrates differences in total precipitation amongst sites. Sprinkling rates decreased over the colder months. These figures can only be taken as a guide due to uneven application from sprinklers and “rain shadows” caused by trees. Both sites would therefore have an heterogeneous pattern of rainfall and the readings vary depending on the location of the rain gauge.

Soil-litter moisture data are shown in Graph 6 on page 26. The UCQ Ecological Reserve has a high clay content and there was some difficulty in drying this to a constant weight. This water-holding ability of the soil means most of the soil moisture

at this site is physiologically unavailable. At the Limestone Creek Environmental Reserve samples were taken from both watered and dry locations but the sandy soil holds little water. Similarly the Biology Compound samples were taken from watered and dry locations since animals foraged in both areas. The Kershaw Gardens samples were from heavily watered areas with abundant organic material.

## Discussion

The differences in breeding patterns between populations in this study cannot be explained by temperature or photoperiod cues, since all sites were within 7 kilometres of each other and intersite variations in these factors were negligible.

Gemmell (1993) suggested that ovulation in *I. macrourus* is inhibited by melatonin, levels of which are elevated at night. Therefore, breeding commences as the length of the night decreases. This primary photo-periodic cue would be modified by extrinsic factors, such as availability of food. A nutritionally stressed population might be expected to have a longer non-breeding season since ovulation could be inhibited by undernourishment as well as high melatonin levels. However, a population with adequate nourishment would still be expected to have a non-breeding season due to the inhibitory effects of elevated melatonin. My study does not support suppression of ovulation by melatonin in the populations studied in Rockhampton, since females at two sites bred in the shorter days of winter.

Temperature is unlikely to be a significant inter-site influence in this study. Three sites were on open ground and the females foraging in the UCQ Biology Compound were probably nesting in or close to the UCQ Ecological Reserve. The Kershaw Gardens site was more sheltered but the animals were nesting in an adjacent gully where cold air could pool. The minimum temperatures in the Rockhampton region over the period of study were above average. If temperature were a primary factor in preventing females breeding, then most or all females would be expected to respond in the same way. If the temperatures were inhibitory, then few or no females would breed. Temperature can be an important factor since Bronson (1985) emphasises that thermoregulatory costs while foraging in mild temperatures can offset any energy gains made by small mammals. A female may then be only maintaining or losing weight and so reproductive attempts will be abandoned or not attempted. Any effect of temperature in this study would be as a modifier, such that heavier females may continue breeding while lighter animals would be unable to do so.

Female body weight is a recognised factor in reproductive condition (Perry 1971). There is evidence to show that ovulation does not occur in humans unless there is sufficient energy available to maintain a subsequent pregnancy (Hogarth 1978). Females of many mammalian species do not commence breeding until they have attained a species-specific body weight (Perry 1971). In Friend's study a critical minimum weight of 550 grams was found, below which no female bred. In this study a critical minimum of approximately 1.0 kilogram was found, and below this weight no female indicated a recent attempt at breeding, while some females above this weight also did not breed.

*Isodon macrourus* is reported to feed primarily on insects and other invertebrates but will also eat plant material (Gordon 1974, 1983). Since it is established that insect abundance (Wolda 1978) and litter arthropod populations (Levings & Windsor 1982) in the tropics vary seasonally with numbers positively correlated with rainfall, higher rainfall and soil moisture levels would be expected to result in greater densities of the bandicoots' preferred food. This would result in heavier body weights which in turn would lead to greater success in breeding. The results of this study corroborate the suggestion of Friend that "food availability ... has an important influence on breeding" (1990, p. 363).

Since body weight depends on food supply, nutrition is important to mammalian breeding. The higher critical weight found in this study can be related to climatic predictability. In the tropics, commencement of the monsoon is usually followed by several months of reliable rain (Friend 1990, pp. 363–364). Hence any reproductive attempt will usually be supported by an ongoing supply of food. Selection will favour females which commence breeding in the earliest rainfalls although they are without body fat stores. In a less predictable climate with irregular and short term rainfall, females cannot be assured of a steady food supply. In this environment, selection will favour females which only attempt reproduction when they carry adequate energy stores to maintain their own condition and provide for the demands of their offspring.

The female bandicoots of the Biology Compound, already heavier than the critical minimum, gained weight and bred after natural rainfall, in early June and in early July, which augmented the trickle irrigation. This is interesting because few conical digging holes were observed at this site, suggesting that most of the food intake was of litter- or surface-dwelling insects. If the abundance of insects were positively correlated with rainfall, an increase would be expected after rainfall, leading to an increase in body weight of bandicoots. This did not occur in the UCQ Ecological Reserve or the Limestone Creek Environmental Reserve, where the female weights were below the critical minimum necessary for reproduction. The rainfall and resultant invertebrates were insufficient to overcome these low weights.

The relationship between body weight and reproductive success is evident in the female bandicoots from the Kershaw Gardens. Seasonal breeding in a captive population in Brisbane (Gemmell 1988) where nearby wild populations exhibited year-round breeding (Gordon 1974; Hall 1983) suggests some inadequacy of the diet supplied to the captive animals. If the captive population were nutritionally stressed, cooler temperatures in late autumn / winter could be enough to prevent females breeding. This would give the appearance of seasonal breeding which may then have been attributed solely to the stimulus of short daylength.

## Conclusions

Continual breeding was only found at one of the sites in this study. At the heavily watered and mulched site, females bred throughout the study period, raised young to late lactation and their body weights were on average heavier than those at other sites. At the trickle irrigated site, breeding occurred infrequently and only one young was raised until late lactation. These females were lighter throughout the study, but gained weight slightly in July. At the remaining two sites, only one litter was known to be produced and this was known to be lost before weaning. At these two sites the average female weights were lighter than at the two thickly mulched sites. These weights changed little throughout the study, suggesting that the animals are existing on minimal nutrition.

Since body weight results from food abundance, breeding in this species is ultimately dependent on rainfall, as demonstrated by the results of this study. The precise pattern of breeding is determined by local factors such as season of rainfall, soil type and surface covering.

Gemmell's finding that captive populations exhibited seasonal breeding while nearby wild populations did not suggests a dietary inadequacy of the captive animals.

Future research will address several questions raised by the results of this study. The UCQ Ecological Reserve should be monitored closely since there is presently little or no recruitment and it appears to be a population sink. The Kershaw Gardens population appears to be expanding into new areas. The source of this population may have been only a few individuals, since the 1990–91 flood is likely to have removed any previous population. Recolonisation by a steady process down Moore's Creek is unlikely since there has been no indication of bandicoots above the present site until very recently. The genetic makeup and relationships of the present population need to be ascertained and to this end DNA analysis of tissue samples needs to be done. Accurate identification of pouch young and ongoing monitoring of the population will be necessary. The recruitment rate, destinations and adult size of the pouch young produced at this site need to be recorded.

## Acknowledgements

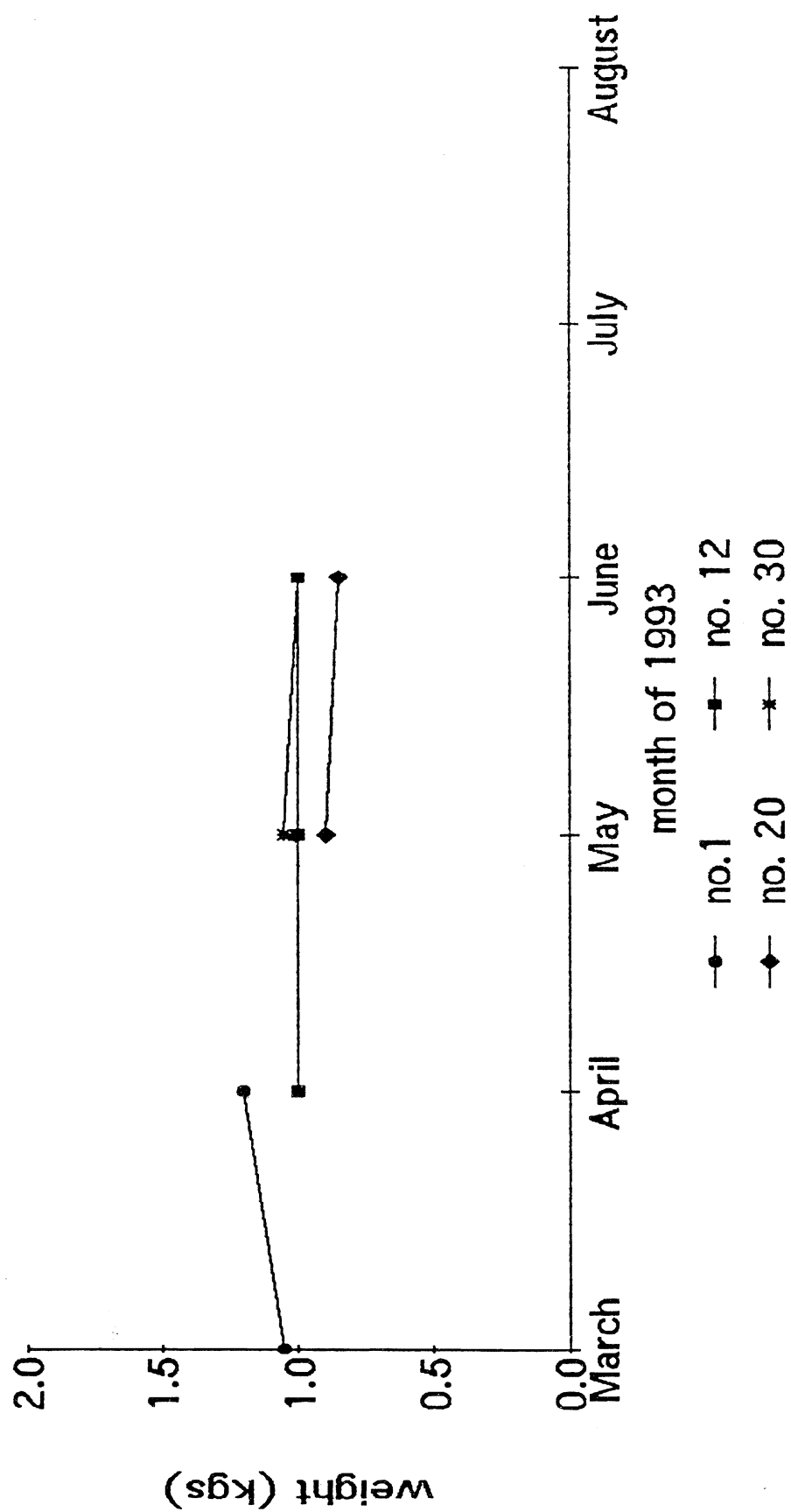
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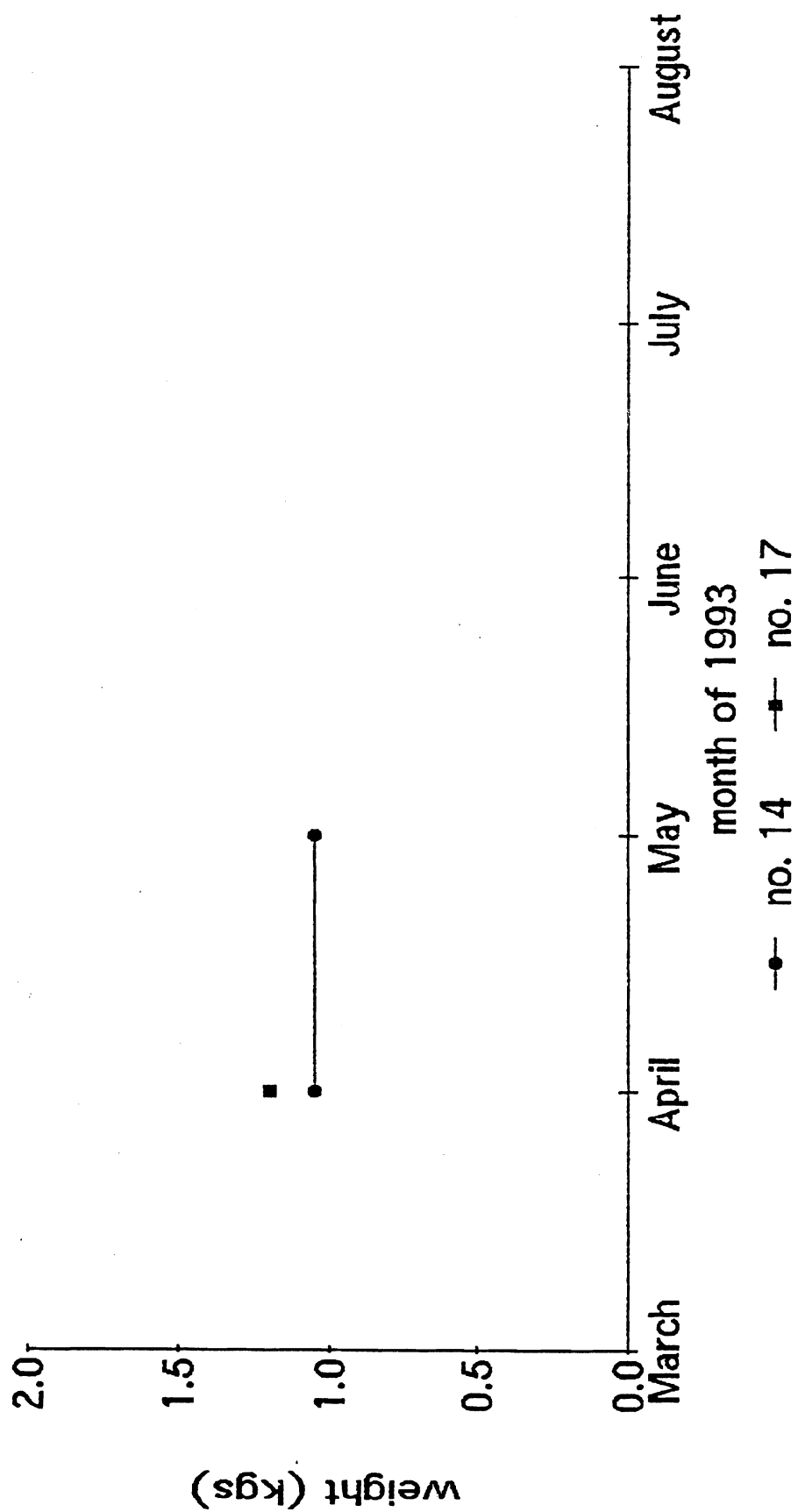
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weight of females versus time



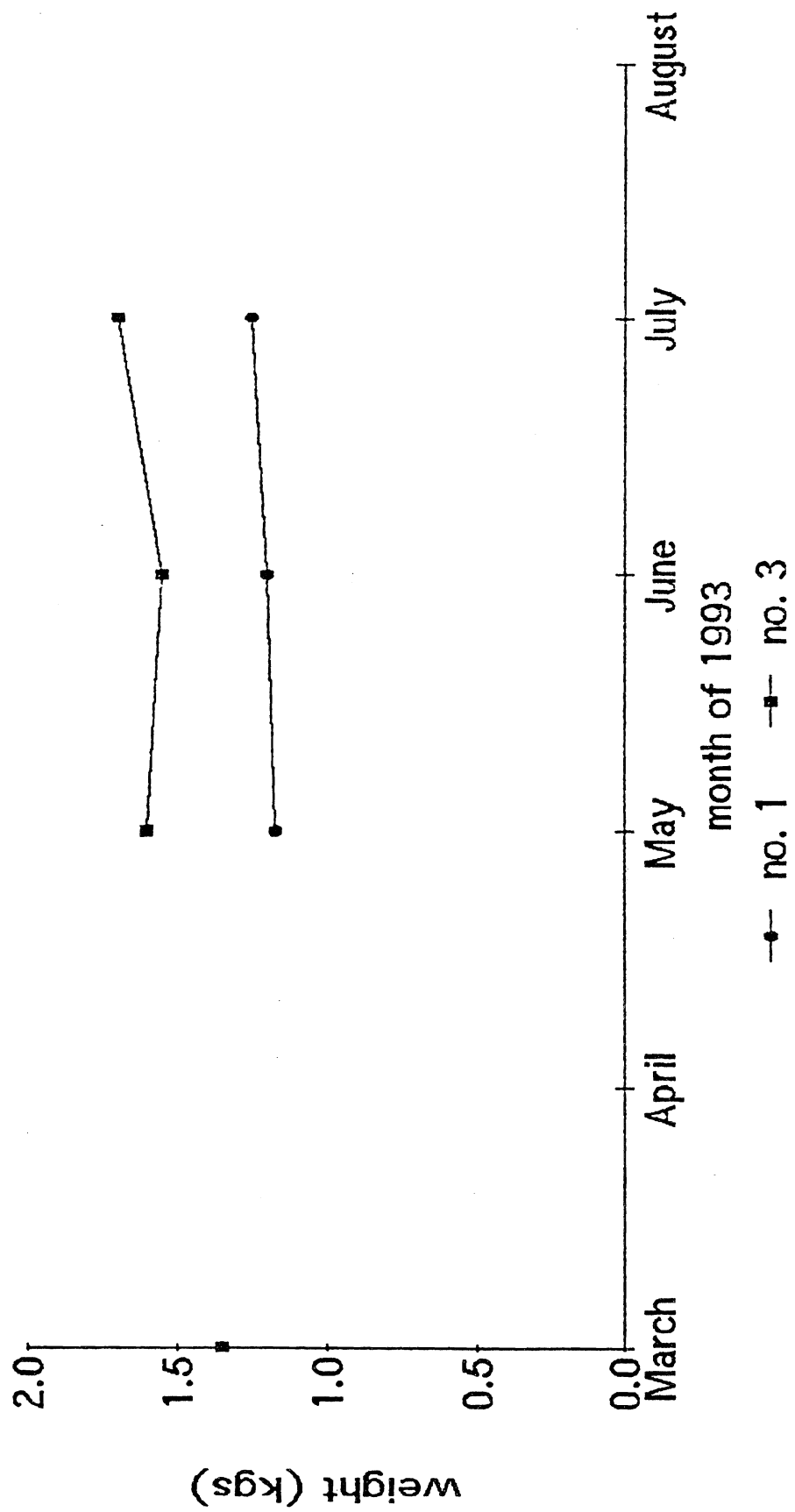
Graph 1: UCQ Ecological Reserve

weight of females versus time



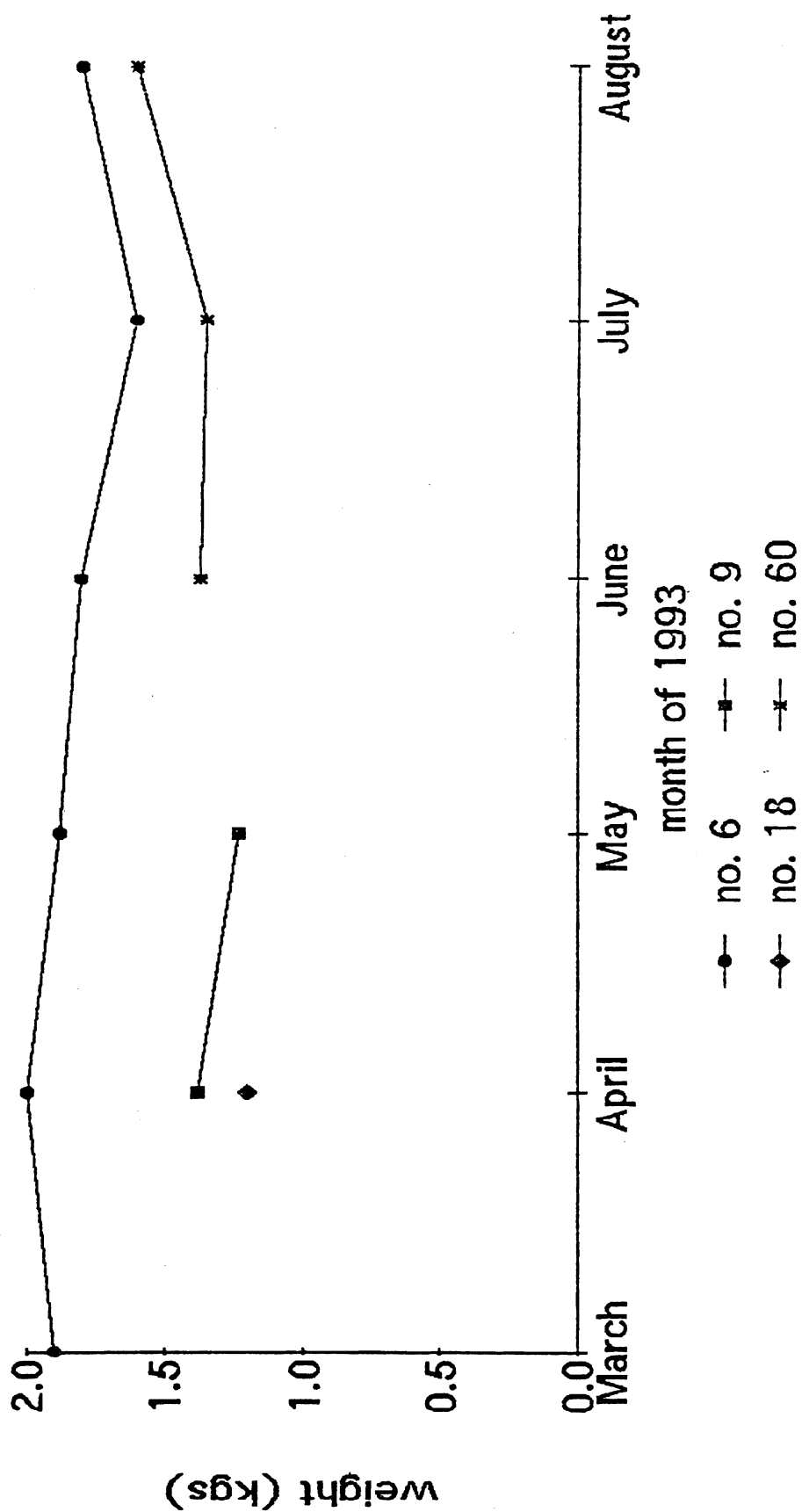
Graph 2: Limestone Creek ER

weight of females versus time



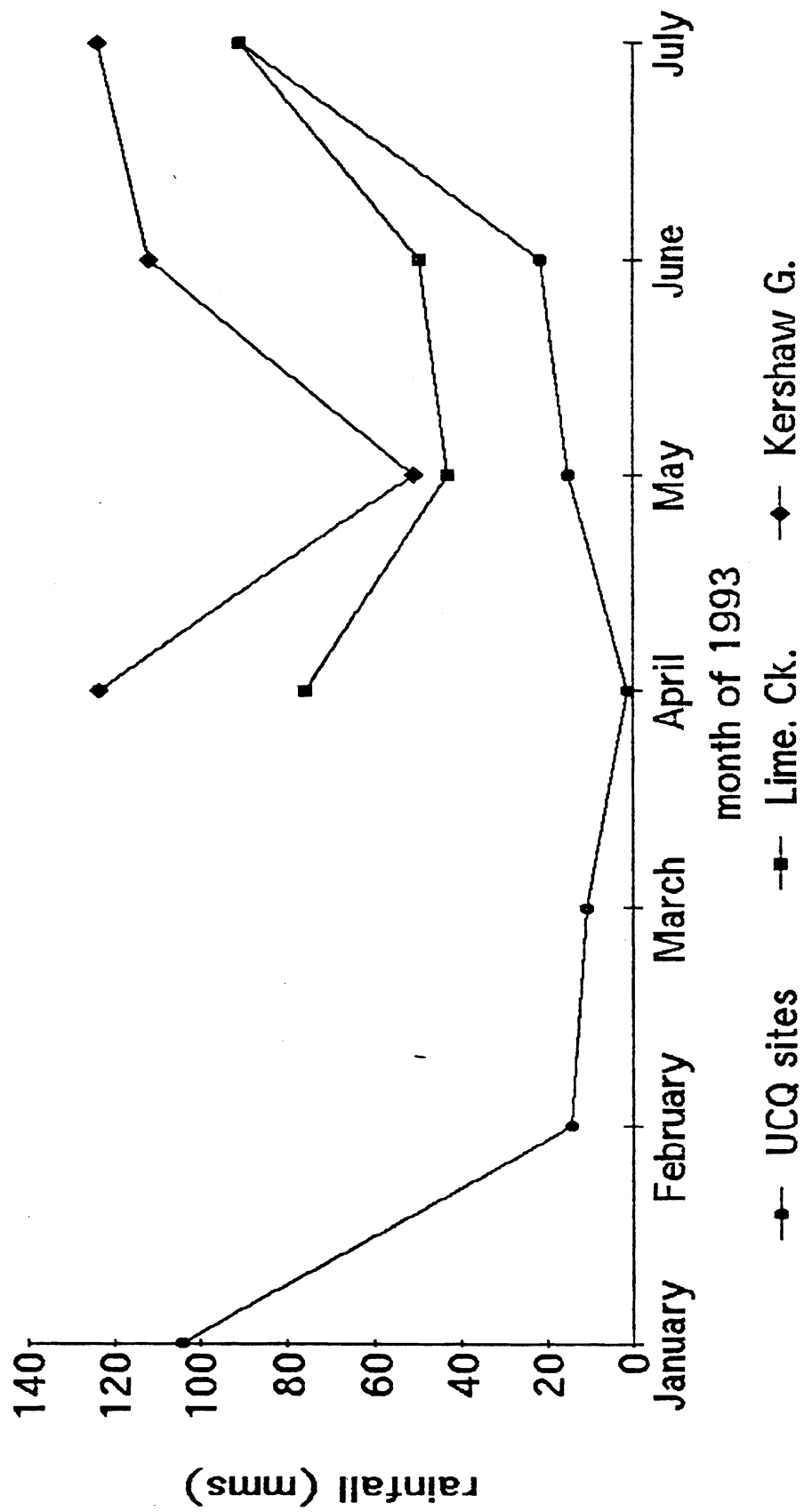
Graph 3: Biology Compound

# weight of females versus time



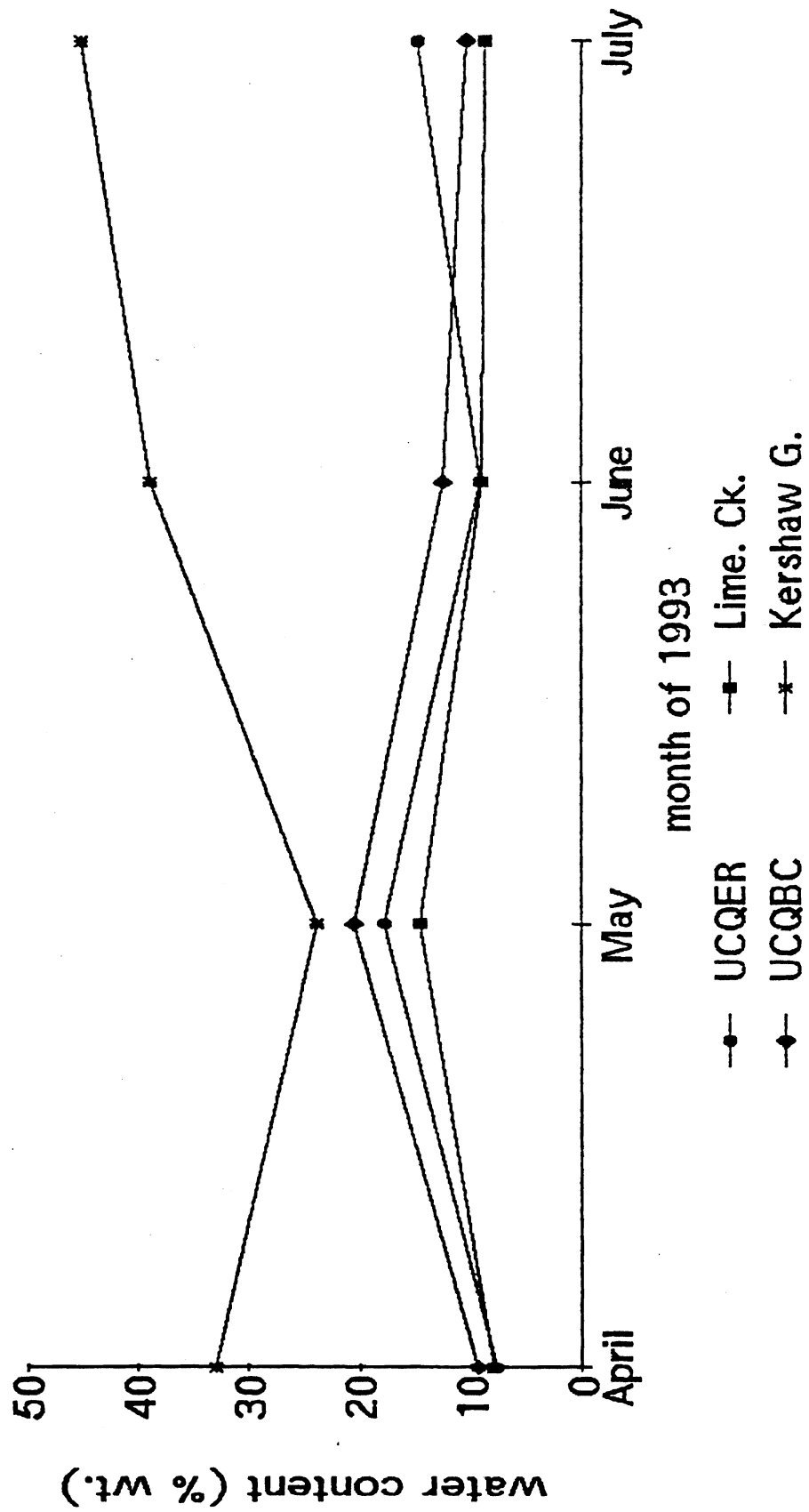
Graph 4: Kershaw Gardens

# comparison between sites



Graph 5: Rainfall records

# comparison between sites



Graph 6: Soil moisture records

# Claims on the night: Towards an erotics of writing

Geoff Danaher  
BA(Hons), DipEd

## Claims on the night

I should begin by saying that this paper has nothing to do with the title, which was merely a ruse to attract your interest, and what I actually intend to do is a semiotic analysis of lawnmowing. But should I do that it's unlikely that I'd get out alive, so I will talk to the proposed topic.

I'll begin with a quote.

Sexuality is part of our behaviour. It's part of our world freedom. Sexuality is something that we ourselves create. It is our own creation, and much more than the discovery of a secret side to our desire. We have to understand that with our desires go new forms of relationships, new forms of love, new forms of creation. Sex is not a fatality; it's a possibility for creative life.

(Cited in Eribon, 1991: 315)

The words are Michel Foucault's, from an interview he gave in October 1982, and they are attendant with irony. Foucault died from AIDS less than two years later, having had a high and hairy time of it with the young men of California. Sexuality is dangerous; it can take life as much as give it. And taking into account its danger, I want to explore the space of sexuality in creative life, as a resource for living at variance to the received meanings of modern Western civilisation.

This talk has its roots in a Pornography hypothetical, moderated by Jan MacNamee and Alison Turner and held at the university on 21 October, 1992, and more particularly my concern with responding to the suggestion made there that the Union shop cease selling certain magazines which were deemed pornographic, including *Playboy*, *Penthouse*, *Picture* and *People*.

This paper provides two arguments for not prohibiting pornography. The first argument might be labelled "social democratic", the second, quite contrary argument, "radical democratic".<sup>1</sup> The first argument is based upon the contention that when a "liberal pluralistic" society does attempt to prohibit certain activities, this attempt invariably fails and with socially debilitating results. Of course the great historic example of this is prohibition in the United States, but we have many recent local examples to draw upon. Attempts to prohibit prostitution, drugs and certain forms of gambling have produced a black economy in these areas, institutionalised corruption, and soaring organised crime. If these activities are not prohibited, a certain degree of control and regulation can be exerted upon them. The same is true of pornography. By not prohibiting it the government can, to some extent at least, limit the access of minors and "dangerous" individuals, categorise publications according to their potential to cause offence, and, not least, also extract revenue from their sale, which can be used to promote Australian industries or get the Arts Faculty out of the red.

So the first "social democratic" argument, is, I'd suggest, socially responsible, that is, it is couched in terms of securing the relatively stable and harmonious functioning of the social order, which maintains itself by according a place to such areas as pornography. My second argument is quite the contrary, that not censoring pornography makes available other sexually provocative texts which can be exploited in terms of subverting the authority of the social order, and lending oneself a creative existence on its margins. This creative life is ultimately anti-community, rejecting the ordering, ranking and control

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1. The choice of the term "radical democratic" was influenced by Ernesto Laclau's and Chantal Mouffe's use of this term in their 1985 text, *Hegemony and socialist strategy: Towards a Radical Democratic Politics*, London: Verso Books.

of experience which is constitutive of any community. And I stress that these two contradictory arguments ought not to be resolved by some kind of dialectic, but should co-exist in some sort of uneasy but necessary tension.

To understand how this second “radical democratic” aspiration might be facilitated, it is worth considering the relations between pornography and “decent, normal” sexual practice. As far as I am aware, there was no attempt during the Hypothetical to define what was meant by pornography, though Tony Schirato spoke of the difficulty of fixing a secure meaning to the term. In fact the etymology of the word is quite curious. The *Oxford English Dictionary* defines pornography as the “description of the life, manners etc. of prostitutes and their patrons. Hence the expression or suggestion of obscene or unchaste subjects in literature and art”. So pornography was originally associated with the scandal of prostitution.

When sexuality does enter the domain of art, to become acceptable it is labelled erotic as opposed to pornographic. The distinction between the two contains its own politics. The editor of *The Gates of Paradise*, an anthology of erotic writing, suggests, “A text that merely stimulates you is pornographic. A text that arouses other senses goes beyond the pornographic and becomes truly erotic” (Dessaix, 1993). This is great rot of course. There is no pure, instinctual erotic response in human sexuality. Our status as linguistic constructs means that sexuality has always already been textualised/fetishised/sublimated/reified in discourse. So-called normal, decent sexual relations have simply been that discourse on sexuality which has been privileged above others, indeed privileged as part of the project of colonising and controlling the other. The *Oxford English Dictionary* defines erotic as “of or pertaining to passion of love, concerned with the treatment of love”. Love here is conceived as a purer, higher, more sensitive realm than the sexual. Note the politics of this, as evinced in love for one’s country that the Germans of the late 1930s exhibited, for example.

This hierarchy of responses to sexuality can be understood in terms of the politics of modern Western civilisation, characterised by what de Certeau calls a scriptural economy, and also the panoptic apparatus of Foucault’s disciplinary society. Among the many aspects of modern society I’ll mention two complementary features:

1. The sexual politics of the gaze, the idea that texts, countries, populations and so forth can be laid bare, surveyed and penetrated so that their meanings can be uncovered and made the possession, the object of attention of the penetrator. This constitutive feature of modern society exhibits a range of values: colonial, capitalist as well as quite obviously sexual. Markets, land masses, and people, are, in these terms, regarded as virgin territories waiting to be explored, mapped, and known.
2. The danger of the “other”, the threat of sexuality in terms of its difference, its heterogeneity. To be in a condition of sexual arousal is not to be in control, thus the work of writing the social text of the scriptural economy is imperilled.

A multiplicity of practices and policies has been adopted in response to the threat of the sexual other. There has been the Freudian notion of sublimation—repressing/suppressing the hideous desires of the unconscious in order that civilisation might be advanced. “Let your erections be sky scrapers and not penises.” An example of this is that during the centuries of imperial advance, certain individuals were engaged in the very sexual activity of penetrating the dark places bearing the seed of their faith. This was acceptable because they were doing so from the missionary position, and indeed urging the people they colonised to do likewise.

Among other responses has been the violent disgust with which males and their discourse have reacted to female sexuality. It is not coincidental that the two nastiest obscenities in our language refer to female genitalia and copulation. Accompanying this has been an idealising of chastity and virginity in females. While masculine status depends in part on promiscuity, the number of conquests the male has achieved, female promiscuity continues to be a subject characterised by shame, fear and loathing.

There has also been a process of regulating sexuality in terms of class politics and cultural capital. While the lower orders might be titillated by Page 3 girls and the colonial ockers of Australia satirised for their scatological rhetoric, people like us who watch the ABC or go to the theatre and art galleries do so sustained by the knowledge that our store of rarefied cultural sensibility equips us with the capacity to evaluate any nudity or sexuality we may be confronted with in terms of its artistic merit.

Behind all these constructions and delimitations of sexuality lies the understanding that it is an excess, a site of difference. Part of the politics of containment has been to conceive the sexual as a problem or a scandal. This has produced a proliferating realm of discourse which Foucault studied in *The History of Sexuality*: “Under the authority of a language that had been carefully expurgated so that it was no longer directly named, sex was taken charge of, tracked down as it were, by a discourse that aimed to allow it no obscurity, no respite ... What is peculiar to modern societies, in fact, is not that they confined sex to a shadow existence, but that they dedicated themselves to speaking of it ad infinitum, while explaining it as **the secret**” (Foucault 1980: 20, 35).

A particular concern of this discourse on sexuality was the perceived problem of masturbation. A professor with the delicious name of Thomas Lacqueur, author of *Making Sex: Body and Gender from the Greeks to Freud*, comments that doctors had not the slightest interest in masturbation from the Greeks to the 18th century (Lacqueur 1993). Lacqueur locates the “problem” of masturbation in with the development of capitalism during the early 18th century, characterised as it was by an economy of surplus, pleasures of speculation and unbound desires—the South Sea Bubble being a contemporary example. Also implicated was novel-reading, indicative of the pleasures of solitude and self-absorption. Lacqueur reports that female masturbation was particularly feared in the 18th century.

This perceived problem area produced some curious responses. Kellogg’s Cornflakes was originally developed as a cure for adolescent masturbation. Which suggests that they ought to modify their advertising campaign. Even the slogan, “The simple things in life are often the best”, is rendered ambiguous. Is it a reference to the product, or the activity it’s designed to curtail?

In the case of pornography, sexuality becomes not merely a problem but a scandal, a scandal conceived of in terms of its deviation from, and consequent threat to, normal sexual practice. Baudrillard comments on the role of scandal in maintaining the order of civilised society: “capital, which is immoral and unscrupulous, can only function behind a moral superstructure, and whoever regenerates this public morality (by indignation, denunciation, etc.) spontaneously furthers the order of capital” (Baudrillard 1983: 27).<sup>2</sup> Pornography scandalises because the reified, sublimated violence of the scriptural economy is stripped away to reveal naked force. The violence displayed is up front.

What I want to argue is that patriarchal sexual violence is not located in the scandal of pornography but in the normal, everyday operations of mainstream society, a hegemony which the scandal of pornography helps secure. Censoring pornography legitimates these normal violences by distinguishing them from the illegitimate excessively violent realm of pornography. This is a distinction which can be deconstructed to recognise that, recasting a phrase Blanchot made about prisons (Blanchot 1988: 66), the function of pornography is to disguise the fact that society itself is pornographic.

To find traces of this pornography we need look no further than this symposium. As an audience you will have been judging the merits of papers according to their vision, focus, insight, far-sightedness, capacity to have made a thorough survey of their field: in short their looks. The authority of the various papers’ gaze, which provides a knowledge of their subject(s) and constructs them as an object of knowledge for our educative edification. This economy of looks governs our behaviour. In the interest of possessing healthy good looks we do obscene things to ourselves: depilation, exposure to the surgeon’s knife and ultraviolet rays. It’s not coincidental that tanning oneself is suggestive of masochism.

Similarly this connection between pornographic and mainstream values is evident in the mass media. One profitable way of reading *Playboy* is to link the reified representation of the centrefold, not so much naked as wearing a body written by the law of the late capitalist scriptural economy, with the consumer values communicated throughout the rest of the magazine—in the advertisements, the articles, the text accompanying the pictorials and so on. For it is in these links that we identify the narrative coherence of the *Playboy* text. This is not to say that the articles are all the same—they’re not—but that their differences are expressed within an overall narrative coherence. The old excuse that one buys the magazine simply for the articles is not a noticeably less violent act than if one buys it simply to look at stapled flesh.

The *Playboy* text also provides an example of how sexuality is sanitised. The model is chosen according to the criteria of healthy good looks. Sixty year old earth mothers are conspicuous by their absence from the centrefold. The problem with the representation of sexuality in *Playboy* is not that it’s dirty, but, on the contrary, that it’s clean, a site not of ecstatic excess, but of regulation and control. The threat of the other is cleansed of its corruption and given a place in the order.

Such objectification of sexuality is not confined to *Playboy*, but extends across the social text: *Business Review Weekly*, the *Women’s Weekly*, the *National Nine News*, the *King James Bible*, parliament, the stock exchange, the school playground. All of these texts exhibit a multiplicity of manoeuvres designed to colonise the other, excess and difference of sexuality within a coherent orderly narrative: elision, aestheticising, reifying, ranking, normalising, disciplining and so on. It is here that the logic of patriarchy can be traced.

The work of controlling sexuality is never complete and never wholly successful. Because sexuality is colonised in discourse and saturated in the polysemic economy, it is characterised by excess and contradiction. On occasions these contradictions can be discerned within the agent of control. An example of this is what might be called the J. Edgar Hoover syndrome. Most people remember J. Edgar Hoover as a jolly transvestite who liked nothing better than traipsing through the small hours in a cocktail frock, an activity he carried off with such panache that he became known among his freedom loving compatriots as the greatest living American. We now know that he had another secret and depraved life. For many years he

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2. Tony Schirato appropriates Baudrillard’s notion of scandal in his paper, “Disaster and Scandal: The Dili Massacre”, presented at the University of Central Queensland on 21.8.1992.

was head of the FBI, an organisation given to suppressing the very liberties he himself enjoyed. Thus our heroes and role models are shown to have feet of clay.

Hoover of course is contained by being made into a scandal, but how do we respond to a figure like Rupert Murdoch, defender of the importance of moral virtue and simultaneously proprietor of the *Sun*, pioneer of that highpoint in journalism, a topless model on page 3? Rather than regarding this as hypocrisy, it seems more useful to analyse this in terms of the class hierarchy of sexuality, in which it has been deemed appropriate to foist low, brazen and scatological sex upon the lower orders, and higher, rarefied, sublimated sexuality for the upper classes through art and literature. Thus it is perfectly feasible in terms of the operations of the hegemony for the *Sun* to campaign for the Conservative Party and for its editor, upon Mrs Thatcher's recommendation, to receive a knighthood.

The challenge then is to work out tactics to respond to the sort of sexuality the mass media and mainstream society propagate. Here's one method (Fig. 1). The satire of *Private Eye* does not constitute an unproblematic subversion of the social order. In this case, the point of the satire is based upon the perception that Murdoch and his editor are corrupting a bastion of the British upper class, the *Sunday Times*, through the incorporation of tabloid values. And of course the article is a despicable and cowardly attack upon a great ex-Australian. But I got a laugh out of it.

It is in this sense that not censoring sexuality makes spaces available for contesting the politics of its representation. Yes, we have a culture in which *Playboy* and *Penthouse* are available. We also have a culture in which females, should they choose and many do, can go topless upon the sands of Keppel Island; in which a play like *Steaming* can be performed at the Pilbeam theatre without the cast and audience being arrested; in which Joyce's *Ulysses* and the fiction of Lawrence, Genet, the Marquis de Sade and Henry Miller might be read; in which films based on novels such as Kundera's *The Unbearable Lightness of Being* might be made and enjoyed. Now these activities and texts don't constitute an unproblematically liberational politics of sexuality; far from it. For example, I think Kundera ends up constructing a high Romantic view of the artist in line with Western humanism, but his use of sexuality as a playful subversion of the claims to authority of the Communist regime in Czechoslovakia is interesting. These performances do do interesting things both sexually and textually, and provide the possibility for transporting the audience elsewhere. Women have marched in order to reclaim the night. Can not an erotic politics, a textual play in the realm of sexual otherness, be itself regarded as a claim on the night? (Of course the texts themselves are colonised into the social order through mediation, and thus become played upon by considerations of genre, cultural capital and an associated politics of reification and social cleansing, but the uses we as an audience make of them can be subversive of that order. This involves employing a tactics of reading, or textual reconstruction, to create meanings at variance to those of the generic order.)

In this regard I'd like to redefine the realms of pornography and erotics. This is in a sense reductive as I'm aware of trends in feminist and gay and lesbian pornography which challenge the civil order. However, for the sake of the narrative coherence of this paper, I'd like to take advantage of the pejorative connotations in which pornography has been couched and define it as that scandalous realm where the latent violences of the constructions of sexuality in the hegemonic order are laid bare. And erotics as consisting of those texts which uncover, contest, and playfully subvert that latent violence. In this sense the distinction between pornography and erotics is not aesthetic but political. And this politics should be a localised strategy, contesting individual texts, and exploiting the spaces they make available, rather than a totalising response, such as censorship.

There is a division between feminists who favour censoring pornography, such as Jocelynn Scutt, and those who oppose such censorship, like Beatrice Faust. From the anti-censorship camp, I find persuasive Liz Grosz's comments: "I think feminists have to admit they're implicated—that we're not in the pure position from which we can judge everything. We've all got desires, hopes and wishes which were produced in the very society we want to challenge. I see feminism as a mode of experimentation, whether you're talking about engineering or sexual pleasure" (in Lumby 1993: 15).

Actually, it might be argued that women's very status as culturally marginal privileges them to some extent in this experimentation. The subject constructed by Western liberal humanism is essentially male—the quest for identity, the rites of passage in which a male engages, involve writing himself into an essential self. Thus advertisements appeal to an essence of man, which turns out to be a brand of deodorant. Speaking personally, I'm not at all interested in finding my essential inner being, as discovering that it amounted to nothing more than a deodorant stick would be rather disheartening. Similarly, the position advocated by such people as the poet Robert Bly that I should spend my evenings running about the bushes naked in search of my essential hairy self holds no great appeal. I am interested in writing myself as a creative writing text, and would claim the right of access to a multiplicity of reference material, including sexual resources.

It's notable that women, denied an essential self, are identified according to their perceived capacity to recreate themselves periodically. "Create a new you for summer", is an advertising appeal that will be aimed at females, but not males (unless one's a sheep farmer interested in genetic experiments). Yet the slogan also works in terms of the dissolution of subjectivity which post-structuralism advocates. This applies not only to femininity and homosexuality, but also surely heterosexual

masculinity. Thus heterosexual males can benefit from studying the strategies feminists, gays and lesbians adopt to create new sexual spaces which disarm the dominance of patriarchal order, which announce that the body is open to play. As Polly Walker, director of *Orlando*, said, gender is a performance (Walker 1993). Or a work of art (Foucault) or a creative writing text (my own preference).

I'm still naive enough to regard the university as a privileged space within society. I speak as a former high school teacher and bank clerk, places in which these sorts of issues weren't raised. All the internal and often debilitating politicking notwithstanding, the university still remains a site for discussion and play. This is facilitated I'd suggest through such avenues as this symposium, conferences such as the one Leonie Rowan and Jan MacNamee are organising, *Idiom 23* literary magazine (please read the story by Daphne in the last edition as an example of what can be done in terms of explorations of sexuality), and the Capricornia Players. In this context, the university ought not to be about closing off spaces through censorship, but about opening them up. I referred to *Private Eye* before, why can't we "private eyes (privatise)" the community by producing an anarchistic or satirical magazine which features debates on such issues as pornography, as well as more nude drawings of Rupert Murdoch? Why does the student union feature mainstream films that can be seen at the local cinema instead of those more challenging ones (*Orlando*, *The Piano*, even Pasolini's *Salò* perhaps) which tend not to reach Rockhampton?

Finally, to argue that self censorship is the best form of censorship is not to evoke some liberal humanist construction of the subject as the autonomous producer of meaning, but is to suggest that we are constructed through the texts, intertexts, and contexts which make us. Accordingly, it is through alternative texts, and/or our alternative responses to the texts that we expose ourselves to, that we can deconstruct and reconstruct ourselves. Control and regulation of sexuality—my socially responsible argument for not censoring pornography—provide a map to place us in terms of our sexual identity. The opportunity for play and subversion that this place provides—my socially irresponsible argument—is a means of showing us that we're not in that place at all, or at least need not be. And, so long as we are made safe to play through certain forms of control and regulation, it is desirable that a multiplicity of texts—including the sexually explicit—ought to be available to facilitate our production of a creative life.

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THE  
**Sun**  
DAY TIMES

Page Three  
Fella!



HERE he is!! Big Rupert Murdoch in an exclusive naughty picture! Taken of course by responsible photo-journalists acting in the public (shurely 'public'? Ed) interest!! What's that he's holding?

"It's just a prick," says porn-again (shurely 'born-again'? Ed) Rupe. "I'm a hands-on proprietor." Well that's 'Andy!!! Brillo, sport!!

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Figure 1: (*Private Eye*, 9 October 1992, p. 15)

# Difficulties encountered by mature health science students in learning statistics

**Janet Norton**  
BAppSc(Mathematics and Computing)



## Abstract

This paper deals with the problems encountered by mature health science students in learning statistics. Health Science students are chosen because they presently form a particular group with well-defined demographics. These students are all mature, predominantly female, working externally, practising professionally in their field and required to upgrade their qualifications to maintain their positions in their career. Health science students also exhibited difficulties peculiar only to themselves.

Difficulties encountered may be divided into four very broad and not necessarily mutually exclusive categories. They are lack of mathematical background, use of language, philosophy and relevance. Each of these categories is discussed and examples of difficulties shown. The current move to include computer aided learning in statistics is also discussed. The paper arises from the author's extensive work with students from all disciplines in many areas of mathematics and a series of case studies of health science students.

The paper concludes with some recommendations of ways to improve students' perceptions of statistics and recommendations with regard to the upgrading of currently available subjects.

## Introduction

This paper deals with difficulties encountered by mature health science students in learning statistics. Mature health science students were chosen because they exhibit several characteristics which identify them as a particular group. Currently all students are mature, predominantly female, working externally and practising professionally in their field. Because of the manner in which health science professionals were recruited in the past, these students have usually not completed high school past Year 10. Professional qualifications were obtained by training courses developed and administered by individual hospitals. Further, these students are required to enrol in tertiary courses in order to upgrade their qualifications to maintain their employment status. Statistics is also a core subject within the relevant award course.

As a provider of remedial mathematics tuition within the Mathematics Learning Centre, University of Central Queensland, and since leaving there, I had dealt with many students from all disciplines with difficulties in learning statistics. Health science students exhibited many of the same problems but with further difficulties that were not evident in students from other disciplines. This paper is based on a case study of five individual students who were tutored on a regular basis supplemented by observation of students seen on a less regular basis.

The case study students were studying through a number of different tertiary institutions. Any similar difficulties could, therefore, not be explained as being a result of material presented by a particular institution. Students were also enrolled in two different types of statistical subjects. Some students were completing subjects that were specifically designed for the health sciences while others were enrolled in more general multi-discipline service subjects. These aspects of health science students also served to distinguish them as a group because statistics students dealt with from other disciplines had all been studying at the one institution and all had been enrolled in a service subject. Despite the differences in institution and type of subject studied, all students displayed a remarkable similarity in difficulties in learning statistics.

The students used as the basis of the case study were all mature age. Three of the students were practising professionals in health science, the others were involved in health science education. The case study group consisted of four females and one male. Three students were studying a service subject through the University of Central Queensland. Two students were studying health science designed subjects through two different Australian universities—University of Western Australia and University of Sydney. One student was working at postgraduate level. All other students were in the final year of an undergraduate degree. All students were studying externally.

The students exhibited difficulties in many areas of learning. These difficulties could however be grouped into four broad categories. These categories cover all areas of difficulty; however there is much overlap between categories. The categories may be broadly titled as—Mathematics background, language, philosophy and relevance.

## Mathematics background

Mathematics background, or more precisely, lack of a mathematics background, is the most obvious source of difficulty for health science students. As stated previously, most students have not progressed beyond Year 10 in formal school education, which results in quite obvious gaps in formal mathematics. In the intervening years little or no mathematics has been attempted and most students exhibit a fear of mathematics (four of five). The students were also restricted in that their knowledge of mathematics was, in reality, a knowledge of arithmetic. Coupled with this was a reluctance to use (and trust) a calculator.

Most students were familiar with the use of a calculator for basic arithmetic calculations but exhibited a resistance to learning how to use a scientific calculator. Those students who were willing to use a more advanced calculator required considerable instruction before they were confident in its use.

Few students had a knowledge of algebra, even at the level of substitution in formulae. The concept of absolute value was also unknown. The use of Rules of Precedence was evident only to the level of multiplication and division. Extension of these rules to powers was not known and indeed some students had difficulty with exponents and evaluation of problems involving exponents. The use of subscript notation and the related concept of summing data using sigma  $\left(\sum_i^n\right)$  notation caused a great deal of confusion.

Unfortunately the first part of most elementary statistics subjects dwells on descriptive statistics and students spend many weeks developing mathematics skills in order to perform these operations. This effort is not rewarded in examinations however because descriptive statistics is only a small part of the complete subject.

Those students with good arithmetic skills exhibited a lack of mathematical sophistication particularly in regard to the reading and application of formulae. Figure 1 shows an extract from the text *Statistics for Management and Economics* by Watson et al. (1990).

### Definition and Equation for Population Variance $\sigma^2$

The variance for a population of  $N$  values,  $X_1, X_2, \dots, X_N$ , is the sum of the squared deviations for the values from their mean  $\mu$  divided by  $N$ , or

$$\sigma^2 = \frac{1}{N} \sum_{i=1}^N (X_i - \mu)^2 \quad (3.7)$$

Thus the variance is the mean value of the squares of the deviations. It can also be found when the computational formula is used to obtain the sum of squares.

### Computational Formula for Population Variance

$$\sigma^2 = \frac{1}{N} \left[ \sum X_i^2 - \frac{1}{N} \left( \sum X_i \right)^2 \right] \quad (3.8)$$

The population standard deviation  $\sigma$ , or root-mean-squared deviation, of the numbers in a population of size  $N$  is the square root of the variance.

### Definition and Equation for Population Standard Deviation $\sigma$

The standard deviation for a population of  $N$  values,  $X_1, X_2, \dots, X_N$ , is the square root of the population variance, or

$$\sigma = \sqrt{\sigma^2} = \sqrt{\frac{1}{N} \sum (X_i - \mu)^2} \quad (3.9)$$

Figure 1: Definitions of population variance and standard deviation

Source: Watson et al. 1990, p. 78

This extract gives the definition of population variance ( $\sigma^2$ ) and a computational formula for population variance ( $\sigma^2$ ). This is followed by the definition of population standard deviation ( $\sigma$ ). Although the definition clearly states that the standard deviation is the square root of the variance, students did not recognise that the standard deviation could be obtained by using the computational formula and then calculating the square root.

$$\sigma = \sqrt{\sigma^2} = \sqrt{\frac{\left[ \sum X_i^2 - \frac{1}{N} \left( \sum X_i \right)^2 \right]}{N}}$$

While it is possible to calculate standard deviation using the definition, students found that in a list of formulae in an examination the computational formula was used. Students then experienced difficulty in performing the computation. This lack of mathematical sophistication was also observed in the inability of students to grasp the concept that when using grouped data the form  $\sum fx$  was equivalent to summing all data.

## Language

The language of statistics causes particular problems to many students. Statistics uses many common English words. However, these words have very particular meanings within the statistical context. These meanings are often slightly different from the accepted use of the word in spoken English. These words include terms such as *population* and *sample* which have particular meanings in statistics. Many students perceive *sample* in terms of a single unit rather than as a collection of *sample units*. It must also be made very clear to students that the *population* of a study is defined by the particular researcher. The concept of a researcher **defining** a *population* and a *sample* is one that many students find difficult to accept.

Statistics also uses words which have value meanings attached to them in spoken English. These are words such as *event*, *success* and *failure*. For many people an event is thought of as a “special function”. Thus the Olympic Games is an event, or Expo 88 was an event. Again within the statistical context an *event* is what the researcher defines it to be. An *event* may, therefore, be “that a red card is drawn from a pack of cards”. The terms *success* and *failure* have a great deal of value added to them in spoken English. That is, we all want to be a success but no one wants to be a failure. Within the statistical context these terms have no value meanings. Again the nature of a *success* or *failure* is defined by the researcher. A *success* may simply be that a six is rolled on a die. A *failure* would, therefore, be that a six is not rolled on a die. The nature of the meaning of all these terms is essential to a good understanding of statistics. Few texts, however, clearly explain the statistical meaning (as opposed to the general spoken meaning) of these terms. This distinction must be clearly spelt out as well as the fact that these terms are defined by the researcher and the actual nature of what they define varies from problem to problem.

There are also terms which have very particular definitions that are the same in all situations. This includes terms such as *independent* and *mutually exclusive*. Because of a lack of clear understanding of these terms students often confuse the two meanings. For events to be *mutually exclusive* means simply that they cannot occur at the same time. Thus a person cannot be both dead and alive. A person must be one or the other (with the accepted definition of death). *Independence* is a different concept. Independent events are events that are not related in any way, that is, the occurrence of one event in no way affects the occurrence of the other. The classic example of independent events is the tossing of a coin. The outcome of any one toss has no bearing on the outcome of a successive toss. Figure 2 demonstrates the different ways in which statistical texts define independence.

The extracts are all similar in that they all give a mathematical definition of independence and also indicate that no concrete example of independent events is given. The extract from Runyon and Harper (Fig. 2) gives the best definition in words of independence. The concept of independence is vital for the understanding of many statistical procedures and as such instructors should ensure that students have a firm grasp of its meaning. However, study guides provided to students do not appear to explain this concept to students.

Coupled with the language of statistics is the fact that health science professionals, like other professional groups, have developed their own particular use of language. This particular use of language means that when examples that are thought to be relevant to these professionals are used they are often worded in a fashion that is unfamiliar, thus causing more confusion.

A

*Special  
multiplication rule*

$$P(A \cap B) = P(A) \cdot P(B)$$

Thus, the probability that two independent events will both occur is simply the product of their probabilities. This rule is sometimes used as the definition of independence; in any case, it may be used to determine whether two given events are independent.

B

### Definition

$A$  and  $B$  are independent events if

$$P(B|A) = P(B) \quad (4.11)$$

or, in words,  $A$  and  $B$  are independent events whenever  $A$  gives no information about the probability of  $B$ .

If events are *not* independent, then we say they are **dependent**. With reference to Equation (4.11) we say that events  $A$  and  $B$  are independent if the conditional probability of  $B$ , given  $A$ , is the same as the unconditional probability of  $B$ . Another way of stating the concept of independence is as follows: If knowing that one event has already occurred does not change the probability that the other event has also occurred, then the two events are independent.

C

**When events are independent.** In the special case where the occurrence of  $A$  is in no way related to the occurrence of  $B$  and vice versa, the events are said to be *independent*. Independence is shown symbolically by  $p(A/B) = p(A)$  and  $p(B/A) = p(B)$ . When events are *independent*, the multiplication rule simplifies to

$$p(A \text{ and } B) = p(A)p(B). \quad (11.10)$$

**Figure 2:** Definitions of independence

Source of A: Freund 1984, p. 134

Source of B: Watson et al. 1990, p. 143

Source of C: Runyon & Harper 1967, p. 118

## Philosophy

Philosophy, like language, needs to be viewed from the point of view of both statistics and health science professionals.

Statistics as a discipline has developed a number of mathematical models which are now used to test gathered data in order to find statistically significant differences and/or to attempt to predict an outcome based on previously collected data. Statistics, therefore, has rules for the correct gathering of data and the types of tests that may be conducted dependent on the type of data collected. Statistics used properly is a very powerful tool.

However, as mature people, health science students have seen, over a long period of time, the misuse of statistics in the media and by people in public positions. As a result they have a learned distrust of statistics. Further, health science students are often able to recognise a bad sample and give reasons why the sample is not good. For example, one student commented that people presenting voluntarily for blood pressure screening could not be used as a basis for predicting the blood pressure of the population and was able to give reasons why this was so. However, when asked, the same student could not describe how

to obtain a good sample. This inability to obtain a good sample leads students to a resistance to the idea of statistical inference. While some of the subjects studied did show students how to select a sample, others did not. Another problem is that the discussion on sample selection occurred at the beginning of the text and was not referred to in the context of statistical inference.

Further, statistics relies only on the gathered data and all descriptions, statements, inferences and expectations are developed using only the available data. This philosophy must be clearly spelled out to students.

Conversely, the philosophy of health science professionals is to view a subject (patient) as a whole. Relying on their previous experience, health science professionals make decisions only after extensive examination of various aspects of the subject. They are trained to work in this manner. It is, therefore, extremely difficult for them to rely on only one aspect of a problem to make a decision. When confronted with a simple exercise it is not uncommon for them to attempt to use their own background knowledge in order to solve it. It is necessary, therefore, to clearly explain that, in an elementary statistics course, only data provided is used for solving problems. It is also necessary to explain the nature of statistical significance.

## **Relevance**

Health science students unfortunately see little relevance in statistics to their profession. This is despite the fact that health science professionals gather a large amount of data in the course of their work. They are also involved in the administration of structural questionnaires in the course of their duties. However, few texts contain any exercises or examples that have a health science background. Most examples are restricted to the humanities, business and science. This apparent lack of application of statistics to their chosen field makes the task of health science students even more difficult. It was noted that this lack of relevance was a problem in both service subjects and specifically designed subjects for much of the subject matter. Specifically designed subjects do introduce areas such as prevalence and incidence in the latter part of the subject. Few students were able to recognise that without a knowledge of statistics they would be severely limited in attempting research at a later date.

## **Use of computers**

The use of computers has not been listed as a difficulty for students for the simple reason that students do not attempt to use a computer in the course of study of statistics. This is despite the provision of statistical programs with the subject studied. Students find they experience sufficient difficulty in the mechanics of statistics without attempting to enter data into a computer. Students also find that the use of a computer reduces the portability of the subject, that is, they are tied to a particular place for study. The failure of subjects to emphasise the importance of interpreting a result rather than the mechanics of obtaining a result can be seen as contributing to this reluctance to use computers. For these external students, some many kilometres from computer terminals, access was also seen to be a source of difficulty. The time taken to master a statistical program was also a contributing factor to this lack of interest. This trend for students to avoid computer use needs to be studied carefully with the development of external subjects which are increasingly computer-oriented.

## **Recommendations**

After studying the case study group and other individuals it can be seen that the difficulties encountered are not entirely a result of poor mathematics background, but rather, a combination of poor background and difficulties in the material presented to students. The lack of mathematics background does, however, have a compounding effect on other problems.

When dealing with this lack of knowledge it is important to notice opposing views on how it should be dealt with. Students argue that elementary statistics subjects have no prerequisite subjects. Universities have accepted them into award courses without querying their mathematics background, they are paying HECS, and therefore, it is the responsibility of the university to provide them with instruction in this area. Instructors, however, argue that as the subject is offered at university level they are entitled to assume a knowledge of basic mathematics processes.

Regardless of who is correct, increasing numbers of students are entering subjects without the necessary prerequisite mathematics knowledge. It should be clearly indicated to students commencing a statistics course that there are minimum mathematics requirements. If necessary, preliminary work may be provided either prior to entering the subject or as an adjunct to material already provided. The type of mathematics required may be summarised as:

- basic arithmetic  
(including use of signed numbers)
- substitution in formulae
- solving equations
- sigma notation  
(including subscript notation)
- linear functions.

While the manner in which this information is provided is subject to argument, the fact that students require this type of knowledge must be clearly indicated at the beginning of the subject.

The issues of language and philosophy can only be addressed by developing material that particularly deals with the issues raised. The development of effective study guides which do more than simply direct students to relevant sections of the text can adequately deal with these issues. Closer consultation with the users of multi-discipline service subjects during the preparation of subjects will eliminate many problems. It must be recognised that distance education students are almost completely reliant on the material provided by the teaching institution for information. As such, study guides should provide information that is not clearly provided in the text. Efforts should also be made to hold teleconferences and workshops with these students in order to deal with problems on a one-to-one basis. Students consistently complained of difficulties in contacting lecturers to discuss problems and felt that they had been abandoned to their fate.

The issue of relevance is much harder to address. The inclusion of exercises and examples that mirror the health sciences will assist in this area. However, the real issue of relevance is the focus these subjects place upon the mastering of the mechanics of statistics. While some knowledge of the mechanics is desirable it is the interpretation of results that is more important. It is the idea of interpretation that is lost to these students because of the amount of difficulty they encounter in obtaining results. It can be argued that these students would be better served by a subject that concentrated on the **methods** of statistics rather than the **mechanics** of statistics. Such a subject would study methods of obtaining samples, types of tests that may be applied and the requirements data must meet for certain tests to be used, as well as the interpretation of results. Again it is the responsibility of the instructor to see that material provides students with the necessary information.

## Conclusion

After examining the type of difficulties encountered by mature health science students, four categories of difficulties were identified: mathematics background, language, philosophy and relevance. Students can be seen as responsible for developing their own mathematics to a level which allows participation in a statistics subject. However, instructors must look to improving their own material to assist in improving the situation in the other areas.

While only a small case study was used to develop this paper, the author has extensive experience with large numbers of students from many disciplines. Health science is only one discipline among many that have an elementary statistics requirement. Many of the difficulties encountered by health science students have been observed to a greater or lesser extent among students of other disciplines. In order to serve these students better, the ways in which elementary statistics courses are presented must undergo much scrutiny and change.

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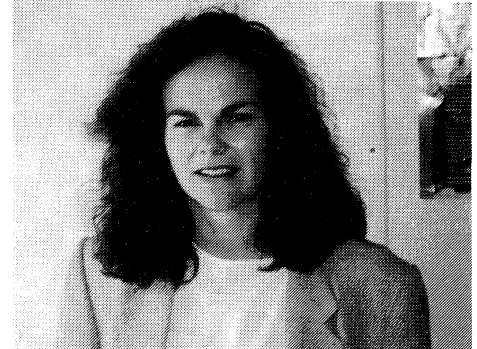
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# Advertising appeals for personal superannuation products targeted to working women

Margie White  
BBus(Dist)UCCQ



## Executive summary

The female market has been described as a *moving target* (Bartos 1982), *elusive* (Free 1985) and a *growing force* (Kreinik 1976) indicating the phenomenal changes that have taken place in this segment during the last several decades. This paper will examine the changing roles of women in society and how these changes have influenced the development of advertising strategies targeted to various segments of the female market.

Personal superannuation companies must segment the working female population taking into account the changing values, attitudes and demographics in this market. Qualitative research in the form of indepth interviews was undertaken to identify key consumer behaviour motivations for working women in the personal superannuation market.

One key finding from the qualitative research is the difference in perspective between women employed in low-occupational-status occupations and women employed in high-occupational-status occupations in terms of financial planning. It was found that women employed in high-occupational-status occupations tended to be more financially aware, having more specific financial plans for their retirement. They believed women should be financially independent, and want security independent of their husband.

On the other hand, women employed in the low-occupational-status occupations tended to live for today and had not planned for their future retirement to any great extent. The younger women were living from payday to payday, whereas the older women were relying on their husband's superannuation or the government pension in their retirement.

The aim of this paper is to identify key consumer behaviour motivations amongst working women for personal superannuation. With increasing numbers of women in the workforce, personal superannuation companies must recognise the inevitable expansion of this segment of the market, and develop appropriate advertising appeals tailored to the different demographic segments of working women.

## Definition of key terms

**Personal Superannuation Fund**—a superannuation plan *not* tied to your place of employment, to which you make contributions over the course of your working life. These plans are based on a person purchasing a superannuation policy from a registered superannuation company. The benefits derived will be dependent upon the amount and period of time it is invested, and the investment performance of the fund manager. A distinction is made between personal superannuation and employer based superannuation. The latter usually provides benefits based on a formula linked to length of service and final salary (Personal Superannuation Planning, Prudential, Portfolio, July/August, 1991).

## Introduction

During the last several decades, the economic and social status of women has changed dramatically, with women becoming more financially independent. Consequently, women have become a growing and viable target market for financial services, including retirement planning in the form of personal superannuation. This paper will examine the changing roles of women in our society and the impact of these changes on the development of advertising strategies for personal superannuation targeted to the working woman.

The paper will examine the results of qualitative research which examined the key consumer behaviour characteristics of low- and high-occupational-status working women in the personal superannuation market.

## Women as a target market

Bartos (1982) has aptly referred to working women as *the moving target* highlighting the difficulty in developing marketing strategies targeted to a demographic segment whose characteristics are continually changing. The women's market is no longer as static or as stereotypical as in the past, creating a major challenge for marketers who must regroup the market into more meaningful segments.

Traditionally, the stereotypical housewife described by Free (1985, p. 33) as the *darling of the mass marketing boom* was the focal point of marketing strategies targeted to women. However, the housewife stereotype has been replaced by a proliferation of consumer segments in the female market. Marketers must recognise the diversity within each segment of the market and be careful not to assume that all women within a particular segment are similar. Take for example, working women, who are diverse in terms of their needs, spending power and lifestyles. A career woman whose income is added to her husband's will have a different spending power and lifestyle to a female head of household with a young family or a young secretary living with her parents (Bartos 1982).

Bartos (1977) urges marketers to recognise the realities of the women's market by examining a combination of old and new demographic facts, as well as changing attitude and value systems. Practical-minded marketers must challenge the underlying assumptions of how markets are defined and bring their marketing procedures in line with reality. A thorough evaluation of the consumer behaviour characteristics of the women's market is a critical first step in any marketing program targeted to women. This in turn will aid with the development of marketing strategies reflecting the diversity of different lifestyle groups within this segment of the market.

## The changing roles of women

One of the most profound changes in the women's market during the past two decades has been a marked increase in the participation rate of women in the formal labour market, with women moving from a primarily nurturing and home-making role to women as wage-earners (Stern 1988(b)). Bartos (1982) has described the dramatic rise in the number of women in the workforce in recent years as *the quiet revolution*, being a symptom of a more fundamental change in women's self-perceptions. Working women are no longer an exception, with the majority of women either in part-time or full-time employment. The increasing number of women participating in the workforce has been particularly pronounced amongst married women.

Increasing workforce participation rates have affected the concept of the traditional family, where the husband is regarded as the primary income earner, with the wife staying at home (Ross-Smith & Walker 1990). With more Australian women entering the workforce, dual career families have become commonplace. A woman's role has changed from being primarily an economic consumer to being both producer and consumer (Stern 1988(b)).

McCall (1977) developed the term *workwife* to describe the dual roles of women who are combining two major societal roles of being mother/housewife with employment outside the house. According to McCall, combining these roles has changed the nature of the traditional family unit due to the power that working women exert in the marketplace. Any change in women's purchasing behaviour will have significant influence on the household as a whole. Families with two income earners have increased spending power, contributing heavily to the rapidly growing affluent market (Engel, Blackwell & Miniard 1986).

## Motivations for work

The assumption that women work only out of economic necessity has also been challenged in the literature, with the vast majority of women stating that they were working because they wanted to, not because it was necessary. Some psychologists describe this phenomenon as a search for self-fulfilment, while others focused on the decline of the stereotype of a perfect mother as the new feminine ideal role model. Social stimulation, a sense of accomplishment and self-development, as well as a yearning for an identity independent of the role allotted to the family structure, were the major reasons stated by women as being positive attractions of work outside the home (Farrar 1984, Free 1985).

Women's changing aspirations are described by Bartos (1989) as a contributing factor in women's increased involvement in higher education. The traditional goal of women was to become a wife and mother; however, younger women are now seeking to combine marriage, career and children.

Bartos (1989) has conducted comprehensive research in the women's market, developing a categorisation scheme for non-working and working women based on their attitudes towards work. In her research, Bartos analysed the consumer behaviour patterns, attitudes and values of both working and non-working women. When Bartos asked housewives if they ever planned to enter the paid workforce, approximately half the housewives indicated that they planned to work within the next year, within the next five years, or "sometime". Working women were asked whether their work is "just-a-job" or a career. This was not a matter of defining their jobs, but how they felt about their work. The responses from both the working and non-working women were used as a basis of segmenting women into four groups according to their career orientations:

- *Stay-at-home housewives*—include the oldest and least educated women, endorsing the traditional roles of wife and mother;
- *Plan-to-work housewives*—these women are generally younger and better educated. They are devoted to their children; however, they look forward to entering the workforce as a means of personal satisfaction and economic reward;
- *Just-a-job working women*—includes women who are financially motivated to work and also gain social satisfaction from interacting with others in the workforce;
- *Career women*—these women are the best educated and most affluent group, gaining from their work a sense of achievement and personal accomplishment.

Detailed analysis of the characteristics of these four groups, including their attitudes and values on work and non-work related issues, found the stay-at-home housewives were out of step with the other three segments. Although plan-to-work housewives were defined as "full-time home makers", their attitudes and values were far closer to those of working women rather than non-working women. Differences were also found between just-a-job working women and career oriented women, which in part, were a reflection of the fact that career women were the better educated, taking a non-traditional perspective on many issues.

In Australia, Clemenger Advertising and Reark Research (1984) examined both the conventional working and non-working woman, similar to the categories used by Bartos (1982). According to their report, *career oriented women* tend to be younger, better educated and to belong to higher income households. These women work for independence, enjoyment and for enhancement of their career. The majority of career oriented women are married (64 percent) and have children (56 percent). On the other hand, *income oriented women* are older and tend to have teenage children. This segment is somewhat less educated and has been in the workforce for a longer period, when compared to career oriented women.

## Women as a segment for financial services

Women are becoming more financially aware and actively involved in financial decision making. They are now requiring more information about finance, money management and business. They have become actively involved in the purchase of financial products including insurance, credit and bank cards, chequing and savings accounts, shares and retirement planning (Stern 1987).

Women as a market for financial services has been the focus of a recent Australian study undertaken by Mattingly and Partners (1993). The report states that the women of today take financial matters seriously, value financial independence and feel confident in their decision making abilities. The research found that the majority of women (71 percent) stated that they have different and special financial needs when compared with men. According to the report, the financial needs of women *are often not recognised by the historically male focussed commercial world* (1993, p. 20).

The report also stated that women are requiring greater flexibility and empathy by financial service providers to cater for their various life cycle changes, such as, marriage, entering and leaving the workforce for children, or divorce. As well, women are particularly conscious of the risks inherent in their lives and are strongly motivated by concerns about protection for the future. Women want to be taken seriously in financial matters. They feel that their needs, views and uncertainties are frequently not taken seriously in major financial decisions, resulting in resentment and a lack of trust towards the financial institution (Mattingly & Partners 1993).

Through cluster analysis, Mattingly and Partners (1993) identified three distinct groups of women, based on the woman's attitude towards financial matters. These groups include:

1. *Confident people*—these women are confident with their dealings with financial institutions and in their ability to make sound decisions. This group tends to lack insecurity and do not believe they have been treated badly because they are women. For them, gender is not an issue, with these women the least likely to agree with any simple sexual stereotypes. These women come from all demographic backgrounds.
2. *Insecure victims*—these women lack confidence in their own abilities, believing they are victimised because they are women. This in turn leads to annoyance and frustration. They perceive themselves as being financially vulnerable, requiring independent advice. Consequently, they place the greatest amount of faith in the recommendations of other women and are the most dismissive of men's ability with money. This group contains a large proportion of women earning low incomes, non-working women and divorced women.
3. *Assertive feminists*—this group of women recognise that they may be exploited by financial institutions, however, they are confident in their ability to cope with this. These women tend to be highly organised and disciplined, focussing seriously on their financial future. This group is the most conscious of being treated poorly by salespeople because they are women. Consequently, they are more likely to take their business elsewhere. This group has a large proportion of white collar women, earning higher levels of income.

Of the above three segments, the assertive feminists have the greatest significance to financial service marketers due to their enhanced spending power. The segmentation of the women's market undertaken by Bartos (1982, 1989), Clemenger and Reark (1984) and Mattingly and Partners (1993) highlights the need for the development of relevant advertising campaigns, taking into account the specific needs of each segment.

## Women and superannuation

In recent years, the coverage rates of the female labour force by superannuation has increased dramatically to 87.5 percent of the female labour force compared with about 80 percent for men. However, at any one time, approximately 52 percent of women of working age are in paid employment, compared with 74 percent of men. Consequently, actual rates of coverage of the total female population by superannuation are much lower. It is assumed that these coverage rates will improve with increased participation rates of women in the labour force and as their access to superannuation is legislated (Rosenman 1993).

The Australian population aged 60 and over is predominantly female. The percentage of women among the oldest cohorts continues to increase due to the higher death rates and lower life expectancies of men. Examination of the population projections into the future suggests that these trends are unlikely to change into the next century. Recent figures from the Australian Bureau of Statistics Social Indicators (1992) predict that the number of persons aged 65 years or more will increase as a proportion of the total population from 11 per cent in 1989, to between 20 and 22 percent in 2031. One implication of these demographic trends is that women are particularly likely to have an extended period over which they will have to manage their retirement incomes. This has implications for retirement income planning both from the individual and societal viewpoint (Rosenman & Winocur 1989, Rosenman 1991).

Qualitative research undertaken in the female superannuation market in Australia has highlighted the strength of the perception that women believe that financial independence is imperative. Other issues revealed include: security through financial independence is important; financial independence is extremely important to women from all spheres; women did not want to be financially reliant on anybody; women did not see marriage as being synonymous with wealth or security; and there is an undercurrent of fear of female poverty (Casey & Dwyer 1991).

Casey and Dwyer (1991) found that specific segments of the female superannuation market believing financial autonomy to be particularly important were: a) women over thirty who have come to the realisation that the number of earning years is reducing; and b) single women including those who have been divorced, separated, widowed or never married, with the emphasis on those that have children.

Melendi (1991) states that women are discovering the harsh realities of facing their retirement without a partner and without adequate retirement planning. One third of all marriages end in divorce, with women having limited access to their partner's superannuation. The majority of lone parents in Australia are women supporting one or two children. Women comprise the majority of the aged population, the majority living alone for the last years of their lives with no access to incomes other than social security. There is also an increasing number of women who will never marry and need to provide for their future retirement during their working life (Australian Bureau of Statistics Social Indicators 1992).

Despite these obvious demographic and social trends, financial service providers have long neglected to develop marketing strategies specifically for women and their retirement planning. Melendi (1991) suggests that women, whether they are single parents, career women, or part of a dual income family, are enthusiastic prospects for retirement planning strategies. Women are becoming more realistic with regard to their financial future and are yearning to protect themselves from the woes of an impoverished retirement.

Yorke and Hayes (1982, p. 84) state that the trend is *towards working women, as a marketing segment, who are more financially independent than before*. Financial marketers have realised that the female segment of the market represents a growing and "untapped" opportunity for product development, and that educated working women can no longer be stereotyped as *financial featherweights* (Conklin 1986, p. 26).

## Advertising to women

During the past decade, researchers have been suggesting that traditional stereotyped roles no longer reflect the roles of women in modern society and have become increasingly less effective as an advertising tool. Critics contend that women's roles are changing; however, advertisers are not keeping pace with these changes or portraying women realistically in advertisements (Courtney & Whipple 1984, Debevec & Iyer 1986).

Advertising and marketing are most effective when they are relevant to their target audience. Bartos (1989) states that women want to be treated with respect, they resent condescension, and do not necessarily want to be defined only in terms of their family roles. According to Adams (1991), women want advertising to reflect their aspirations, not where they are today. Women do not want to be depicted within narrow confines, but as individuals with particular needs. Recognising women as individuals is part of a trend towards niche marketing, where the market is segmented using attitudinal and lifestyle values rather than the traditional demographic variables such as socio-economic status, work status, or sex. In seeking to understand the female consumers, advertisers should concentrate on the woman's **attitude**, that is, how they think and feel as opposed to where they are and what they look like. It is through a woman's attitude that advertisers are able to distinguish between the contemporary and the traditional woman. Once that attitude is isolated, the advertisers will then be in a position to portray women in a manner that does not offend the female audience.

According to Bartos (1989), advertising practitioners have a knee-jerk reaction to criticisms regarding role portrayal of women, claiming that the critics are not representative of the "real consumer". In reality, the best educated and most sophisticated consumer is the career woman, who is sceptical about business in general and advertising in particular. Yet for many marketers, it is this segment of women that represent the most desirable prospects for many products and services.

Mattingly and Partners (1993) examined women's views towards financial services and advertising and found that women were generally critical and dismissive of advertising undertaken by financial institutions. In many cases they saw current advertising as a confirmation of the inherent bias of the institution against them, indicating how out of touch with their needs they were. Statements made by respondents during the qualitative research were indicative of this:

*"Don't give us those yuppy career minded women in ads. It's a con."*

*"It's not the 60s any more."*

*"They don't have to have business women in them. Have someone like me."*

According to Leigh, Rethans and Whitney (1987), advertisers must examine the relationship between role portrayal in the advertisement and the target audience's expectation. Advertisers need to understand their target audiences in terms of these expectations, and develop their advertising appeals accordingly. When targeting women, personal superannuation advertisers must avoid offending potential customers by identifying the most appropriate appeals for their financial products.

## Results of qualitative research

Qualitative research in the form of indepth interviews was undertaken to identify key consumer behaviour motivations for working women in the personal superannuation market.

A sample of thirty women currently in the paid workforce were interviewed. Prior to conducting the indepth interviews, the female market was segmented according to the woman's stage in the family life cycle. Bartos (1989) recommends marketers combine the two key demographic variables of marriage and parenthood, with the following life cycle groups being identified:

1. Unmarried working women with no children
2. Unmarried working women with at least one child
3. Married working women with no children
4. Married working women with at least one child.

These segments were cross-tabulated with the woman's occupational category according to the classification scheme used by Schaninger and Allen (1981). These categories included: non working wife (NWW), low-occupational-status working wife (LSW) and high-occupational-status working wife (HSW). The qualitative research focused on the latter two categories.

This classification scheme is based on the seven occupational categories of the Hollingshead Index of Social Position (Hollingshead & Redlich 1985, Reynold & Wells 1977 in Schaninger & Allen 1981). High-occupational-status women were employed in the top three white-collar categories, including those employed in managerial, professional, administrative and semi-professional occupations. Examples include doctors, accountants, engineers, teachers, nurses and professional sales people. Low-occupational-status women are those women employed in the lower four categories, for example, secretarial, clerical, technicians, retail sales, as well as blue collar and service workers.

The results of the qualitative research will be discussed according to the segments described by Bartos (1989), followed by an overall discussion of results from a low- and high-occupational-status perspective.

## Unmarried working women, no children

### *Low-Occupational-Status Women*

This group of women were aged from 19 to 23 and were employed in service occupations, including a receptionist, waitress, telemarketer and a shop assistant.

Overall, the low-occupational-status women in this segment had no financial goals and were living from day to day, or on a payday to payday basis. This group of women had not taken much interest in personal superannuation and felt that personal superannuation was not an issue for young people. None of the respondents had personal superannuation; however, two were contributing small amounts to their employer sponsored scheme.

### *High-Occupational-Status Women*

This group of women, ranging in age from 21 to 25, tended to have higher educational qualifications, and included two women who owned their own businesses. This group believed in financial independence for women and wanted to be financially secure in the future. They were aware that there may not always be a male to support them.

This group did not understand much about personal superannuation and were concerned about fees, flexibility and not being able to use the money until the age of 55.

### *Commonalities in Segment*

Both low- and high-occupational-status women in this group felt that sales representatives for personal superannuation were "pushy". They also believed that they would probably have to work in the formal labour force for most of their lives.

## **Unmarried working women, children**

### *Low-Occupational-Status Women*

Women in this segment were in their early 30s and were either divorced or separated, with teenage and pre-teenage dependants.

These women expressed concern about the ability to afford personal superannuation. Their main priority was to secure their future with the purchase of a home, using their money in the short-term for survival reasons. They felt putting money aside for personal superannuation at this stage was premature. However, it was expressed that personal superannuation would be ideal in the future when they wished to invest elsewhere.

### *High-Occupational-Status Women*

Most of the women in this group were divorced, with one woman who had never married. Ages ranged from 33 to 56 years, with each respondent having one dependent child. These women were employed in government positions and felt that their current government sponsored schemes were very good. It was felt that private personal superannuation schemes could not compete with their work superannuation. Two women were contributing to their schemes; however, they were not sure how much the scheme would be worth when they retire.

This segment of women were sceptical towards personal superannuation companies and stated that the sales representatives were “pushy”. The older women in this segment felt that advertisements that targeted women who were single (and down and out) were insulting to a woman’s intelligence.

### *Commonalities in Segment*

Women in this segment tended not to have personal superannuation. Overall the priority for these women was to own their own home.

## **Married working women, no children**

### *Low-Occupational-Status Women*

Women in this segment ranged in age from 19 to 42 years, employed in general office work including a book-keeper, secretary and administrative officer.

Overall this segment did not know much about personal superannuation. Their priority was to pay off their present home. They were not impressed by the selling methods employed by insurance companies, including pressure and scare tactics.

### *High-Occupational-Status Women*

Respondents in this segment ranged in age from 28 to 35 years. All women in this segment had personal superannuation; however, two of these were self-employed.

These women were focussed on real estate as an investment, stating that personal superannuation is only one part of retirement planning. Respondents believed that personal superannuation was not explained in terms that people can understand. Other issues include the need for a solid financial institution and the importance of a personal relationship with the sales representative. Women in this segment were married to men who either had employer-sponsored or personal superannuation.

### *Commonalities in Segment*

Both segments believed that there would not be a government pension when they retire. They expressed the need for one to have money for retirement over and above the pension.

## Married working women, children

### *Low-Occupational-Status Women*

Women in this segment were aged between 38 and 58 and employed in blue collar positions such as cleaners and domestics, as well as clerical workers, such as, a cashier, a loans assistant and clerk.

Most of these women stated they were relying on their husband's superannuation. Despite the older ages of some of the women in this segment, they had not thought much about retirement and had not planned for their future in a big way. Some women were not sure of what superannuation they had at work, with only one woman with a personal superannuation policy. This group also felt that the government will support people less and less in the future during their old age.

### *High-Occupational-Status Women*

This group of women ranged in age from 36 to 48 years, employed in a variety of occupations including bank manager, nurse educator, credit controller and small business owner.

These women were more likely to have specific financial plans, which included the acquisition of real estate. All women had employer sponsored superannuation and were either contributing to that plan, or had a personal superannuation policy. Their husbands also had personal or employer-sponsored superannuation.

There was variation in the amount of emphasis placed on superannuation and its role in their retirement plans. One woman wanted financial security independent of her husband and had two personal superannuation policies in place. Another woman had specific goals relating to the purchase of investment properties, believing that personal superannuation did not give her the control she wanted with her money. It was felt that personal superannuation was subject to considerable government intervention, through changes in tax structures and rulings, and was therefore not a good long-term investment.

### *Commonalities in Segment*

A comment made by both groups pertained to the fact that women do not know enough about personal superannuation.

## Self employed women

Of the 30 women interviewed during the qualitative research, six (6) were self-employed, in real estate, hairdressing and beauty therapy businesses, landscaping design and a small business.

Most of these women had personal superannuation policies in place. Motivations for purchasing these policies include:

*"tax advantage, plus a little bit for me later on"*

*"it's a safety net to know at 55 or 60 you have got x dollars"*

*"government started putting heavies on employers to pay employee contributions and there were tax benefits for self-employed people"*

*"once the flavour of the month ... at the time I was looking for a tax advantage"*

*"my own theory that superannuation is OK, it's fixed, but there are certainly other ways to make your money work for you"*

*"when you're self-employed you have to work until you're 60 ... noone is going to give you a redundancy cheque to finish at 50 or 60"*

*"I've got five staff, I'm putting money into their super each week and I just felt that by the time I'm 55 I should have some money coming in from there too"*

One of the key motivations for self-employed women to purchase personal superannuation was for the tax advantage. These women had purchased these policies as part of their overall investment plan, with their main priority being real estate. The income to be gained from their personal superannuation policy was considered primarily as a bonus, above their other investments. Some felt personal superannuation was over-rated as a investment option because of the lack of accessibility to the funds until they were 55 years, complicated by the fact that the government has been changing the regulations and tax structures regularly.

## Comparison of low- and high-occupational-status women

Appendix A outlines the results of the qualitative research for both low- and high-occupational-status women in each of the four life cycle segments.

One key finding from the qualitative research is the difference in perspective between women in low-occupational-status and women in high-occupational-status categories in terms of financial planning. It was found that women employed in high-occupational-status occupations tended to be more financially aware, having more specific financial plans for their retirement. They believed women should be financially independent, and wanted security independent of their husband.

Women in the low-occupational-status category tended to live for today and had not planned for their future retirement to any great extent. The younger women live from payday to payday, whereas the older women were relying on their husband's superannuation or the government pension for income in their retirement.

## General findings

Some general findings from the qualitative research include:

- personal superannuation was considered only one part of retirement planning
- government intervention and rule changing with personal superannuation has contributed to uncertainty in the market
- there was a need for women to know more about personal superannuation
- older women are sceptical about insurance companies in general
- personal superannuation needs to be explained in terms people can understand
- relationships in personal selling are considered important
- "pushy" salespeople are resented
- it was felt there was a strong possibility that there would not be a pension in the future.

## Conclusion

The aim of this research was to identify key consumer behaviour motivations for working women in the personal superannuation market. The results of this research will be used in the development of print advertisements targeted to working women for personal superannuation.

With increasing numbers of women the workforce, personal superannuation companies must recognise the inevitable expansion of this demographic segment and develop appropriate advertising appeals tailored to the different demographic segments of working women. Advertisers who recognise the importance of this segment will be in a better position to develop effective advertising campaigns using appropriate advertising appeals and presenters.

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# Appendix A

## Results of qualitative research

### *Unmarried working women, no children*

#### LSW

- no financial goals
- living for today
- never taken interest in personal superannuation
- scary to think of future
- does not think there will be a pension
- have not looked at where they want to be at 55

#### HSW

- believes in financial independence for women
- wants to be secure in the future
- believes there will not always be a man there
- concerns about fees and flexibility

### *Unmarried working women, children*

#### LSW

- focus on short-term survival
- wants to use their money to buy a house
- premature to put money aside for personal superannuation
- personal superannuation ideal later for diversification

#### HSW

- relying on government sponsored superannuation schemes
- sceptical towards personal superannuation companies
- ads targeting women as single (down and out) insulting a woman's intelligence

### *Married working women, no children*

#### LSW

- paying off home
- has not thought much about personal superannuation
- companies use pressure and scare tactics
- no government pension in future

## **HSW**

- husband has personal super or employee sponsored super
- personal superannuation only one part of retirement planning
- focus on real estate
- need for a solid institution and to be explained in terms people can understand

## ***Married working women, children***

## **LSW**

- sceptical towards personal superannuation
- relying on husband's super
- have not thought about retirement in a big way
- less and less government support in future

## **HSW**

- have specific financial plans
- real estate a priority
- wants financial security independent of husband
- government keeps changing rules for superannuation
- believe women don't know enough about personal superannuation

# The relationships between *Cycas ophialitica* K. Hill (Cycadaceae), the butterfly *Theclinessthes onycha* (Lycaenidae), the beetle *Lilioceris nigripes* (Coleoptera: Chrysomelidae) and the ant *Iridomyrmex purpureus*

Gary W. Wilson  
BAppSc(Biology)

## Abstract

This paper details the relationship between the Central Queensland cycad *Cycas ophialitica*, the “blue” butterfly *Theclinessthes onycha*, the chrysomelid beetle *Lilioceris nigripes* and the ant species *Iridomyrmex purpureus*. The butterfly *Theclinessthes onycha* was found to lay its eggs singularly on the emerging fronds and megasporophylls of *C. ophialitica*. Egg predation was >90% but the predator was not identified. The larvae that hatched from the eggs fed on the epidermal tissue of the frond rachis and pinnae. The most recently hatched larvae fed on the youngest and softest and least toxic foliage and the older larvae on both young and mature foliage. The larvae were able to metabolise the beta-bonded glycosides and were tolerant of cycasterone and the biflavonoids present in the foliage. The larvae exuded metabolic wastes consisting of simple sugars and amino acids from dorsal glands. *Iridomyrmex purpureus* ants attended the larvae and took the waste product as a food source. They defended the larvae and the plant from the attentions of potential predators and herbivores. The butterfly did not sequester the phytotoxins and is cryptically coloured. The fronds of *C. ophialitica* were also browsed by the larvae and adult forms of the chrysomelid beetle *Lilioceris nigripes*. They eat the epidermal tissue of the pinnae and do so by commencing at the tips and working towards the rachis of the frond. The larvae of the beetle are gross feeders and have a distended and unprotected abdomen. The metabolic wastes material is accumulated about the larvae as frass. The *I. purpureus* ants attend the beetle larvae and take the frass as a food source. Their presence lessens the likelihood of predation of the larvae. The ant has not been observed to take larvae or to attempt to prey upon the adult form.

This paper details the interaction of one plant and three insect species. The relationships require a high degree of specialization in the insect species and are indicative of a long association between them and the plant. The paper presents and discusses ideas for further research that will fully elucidate the associations and the life cycles of the species involved.

## Introduction

The associations between plants and insects have been of long standing interest to our species. The importance of those associations became the more apparent as our ancestors changed from a hunter/gatherer to an agrarian lifestyle and again with the advent of modern biocides and the subsequent resistance to those agents by a growing number of target species.

The effective management or conservation of a species relies on an understanding of the ecology of that species. Moves to use biological agents to control species have heightened the demand for such knowledge and led to systematic studies of many species and ecosystems.

This paper details the relationship between the Central Queensland cycad species *Cycas ophialitica*, the lycaenid butterfly species *Theclinessthes onycha*, the chrysomelid beetle *Lilioceris nigripes* and the ant *Iridomyrmex purpureus*. I discuss physiological aspects of the associations and present and discuss ideas for further research on the subject. The data presented in this paper results from observations made by me during studies for an MSc on the ecology and phylogenetics of the Cycadales with specific reference to *Bowenia serrulata* and I thank my supervisors Dr C.S. Low and Dr K. Walsh for making the study possible.

The cycads are an order of gymnosperms of Permian Paleozoic origin (Mamay 1976). They comprise 11 genera and some 200 species (Jones 1993) and are pan-tropical in distribution. They are characterised by the presence of methylazoxymethanol glycosides, particularly macrozamin and cycasin (Moeretti et al. 1983); phytoecdysones (Harborne 1988); biflavonoids (Dossaji et al. 1975) and mucilages in their foliage (DeLuca et al. 1982). These phytochemicals are deterrents to insect and animal herbivores and to bacterial and fungal pathogens. Those species of insects which feed on or breed in cycads tend to be host specific.

The members of the genus *Cycas*, the most widely distributed (Jones 1993) and oldest of the extant cycad genera (Stevenson 1990) have been found to contain the lowest levels of MAM glycosides of any of the cycads (Moretti et al. 1983). They found values of 0.06–0.72% cycasin and 0.20–0.45% macrozamin in samples of seven species of *Cycas* analysed by them. However *Cycas* species contain high levels of the potent phytoecdysone (insect moulting hormone) cycasterone (Harborne 1988).

The cycad *Cycas ophialitica* is found in the area between Mount Morgan and St Lawrence in Central Queensland. It was described in 1992 by K. Hill (1992) of the Royal Botanic Gardens of New South Wales after a revision of the genus in preparation for a forthcoming volume on cycads in the **Flora of Australia** series. The species previously formed part of the loose association known as *C. media*.

There are many records in the literature (see Mathews & Kitching 1984; Jordano et al. 1992; DeVries 1992; and records therein) of mutualistic association between lycaenid butterflies and ant species but few where the plant host species is a cycad (Rawson 1961; De Vries 1976). The only records of the beetle *Lilioceris nigripes* on members of the genus *Cycas* are Hawkeswood (1992) with a single record of the species feeding on the cycad *Bowenia spectabilis* at Mosman, and this author (unpubl data) on *B. serrulata* at Tinaroo, both in North Queensland. In New Guinea *L. clarki* has been observed feeding on *C. circinnalis* (Svent-Ivany et al. 1956). There are no previous records of interactions between ant and *Lilioceris* species.

## Materials and methods

I observed and recorded insect interactions on a population of *Cycas ophialitica* at Tungamull near Keppel Sands on the Capricorn Coast during the period November 1990 through August 1993. I photographed and collected samples of the insects observed. These insects were identified by staff of the CSIRO Division of Entomology.

## Results

I found that the lycaenid butterfly *Theclinessthes onycha* laid its eggs on the emerging fronds and megasporophylls of *Cycas ophialitica*. Unidentified predators took >90% of all eggs laid. The larvae that hatched from the eggs fed on the epidermal material of the frond rachis and pinnules.

The most recently hatched fed on the youngest and softest foliage and the older larvae on both young and mature foliage. The larvae exuded some metabolic wastes in the form of sugars and amino acids from dorsal glands. The ant *Iridomyrmex*

*purpureus* attended the larvae and fed on the waste product produced by it. The ants were observed to defend the food resource and thus the larvae from other ant species and parasitoids and the host plant from other herbivores.

I also observed that both young and mature fronds of *C. ophialitica* are browsed by the larvae and adult forms of the chrysomelid beetle *Lilioceris nigripes*. The beetles ate the epidermal tissue of the pinnae and did so by commencing at the tips and eating towards the rachis of the frond.

The larvae of the beetle are gross feeders and have a distended and unprotected abdomen. The metabolic wastes accumulated around the larvae as frass. I observed that *I. purpureus* ants attended the beetle larvae and fed on the frass. The presence of the ant reduced predation of the beetle larvae and the browsing of the plant by other insect species. The ant was not observed to take larvae or to attempt to prey upon the adult form of the beetle. The ant was also observed to feed directly upon the mucilage and vascular contents issuing from wounds in the epidermis of young fronds of *C. ophialitica*.

## Discussion

We have an association between a plant containing a cocktail of potent chemicals several of which are known to be deleterious to insect life, and three insects. Two of the insects are feeding on the plant tissue and the third on the waste products of the other two and the sap and mucilage of the plant. Such associations are indicative of a high degree of specialisation and possible co-evolution of the species involved. I now consider these matters in more detail.

The larvae of six lepidopteran families are known to feed on cycad tissue. The Arctiid Tiger Moth *Seirarctica echo* (Teas 1967; Teas et al. 1966) and the lycaenid Hairstreak Butterfly *Eumaeus atala florida* (Rothschild 1973) both feed on *Zamia floridana* and accumulate cycasin, the B-D-glucoside of methylazoxymethanol. Larvae of *E. a. florida* contain 0.02% and adults 1.0–1.8% dry weight of cycasin respectively (Rothschild et al. 1986). *Eumaeus atala* also feeds on the tissue of the meso-american cycad species *Dioon edule* (Vovides 1990). *Zamia* and *Dioon* contain 0.01–0.28 and 0.01–0.43% cycasin respectively and thus the butterfly can be demonstrated to concentrate cycasin within its body. At this concentration cycasin is a powerful deterrent to insect and avian predators. The adult forms of the moth and the butterfly are aposematically coloured to warn those potential predators of the unpalatability of the prey. The species avoid MAM intoxication by glycosylating or reglycosylating MAM released in the gut by B-glucosidase. The cycasin thus formed is stored in the haemolymph (Harborne 1988).

The New Guinea species *Luthrodes cleotas* (Lycaenidae) and some *Taenaris* species (Nymphalidae) also feed on members of the genus *Cycas*, sequester cycasin and are aposematically coloured (Parsons 1984). Those species of *Taenaris* which do not feed on cycads are cryptically coloured. The larvae of the moth *Cryptotilla immersana* (Tortricidae) feed on the foliage of the cycad *Bowenia serrulata* which contains 0.26% cycasin (Moretti et al. 1983). The moth is nocturnal and cryptically coloured.

The observations that the butterfly species in this study, *Theclinesstes onycha*, is cryptically coloured, despite feeding on a cycad of similar cycasin content to aposematically coloured moth and butterfly species, suggest that it does not sequester phytotoxins. This hypothesis is supported by Nash et al.'s (1992) finding that the adult of *T. onycha* did not contain cycasin. The reason for the differences between the various species is yet to be explained.

We know that the larvae of the species has to deal with the methylazoxymethanols in the plant and that the adults of some lepidopteran species have the ability to sequester and to accumulate the aglycone of them. Is all the material degraded in the gut and exuded through the dorsal glands and/or sequestered and left in the pupa case, or is some other process operational?

The observation that young *Theclinesstes onycha* larvae eat young foliage with low toxin levels and then move to mature foliage with high toxin levels suggests that they learn to accommodate increasing toxin levels with continued exposure to them.

The *Lilioceris nigripes* beetle larvae and adults also have to manage the MAM glycosides in *Cycas ophialitica*. The ability of chrysomelids to sequester or modify phytotoxins is well recorded (see DeRoe & Pasteels 1982) and the by-products are sometimes used as a defensive secretion (Pasteels et al. 1982, 1984 and 1986; Harborne 1988). There is no data available on the chemical contents of *L. nigripes* frass but denaturation of cycasin by the beetle would result in the production of sugars and amino acids attractive to ant species. The single record by Parsons (1984) of the New Guinean lycaenid *Taenaris catops* containing low levels of cycasin after probing the fresh frass of *L. clarki* which had been feeding on a *Cycas* plant suggests that some cycasin may occur in the frass of *L. nigripes*.

Neither *Lilioceris nigripes* or *Theclinesstes onycha* is found feeding on the foliage of the cycad *Macrozamia miquelii* which grows in company with *Cycas ophialitica*. The cycasin levels of *M. miquelii* have an average value of 0.09% (Moretti et al.

1983), lower than that of *C. ophialitica*, *Z. floridana*, *D. edule* and *Bowenia serrulata*. This leads to the hypothesis that another feeding deterrent is present. There is no data available on phytoecdysones in *Macrozamia* but should this be the reason then we might assume that it is more potent than cycasterone.

The fact that the ant *Iridomyrmex purpureus* attends both the larvae of *Theclinessthes* and the larvae and adult of *Lilioceris nigripes* suggests a commonality of by-product that is attractive to the ant. The attention to both of the species results in a mutualism known as myrmecophilly. If the ant is feeding on a sugar and amino acid product the association is of some interest but if it is feeding on, inadvertently or otherwise, a cycasin-containing product then we have an association of very considerable interest and evolutionary significance.

The observations presented in this paper suggest several lines of future possible inquiry:

1. the analysis of the frass of *Lilioceris nigripes* to determine if cycasin is present and thus if *I. purpureus* is tolerant of it
2. the analysis of the phytoecdysones of *Macrozamia miquelii* and *Bowenia spectabilis* and *B. serrulata* to ascertain the contents and concentrations of them
3. an analysis of cycasin levels in the *Bowenia serrulata*-feeding moth *Cryptotilla immersana* to see how that cryptically-coloured nocturnal species manages the compound.

The data also suggests the need for further research into the life cycle of *Theclinessthes onycha* to see if the association between it and *Iridomyrmex purpureus* is more complex than thus far detailed.

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# Fire and ice or water on stone?: Japan's influence in Australia's history and development

Oliver Simmonson  
MA(Hons)UQ

## Contemporary concern and superficial perceptions

Nearly three years ago a book entitled *The MFP debate* suggested that concern about the Multifunction Polis (MFP) proposal, and also about Japanese investment in Australia, had revealed the extent to which Japanese individuals and firms are able to affect the lives of ordinary Australians.<sup>1</sup> This late and limited revelation highlights the problem of how little Australians know about the influence Japan historically has had on the evolution of Australia towards nationhood. This paper will address that deficiency directly by arguing that contact with Japan has been crucial in changing Australia from a set of complacently British colonies, thoroughly dependent and largely inward-looking, into a more self-assured, more independent and more multicultural nation.<sup>2</sup> The nature and extent of Japan's hand in these changes have been masked by a reluctance to look beyond what appear to be strangely satisfying icons, attitudes and assumptions about the "Japs" and Australia. Fears about immigration and economic competition from Japan, and later on fear of invasion and anger over cruel treatment of prisoners of war by the Japanese, are important markers that hide other important aspects of the history of Australia/Japan relations.

There is a long history of contact between Japan and Australia.<sup>3</sup> Many brief accounts and some monographs give what has now become a fairly standard but superficial outline of the history of relations between the two countries.<sup>4</sup> There are numerous works that focus on particular features of the relationship.<sup>5</sup> My own research deals with Australia's role in the Occupation of Japan from 1945–1952, or what I have called a "slice of Australian history that was generated in Japan".<sup>6</sup> This paper will not offer the "standard" history outline of Australian-Japanese relations nor examine a single aspect of the relationship. The focus of this paper will fall on how Japan has changed, and in some cases determined, the course of Australian history and Australia's policy on trade, defence, foreign affairs, immigration and economic development. It suggests that historical attention has not probed deeply enough into Japan's outward-looking dynamism since the 1860s or how its searing encounters with Australia during the last century have helped to melt away what were once held to be essential elements and icons of what it meant to be Australian.

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1. R.E. Mouer and Yoshio Sugimoto, *The MFP debate*, La Trobe University Press, Melbourne, 1990, p. 1.
  2. This paper reflects and extends work for my published teaching material in Japanese history, Australia and Japan, Chapter 14 of the subject, History of Modern Japan, *Study Guide*, UCCQ, Rockhampton, 1991, and my research on the history of Australia's role in the occupation of Japan.
  3. Henry Frei's book *Japan's Southward Advance and Australia*, traced these links back to at least the 16th century, while J. Armstrong's article "Aspects of Japanese Immigration to Queensland before 1900" *Queensland Heritage*, Volume 2 Number 9, p. 3, claimed that Japanese legend suggests that contact dates from the 15th century.
  4. *Ibid.*, Frei; See also Roslyn Hayman, *Episodes: A glimpse of Australia-Japan relations 1859–1979*, Eric White Associates, Canberra, undated; Gavan Mc Cormack's chapter entitled "The Australia-Japan Relationship—The First Hundred Years", in McCormack (ed) *Bonzai Australia Banzai*, Pluto Press, Leichardt, 1991, pp. 13–34, is typical and one of the most recent of these outlines.
  5. Two examples: D.C.S., Sissons, is an excellent authority on early contacts between Australia and Japan. "The Japanese in the Australian Pearl Industry", *Queensland Heritage*, Volume 3, Number 10, May 1979., p. 11, is typical of his work; Alan Rix has written on the re-establishment of Australian-Japanese trade since the Second World War in his book *Coming to Terms*, Allen & Unwin, Sydney, 1986.
  6. Oliver Simmonson, Commonwealth Fraternisation Policy in Occupied Japan, MA Thesis, University of Queensland, 1992, unpublished; Exotic Equal or Problem Child? Allied forces and Japanese people during the Occupation, *Proceedings of the Seventh Biennial Conference*, JSAA, Volume 2, ANU, Canberra 1991, pp. 121–129; Frank Loyal Weaver, a masterless Australian in Japan ASAA Conference, Armidale, July 1992, unpublished.

## ERRATA

Passages on the following pages should read as set out below;

p. 59 "had revealed the extent to which Japanese individuals and firms are able to affect the lives of ordinary Australians".

p. 60 "the White Australia idea was a major force, perhaps the major force which nurtured, sustained, and ultimately ensured the triumph of the federation movement itself".

"should be one people without the admixture of other races".

p. 61 "led Australians to increase the rate of European immigration so as to populate Australia's empty spaces".

p. 62 "the birth of Australian diplomacy".

"thus spelling out Australia's autonomy in a way which previous governments had not chosen to stress".

p. 63 "five years of occupation is too short a time to humanise or democratise these barbarians".

"that Australia would be overrun unless it built its population to 20 million within 25 years".

## Early indifference

Early colonial knowledge of Japan came in 1863 through news of clashes and rumours of possible war between Britain and Japan.<sup>7</sup> Real war was avoided, however, by the relative military weakness of Japan and wise handling of its relations with western powers during this period. From 1863 onwards growing friendliness between Britain and Japan meant that the first three decades of interchange between Australia and Japan were largely positive and relaxed. In 1876, for instance, a missionary named Wilton Hack, with the authority of the South Australian Government, tried to interest the Japanese Government in setting up an emigrant settlement in the Northern Territory.<sup>8</sup> In the event the Japanese Government declined the offer. That the offer was made at all is indicative of quite relaxed colonial attitudes towards Japan in the 1870s.

In 1878 a Japanese delegation came to Australia to examine the potential for trade and by 1888 Victoria had a useful wool trade with Japan. In the 1880s most of the exposure Australians had to the Japanese came through cultural exchange, trade, and labour contracts.<sup>9</sup> Until the early 1890s there had been no notable Japanese impact on everyday life or national development in the Australian colonies. Within a decade, however, this situation had changed completely as Japanese actions on the broader international stage, more than within Australia, caused a rise in the level of Australian awareness of and concern about Japan. From this point, exactly a century ago, responses to Japan began profoundly to affect Australia's national life and development.

## Growing awareness and rising concern

Two virtually concurrent events in 1894–95 shook Australia out of its casual indifference towards Japan. The signing of a Japanese-British Commercial Treaty in 1894 raised the spectre of increased Japanese immigration to Australia, and the Japanese victory in the Sino-Japanese War by 1895 was a first sign that Japan was becoming a powerful nation.<sup>10</sup> Reactions to the war, but more especially to the changed British/Japanese relations that accompanied it, took place in Australia. Australian historian B.K. de Garis summed up colonial response to these events in this way:

During the 1890s the established practice of excluding the Chinese broadened into a fully-fledged “White Australia Policy”. The attention of colonial leaders was forcibly drawn to Japan by her victory over China in 1895 and the Anglo-Japanese Commercial Treaty of 1894 to which the colonies were invited to adhere. At an intercolonial conference held in Sydney in 1896 they decided not merely to spurn the treaty but to take precautions against Japanese migration. Reid [George Reid, a Free-Trade Party leader and important figure in moves to federation] and others voiced fears that if a Japanese minority were allowed to build up in Australia there would be a risk of subsequent intervention by Japan.<sup>11</sup>

Reid's concern was the first colonial expression of fear of “intervention”, or the idea of Japan forming a potential diplomatic or military threat to Australia. More importantly, the effects inside Australia of Japan's actions prompted widespread acceptance of the White Australia concept in the colonies as a cornerstone of a future Australian national identity and policy.

According to early White Australia Policy analyst, Myra Willard, the White Australia idea was a major force, perhaps the major force, which nurtured, sustained, and ultimately ensured the triumph of the federation movement itself.<sup>12</sup> Alfred Deakin's famous statement about the desire that we should be one people without the admixture of other races breaking down the barriers to federal union tends to support Willard's argument.<sup>13</sup> There are other views about what prompted federation including defence, trading practices, nationalism and anti-Britishness, all of which are less convincing than colonial urgency to reinforce colonial immigration laws with the weight and prestige of Australian nationhood.<sup>14</sup> Colonial responses to Japan suggest that worry about Japanese power, and the implications of Japan's warming relationship with Britain, were crucial imperatives in Australia's first steps on the road to fledgling nationhood through federation. But that was only the beginning of the story.

7. See, for example, a report on the likelihood of war between Britain and Japan in the *Rockhampton Morning Bulletin*, 25 July 1863, p. 4. (This report was based on a treatment of the topic in the *Adelaide Observer* a month earlier.)

8. Hayman, *op. cit.*, p. 5.

9. *Ibid.*, pp. 4–7.

10. Neville Meaney, *Australia and the World: a documentary history from the 1870s to the 1970s*, Longman Cheshire, Melbourne, 1985, pp. 109–111, contains a copy of the 1894 Anglo-British Treaty.

11. Frank Crowley, (ed) *A New History of Australia*, William Heinemann, Melbourne, 1984, pp. 242–243. See also Frei, *op. cit.*, pp. 75–81.

12. Myra Willard, *History of the White Australia Policy to 1920*, Melbourne University Press, Melbourne, 1923, p. 43.

13. *Ibid.*, Deakin quoted on p. 44.

14. See, for example, R. Norris, *The Emergent Commonwealth*, Melbourne University Press, Melbourne, 1975, pp. 43–80, for an energetic yet ultimately unconvincing attempt to argue against Willard's conclusion.

## Immigration, external affairs, and defence

Japanese sensitivity about Australia's immigration laws pre-dated federation and was a major issue for the new Commonwealth government from the start.<sup>15</sup> The whole matter was complicated by the fact that at the time Australia's relations with other countries were normally carried out through Britain. Thus some of the Japanese complaints about Australia's immigration laws were directed to Britain and caused tensions between Britain and Australia.<sup>16</sup> These difficulties, and the signing of a full-scale military alliance between Britain and Japan in 1902, led to a certain amount of direct exchange (mostly on the issue of restrictions on Japanese immigration to Australia) between Japan and the new federal government of Australia.<sup>17</sup> One outcome of these contacts was that late in 1905 Australia's Prime Minister, Alfred Deakin, altered the *Immigration Restriction Act* of 1901 in an attempt to placate the Japanese.<sup>18</sup> By 1905 Japan had achieved a convincing land and naval victory over Imperial Russia that sharply heightened Australian concerns with its defence. This gave impetus to the formation of an Australian Navy, prompted the imposition of a system of compulsory military training, and, according to Yarwood, led Australians to increase the rate of European immigration so as to populate Australia's empty spaces.<sup>19</sup>

Five main effects within Australia flowed from these Japanese complaints and actions. Firstly, Japanese opposition to Australia's immigration laws caused tensions and some alienation from Britain's imperial imperatives at a time when Australia was very actively seeking to influence them in the Pacific. Secondly, the government-to-government exchanges between Japan and Australia between 1898 and 1905 over immigration gave federated Australia its earliest experiences in dealing directly with foreign powers.<sup>20</sup> Thirdly, Japan's influence on the nature of the original *Immigration Restriction Act*, and the changes made by Deakin later, show that, from the outset of Australia's fledgling nationhood, Japan was able to influence Australia's national lawmaking. Fourthly, the beginnings of clearly Australian defence systems were being put in place within five years of Japan's triumph over Russia. And fifthly, the earliest Japan-related expressions of the "populate or perish" idea affected Australian views about the need to increase European immigration.

## Intensifying the slaughter of an Australian generation

When the First World War started Australia and Japan were technically allies through the Anglo-Japanese Alliance of 1902. Under this alliance, which had been renewed in 1911, Japanese naval ships escorted Australian troop carriers taking diggers to fight in the Middle East and Europe.<sup>21</sup> Japanese warships also patrolled Australia's coastline to protect Australia against attacks by German vessels. Australia's underlying agenda in the war from 1915 onwards (before the great conscription campaigns), however, was heavily influenced by fear of Japan's wartime and postwar aims.<sup>22</sup> When Australia's Prime Minister during much of the First World War, William Morris Hughes, reported to Parliament on the Paris peace negotiations in 1919 he claimed that Australia's greatest gain from the war, and its best outcome from the Paris negotiations, was the preservation of the White Australia Policy against what he saw as Japanese attempts to undermine it.<sup>23</sup> Speaking about what Australia had gained from the war and the Paris negotiations, he told Australia's Parliament and people that "I venture to say, therefore, that perhaps the greatest thing we have achieved, under such circumstances and in such an assemblage, is the policy of a White Australia". Hughes' own analysis of the war, and the peace negotiations that followed it, suggest that retaining British protection of Australia in the Pacific, preventing Japan from acquiring territory south of the equator, and frustrating Japanese attempts to insert a racial equality clause into the Covenant of the League of Nations, had been major gains from the sacrifice of a generation of Australians. The effects on Australia's development of the loss of 60 000 dead, and its debt burden of £350 000 000 from the First World War, were profound and lasting and were, in important ways, linked to

15. See Frei, *op. cit.*, p. 83, for an account of how Japan (mostly through London) influenced Australia to adopt the Natal formula as the basic instrument of the Immigration Restriction Act of 1901.

16. A.T. Yarwood, *Asian Migration to Australia*, Melbourne University Press, Melbourne, 1964, pp. 84–92.

17. A series of relevant original documents are reproduced in G. Greenwood and C. Grimshaw, (eds.) *Documents on Australian International Affairs, 1901–1918*, Thomas Nelson, Melbourne, 1977, pp. 390–397; See also Frei, *op. cit.*, p. 83 where he observes that The immigration dispute with Australia from 1897 to 1921 fills nine thick volumes of documents in Japan's Diplomatic Records Office; See also Crowley, *op. cit.*, p. 243.

18. *Ibid.*, Greenwood & Grimshaw, p. lxxxv.

19. Yarwood, *op. cit.*, pp. 84–92.

20. *Ibid.*, Yarwood, suggested that Deakin's action foreshadowed the eventual evolution of an independent Australian approach to foreign affairs.

21. Frank Crowley, *op. cit.*, p. 317 and McCormack, *op. cit.*, pp. 16–17.

22. W.J. Hudson, *Billy Hughes in Paris: the birth of Australian diplomacy*, Thomas Nelson, Melbourne, 1978, p. 55.

23. The Japanese delegation to the Peace negotiations attempted to have a racial equality clause inserted into the Covenant of the League of Nations. Hughes felt this would undermine the White Australia Policy and doggedly (and successfully) resisted the Japanese move.

Australia's (and Hughes') contemporary fear of Japan. There was, however, a somewhat more positive outcome from Australia's diplomatic clashes with Japan in 1919.

Well known Australian historian W.J. Hudson has claimed that Hughes' activities at the Peace Conference in Paris constituted the birth of Australian diplomacy.<sup>24</sup> The obvious implication of Hudson's argument is that fear of Japan, and Hughes' vitriolic opposition to Japanese aims after the First World War, prompted the birth of Australian diplomacy and foreign affairs.<sup>25</sup> Whether one fully accepts Hudson's view, or Yarwood's suggestion that earlier exchanges between Australia and Japan constitute the beginnings of a distinctive approach to foreign relations, the conclusion that Japan was the main motivating force in these key developments towards Australian nationhood is soundly supported by the evidence.

## War, Westminster and Washington

Japan's powerful military attack into the Pacific, that threatened Australia directly early in 1942, profoundly affected the history and development of Australia. Most military events of the war against Japan are sufficiently familiar not to warrant rehearsal here. Longer-term implications of Australia's responses to the Japanese threat, however, are perhaps less known. These included increasing Australia's will and capacity to act independently as a nation, and re-orienting Australia's defence, diplomatic and economic relations with Britain and the United States.

Australia's wartime Prime Minister, John Curtin, began these processes by declaring, somewhat precipitously even given the perilous situation in early 1942, that henceforth Australia would look to America rather than Britain for its security.<sup>26</sup> Given that during much of the previous decade Australia had been engaged in a virtual trade war against the United States, Curtin's bonding of Australia and the United States was clearly a marriage of emergency between the two Anglo-Saxon nations in the face of an Asian threat. The bond has, however, proved durable indeed and still remains the cornerstone of Australia's postwar security arrangements. It was a marriage made by Japan and formally solemnised by the largely Japan-prompted ANZUS Alliance as the occupation of Japan came to a close early in 1952. Britain never regained its military power and prestige in Australia's environs in the Pacific or the full substance of its prewar relationships with Australia and Japan.

The threat from Japan also prompted increased Australian control over its own military, diplomatic and national destiny. Less than a year after bitter wrangles between John Curtin and Winston Churchill over whether Australian troops should be deployed according to the strategic imperatives of the British Empire in Burma, or in the direct defence of Australia at home and in New Guinea, the Australian Parliament ratified the Statute of Westminster.<sup>27</sup> This law, which enhanced the diplomatic and national independence of British dominions, had been enacted in London in 1931 and virtually ignored by Australia before the war. Faced with peril from Japan, and what Australian leaders saw as unconcern with its dangers by its erstwhile security guarantor, the Australian Parliament ratified the Statute of Westminster, thus spelling out Australia's autonomy in a way which previous governments had not chosen to stress.<sup>28</sup> Ratifying the Statute enhanced Australia's ability to define, develop and pursue its own foreign policy and conduct an autonomous national diplomacy, thus strongly advancing Australia towards the status and condition of a fully independent nation.

In several ways, then, Japan's aggressive thrust into the Pacific played an unwitting role in propelling Australia out of its comfortable relationship with Britain into a long-term security and economic arrangements with the United States, and several key steps closer to the attainment of *bona-fide* nationhood. Japan's attempt to grab an Empire in Asia was a powerful agent and instrument of Australian national growth and maturity. Yet the most profound and important change in Australian national life and identity caused by fear of Japan was yet to come.

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24. W.J. Hudson, *op. cit.*, (title and central argument of his book)

25. A.G.L. Shaw, *The Story of Australia*, Faber & Faber, London, 1955, pp. 229–232, also offers a brief outline of Hughes' diplomatic victory at Versailles.

26. *Ibid*, Curtin quoted pp. 258, and in Crowley, *op. cit.*, p. 466. (This is one of the most famous and overused quotes in Australian history.)

27. E.M. Andrews, *A History of Australian Foreign Policy*, Longman Cheshire, Melbourne, 1979, pp. 109–110, contains reproductions of telegrams exchanged between Churchill and Curtin on the issue; See also Geoffrey Bolton, *The Oxford History of Australia*, Volume 5, The Middle Way, Oxford University Press, Melbourne, 1990, p. 9, for a succinct statement about the Curtin/Churchill clash.

28. Crowley, *op. cit.*, pp. 467.

## Victory and occupation

The earliest postwar “relationship” between Australia and Japan was that of victor and vanquished. Australia’s Minister for External Affairs, Dr H.V. Evatt, was successful in his efforts to have Australian Field Marshall Sir Thomas Blamey sign the instrument of surrender and this ensured that Japan formally surrendered to Australia as a separate enemy power. Australia led a combined British Commonwealth Occupation Force (BCOF) of 37 194 troops into southern Japan from February 1946 and Australian elements of BCOF were still there when the occupation ended in 1952.<sup>29</sup> Australia’s enthusiasm for this commitment signifies that Japan’s total defeat and the end of the war did not end Australian fears of Japan.<sup>30</sup> Indeed Australia’s fear of a possible resurgence of Japanese power was only mollified by the ANZUS Alliance of 1951 and by Japan’s refusal to rearm during the Cold War. The greatest and most profound effects of Australia’s continued wariness of Japan, however, took place within Australia itself.

## Immigration and the White Australia Policy

It was noted earlier that Japan’s victory in the Russo-Japanese War prompted a renewed emphasis on attracting European immigration to fill the so-called empty spaces of Australia. The spectre of Japan’s more direct threat to Australia in 1942 provoked what became a virtual national obsession with immigration after the Second World War. Australian leaders were unambivalent about the reasons for greatly increasing Australia’s population as rapidly as possible. As early as 1947, Australian Minister for Immigration, Arthur Calwell, claimed that Australia needed to triple its population to defend itself against a future attack from Japan because, he said, five years of occupation is too short a time to humanise or democratise these barbarians.<sup>31</sup> In a similar vein two years later he claimed that Australia would be overrun unless it built its population to 20 million within 25 years.<sup>32</sup> Calwell’s apocalyptic pronouncement that without an immigration plan the future of Australia would be extremely dark clearly identified Japan as the source of the future threat and as his justification for rapidly increasing Australia’s European-derived population through immigration.<sup>33</sup>

It is fair to conclude that reaction to Japan’s fiery foray into the Pacific was the principal causal factor in Australia’s postwar enthusiasm for an enormously increased population. That Australian goal has led directly to the great inflow of people—first from Europe and later from all over the world—that has helped to melt away earlier icons of Australianness like the White Australia Policy, and made Australia the richly diverse, culturally vigorous and multi-ethnic nation it now is. There has been speculation recently that the admission of about 600 Japanese war brides of Australian occupation servicemen after March 1952 began the process of breaking down the White Australia Policy.<sup>34</sup> In some minor measure this may be so. It is more to the point, however, to suggest that the most crucial factor involved in dissolving the White Australia Policy was the great postwar inflow of millions of migrants from non Anglo-Celtic backgrounds who could not and did not readily relate to this earlier and essentially artificial symbol of national identity.<sup>35</sup> From the outset the White Australia Policy had been aimed at Japan and had drawn the most active and fervent opposition from that quarter. It is an irony of Australia’s history that, through the hand and actions of Arthur Calwell, the Policy’s strongest postwar advocate and Japan’s bitterest critic, anxiety over Japan prompted the process of changing the fundamentals of Australia’s population and diluting whiteness as a central criterion of national identity.

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29. Simmonson, MA thesis, *op. cit.*, p. 18.

30. See Office of Strategic Services Report No. 3256., sent to the Australian Legation in Washington 25 September, 1945, Australian Archives file AA: A3300/2/ 290, for clear expression by Evatt of Australia’s overarching fears of Japan even in total defeat.

31. *Nippon Times*, Tokyo, 18 August 1947, p. 1.

32. *The Argus*, 22 April 1949, Copy in the Australian Archives file AA: A5954/1 Box 2122.

33. *Ibid.* The obsessive nature of Australian fears of Japan are shown in that in 1949 Evatt saw the spectre of threat from Japan arising even from the ashes of a third world war between Communism and Capitalism.

34. Takeshi Chida, *The Occupation of Japan by the BCOF*, unpublished conference paper, Kure, 1992. (Mr Chida is head of the History Compiling Section of Kure City, where the headquarters of BCOF was located.)

35. It is hard indeed to see how a sustainable and naturally arising national identity based on White Europeaness could be reconciled with the total exclusion of 50 000 years of occupation and the intricate culture of those most original Australians—the Aborigines. The Chips Rafferty image of quintessential Australianness was a carefully constructed and fundamentally artificial icon of Australian national identity.

## Breaking the “Bonds of Empire”

Postwar trade with Japan had resumed from tentative beginnings in 1947.<sup>36</sup> By mid-1957 Australia and Japan had signed a Trade Agreement. That Agreement is seen as a turning-point in Australia's postwar relationship with Japan.<sup>37</sup> More significantly for this paper, it also constituted an important shift in Australian-British relations. Professor Alan Rix, who specialises in Australia-Japan relations, has argued convincingly that the Trade Agreement was important for Australia because it marked, “...a breakaway from the bonds of Empire”.<sup>38</sup> The clear implication of such a breakaway is that Australia's trade with Japan has brought further important change in its long-cherished relationship with Britain. Equally importantly, the Trade Agreement of 1957 laid the formal foundations for a more balanced and long-term trading partnership between Japan and Australia. That partnership has become a keystone of Australia's postwar economic prosperity and yet is a source of renewed anxiety.

## Fear of economic dependence

The expansion of trade with Japan was greatly assisted by a fundamental compatibility between Japan's need for resources for its industrial growth and Australia's ability to supply a substantial proportion of them. The rhetoric of this economic compatibility has included terms like “interdependence”, “complementarity”, and the “resources boom”. By the early 1970s some official discomfort was being expressed about the consequences of Australia's increasing dependence on its trading partnership with Japan, as well as the narrow base of the Australia-Japan relationship. One response was Australia's somewhat wistful quest to develop a real “special relationship” with Japan in order to broaden and deepen its trading one.<sup>39</sup> The term “special relationship” has been applied to Australia's dealings with Japan for about a decade. It indicates that debate about the relationship has centred on whether any form of real friendship between the two nations has emerged since the war.

In *The MFP Debate* Mouer and Sugimoto have pointed out that many ordinary Australians are increasingly concerned about the influence of Japanese economic power on their lives and on the future of their country. Australians need to be aware of these matters and are right to be concerned about them. They might be re-assured to know that, despite some pain and loss, for at least a century Australian responses to Japan have led to some of the best and most constructive decisions Australia has taken on its road to independence and maturity as a nation. In contemporary terminology the Australia/Japan relationship is described as the “constructive partnership”.<sup>40</sup>

The extent to which Japan has driven and determined the construction and change of Australia's national life and identity during the first century of its existence makes this term seem a rather appropriate one to describe the history and longer-term effects of the relationship.

Heat from Japan's earlier entry, and its contemporary attempts at re-entry, into the world community of nations has propelled Australia's national development and will continue profoundly to influence its future. In some important ways Japan has made Australia into the country that it is today. Going beyond the apparently satisfying yet essentially dismissive “Burma railway” and “buying up Australia” perceptions about the Japanese has the potential to highlight a range of positive outcomes from Japan's earlier clashes with Australia. New generations from both countries may need to focus on these and work together, more like water on stone than fire and ice, in order naturally to craft a fresh century of mutual growth and change into real understanding and friendship.

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36. See Alan Rix, *Coming to Terms*, *op. cit.*, for the best available treatment of the resumption of postwar trade between Australia and Japan.

37. Alan Watt, *The Evolution of Australian Foreign Policy*, Cambridge University Press, Cambridge, 1967, p. 215.

38. Alan Rix, “Australia and Japan: The Reality of the ‘Special Relationship’”, in F.A. Mediansky and A.C. Palfreeman, *In Pursuit of National Interest: Australian Foreign Policy in the 1990s*, Pergamon Press, Sydney, 1988., p. 160.

39. For an overview of developments in this period see Simmonson, *Australia and Japan* (published teaching material) *op. cit.*, pp. 13–17.

40. Alan Rix, *Australia and Japan: A Regional Alliance Relationship*, conference paper, Eighth Biennial Conference of the Japanese Studies Association of Australia, Newcastle, 7 July 1993.

# Improved approximation and control using Recursive least Squares based on Kohonen Network

**Paul Hannah**

BAppSc(Hons)(Mathematics)

**Russel Stonier**

BSc(Hons), PhD(Qld)

**Stephen Smith**

BSc(Hons), MSc(Manc)



## Abstract

In this paper we consider an extension to the basic Kohonen Self Organising Map for which the output of each node is a continuous function generated by a basis structure. Insertion and removal of nodes to and from the network are described. We apply this network to function approximation and in control to the classical pole balancing problem.

## Introduction

The basic Self Organising Feature Map (SOFM) of Kohonen [2] takes a number of forms depending upon the learning paradigm that is used to update the nodes to optimize the spatial distribution of the node responses within the layer. There are a number of methods for updating the nodes that are in widespread use. The algorithm used in this paper is Conscience Learning [1], whereby each input only affects one node but that node is chosen using a biased distance function that penalises nodes that have won more than their fair share of the competitions.

The Self Organising Motor Map (SOMM) [3] is a minor extension of the SOFM where each node has both input and output vectors. The input weight vector is updated towards the input vector and the output weight vector towards the output vector.

SOFM attempts to approximate the multidimensional discrete function  $f : \mathbb{R}^n \rightarrow \{A B C \dots Z\}$ , by dividing the input space into regions and allocating one of  $\{A B C \dots Z\}$  to it. SOMM attempts to approximate the multidimensional continuous function  $f_c : \mathbb{R}^n \rightarrow \mathbb{R}^m$  with the discrete function  $f_d : \mathbb{R}^n \rightarrow \{a_1 a_2 a_3 \dots a_n\}$ , with  $a_i$  the output of the  $i$ th node. The output from a number of nodes may be used to attempt to smooth this function.

We extend the definition of the SOMM network to approximate the continuous function  $f_c$  with another continuous function. As with the previous two networks, every piece of the new network need only be defined by its functionality, that is, any structure that is functionally equivalent is acceptable.

## Abstract Kohonen framework

**Definition 1 (Node)** A node  $\eta$  is represented by a position in the input space  $\mathcal{A}$  and an input/output relationship  $\mathcal{A} \rightarrow \mathcal{B}$ . The node must be able to perform both of the following tasks:

- When presented with an input  $x \in \mathcal{A}$  it will return an output  $y \in \mathcal{B}$ .  
For the SOFM above,  $\mathcal{B} = \{A B C \dots Z\}$ . For all other networks described here,  $\mathcal{B} = \mathbb{R}^n$ .
- When presented with an input/output pair, it will somehow modify itself with the aim of better describing the input/output relations being presented it.

**Definition 2 (Network)** A network  $N(\eta)$  is a collection of  $\eta_i$  which it utilises to represent an input/output relationship  $\mathcal{A} \rightarrow \mathcal{B}$ . The network must be able to perform both of the following tasks:

- When presented with a input  $x \in \mathcal{A}$  it will return an output  $y \in \mathcal{B}$ .  
This is usually accomplished by performing some competition over the nodes and choosing one or more winning nodes. The input  $x$  is then presented to each of these nodes and an output  $y_i \in \mathcal{B}$  is received. A weighted combination of these outputs  $y_i$  is then returned by the network as the output  $y$ .
- When presented with an input/output pair, it will somehow modify itself with the aim of better describing the input/output relations being presented it.  
To accomplish this, it will usually perform the competition as the SOFM above and present the winning nodes with the input/output pair.

We note first that both the SOFM and SOMM fit this structure. Second, it is possible to define a network recursively, that is, the definition of a node and network are functionally the same. The only restriction on the definition of a network or a node is the requirement that the node converges very quickly to a “good” approximation of the input region and the custom of defining the network to perform the competition over the nodes. It is in fact possible to define the nodes to be small feedforward networks.

## The Self Organising Continuous Map (SOCM)

The SOCM network, instead of returning a discrete value or a single continuous value over the entire range of the winning node, returns a value that is a continuous function of the input vector. That is, when using SOFM and SOMM, the winning node  $\eta_w$  returns the output  $y = \eta_w$  and when using SOCM, the node returns the output  $y = \eta_w(x)$ , a continuous function.

Two algorithms are used to generate the network output: one which results in a piecewise continuous hypersurface and another which returns a hypersurface whose derivatives are piecewise continuous. The first algorithm merely returns the node output  $y = \eta_w(x)$ , and the second algorithm is generated by retrieving an output from every node  $y_i = \eta_i(x)$  in the network and returning a scaled weighted sum of these as the final output  $y$ . One weighting function found to be effective was  $1/(1 + d)$  with  $d$  the distance between the node and the input value. An adaption of the least squares algorithm described below was used to generate this continuous function.

## Recursive Least Squares (RLS) algorithm

This algorithm approximates an arbitrary function  $g(x)$  by a function  $f(x)$  in the function space spanned by the finite set of orthogonal functions  $\{f_1(x), f_2(x), f_3(x), \dots, f_n(x)\}$ . It is required that the algorithm continually improve and update its approximation as it is passed input/output pairs  $x_i, y_i = g(x_i)$ . With this aim in mind, we set up the linear system,

$$\begin{bmatrix} 1 & x_1^1 & x_2^1 & \dots & x_n^1 \\ 1 & x_1^2 & x_2^2 & \dots & x_n^2 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & x_1^m & x_2^m & \dots & x_n^m \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ \vdots \\ a_n \end{bmatrix} = \begin{bmatrix} y^1 \\ y^2 \\ \vdots \\ y^m \end{bmatrix}$$

and solve for  $x_k$  where  $x_n^m$  represents the  $n$ th element of the  $m$ th input and  $y^m$  is the  $m$ th output. This linear system grows without bound vertically as input/output pairs are continually presented it. To be useful, an algorithm had to be found that could solve this system while keeping memory requirements small. This algorithm is generated as follows:

$$\begin{aligned}
A_k x_k &= b_k \\
A_k^T A_k x_k &= A_k^T b_k \\
(A_k^T A_k)^{-1} (A_k^T A_k) x_k &= (A_k^T A_k)^{-1} A_k^T b_k \\
x_k &= (A_k^T A_k)^{-1} A_k^T b_k \\
x_{k+1} &= (A_{k+1}^T A_{k+1})^{-1} A_{k+1}^T b_{k+1} \\
A_{k+1} &= \begin{bmatrix} A_k \\ \alpha_{k+1} \end{bmatrix} \\
(A_{k+1}^T A_{k+1}) &= \begin{bmatrix} A_k^T \alpha_{k+1}^T \\ \alpha_{k+1} \end{bmatrix} \begin{bmatrix} A_k \\ \alpha_{k+1} \end{bmatrix} \\
&= A_k^T A_k + \alpha_{k+1}^T \alpha_{k+1} \\
x_{k+1} &= (A_k^T A_k + \alpha_{k+1}^T \alpha_{k+1})^{-1} [A_k^T \alpha_{k+1}^T] \begin{bmatrix} b_k \\ \beta_{k+1} \end{bmatrix} \\
x_{k+1} &= (A_k^T A_k + \alpha_{k+1}^T \alpha_{k+1})^{-1} (A_k^T b_k + \alpha_{k+1}^T \beta_{k+1})
\end{aligned}$$

This system will work as stands, but as the diagonal of the matrix becomes steadily larger, the new inputs have less and less effect on it. One way to avoid this problem is to scale  $A$  and  $b$  by a scaling factor  $0 < \eta < 1$  and scale the latest additions  $\alpha$  and  $\beta$  by  $1 - \eta$ . This has the effect of stabilising the magnitude of the system. The value  $\eta$  can be thought of as the learning rate, when  $\eta$  is small the network converges slowly and when  $\eta$  is large the network converges rapidly.

Because of the nature of the method, the system tends to be diagonally dominant and the matrix inverse operation can be done using an approximation technique. One that is quite effective is an iterative scheme that can be run a set number of times rather than till convergence and thus will trail the ideal system but continue to track it. This would also be extremely useful on a parallel system where this approximation technique might be continually running with the output returned using the latest result available so that a maximum response time can be guaranteed. Also, using the iterative inverse on a parallel machine, only one vector by matrix multiplication must be performed to get the output back to the network. Once the output has been returned, the node can proceed to update itself.

## Node insertion and removal

Since the network is a distributed system of independent pieces, nodes can be inserted and removed on line without disrupting the performance of the network. To insert a node, we merely clone a node in the region where the node is to be inserted. To delete a node we remove it from competition. Once removed, it is then possible to adapt the surrounding nodes with the information of this node.

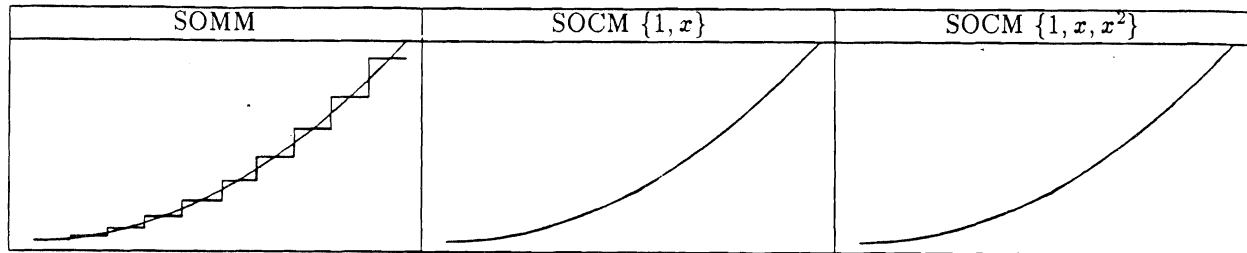
An effective method is to decide on the number of nodes required, usually chosen equal to the number of processors free. Each node has a queue in which it holds input/output pairs until it has time to process them through the RLS algorithm. If that queue fills up, a node is transferred from elsewhere and clones the node whose queue has filled up. The queued input/output pairs are split between them. The required node is usually transferred from an area that has been unused for some time or is cluttered with redundant nodes. This means that the update can be performed while the next input/output pair to the network is being used in a new competition phase.

The ability to increase and decrease the size of the network to balance accuracy against response time and the ability to converge onto a solution very quickly make this network ideal for time critical systems like control and optimal control where you have a set period of time before the next control signal is required. Also, when a recursive inverse algorithm is being used in the RLS algorithm, the nodes can be improving their inverse approximation while they are dormant. This shift in computation time from the central competition process, which is inherently non-parallel to the local node update which is distributed, means that the SOCM can be more effectively implemented on powerful parallel desktop supercomputers.

## Motor map vs continuous map

Below is a table showing the difference between the SOMM and SOCM when being used for function approximation. The function being approximated is a segment of the curve  $y = \sin(x)$  and input vectors  $x$  are drawn equiprobably over the input space.

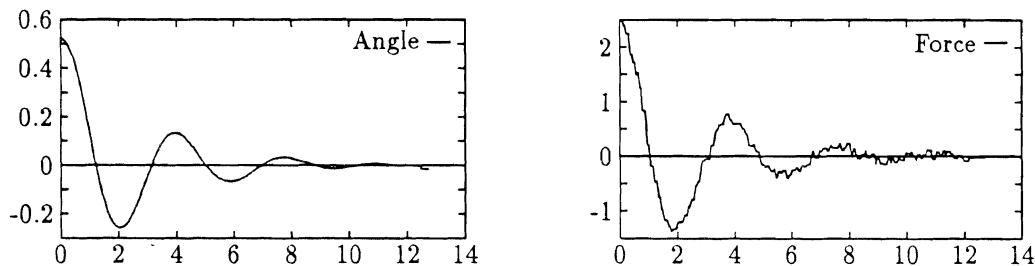
The diagrams below show the improved function approximation ability of the linear and quadratic SOCM networks over the SOFM network.



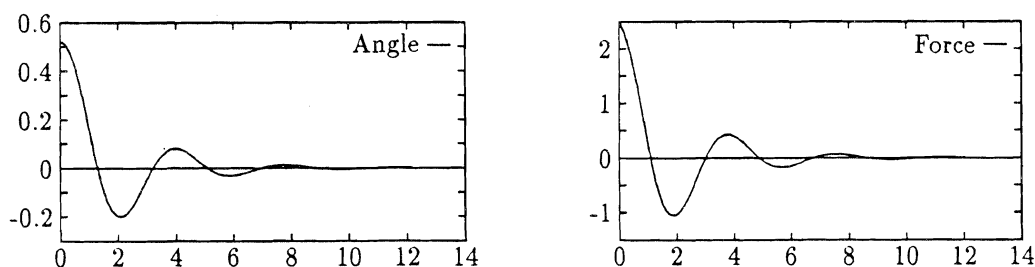
We now demonstrate the relative performance of the SOMM and SOCM when being used with supervised learning on the “Pole Balancing Problem” [3]. Consider the problem of balancing a pole of unit length in the vertical plane by appropriate movements of the base of the pole. The equation of motion of the pole is

$$(m + \sin^2 \theta) \ddot{\theta} + \frac{11}{2} \dot{\theta}^2 \sin(2\theta) - (m + 1) \sin \theta = -f \cos \theta$$

where  $\theta$  is the pole angle measured clockwise against the vertical and  $f$  is the horizontal force acting at the base. The motion of the pole is simulated using the fourth order Runge–Kutta method with a step size of 0.01.



The SOMM network that was used to perform the control above had 200 nodes. The jittering is due to the fact that the output force “jumps” as the winning node changes, resulting in sudden changes in the force output.



In contrast to the previous control simulation, the SOCM network has been able to accurately describe the exact surface such that the largest error over the simulation surface is less than  $10^{-4}$  (50 nodes). Also, the number of nodes used to solve this

problem can actually be reduced to one and the performance of the network is still visually indiscernible from the exact result.

The advantage of the SOCM over the SOMM shown is a direct result of its ability to describe a continuous hypersurface by a continuous curve rather than a set of discrete responses. This increase in accuracy also means an associated reduction in the size of the network, resulting in increased convergence speed and decreased memory requirements. The increased convergence speed is due to reduced network response time.

## Conclusion

In this paper we have presented a further extension to the Kohonen problem that achieves better function approximation by realising a continuous function output at the node. This is illustrated further to the application of pole balancing.

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# Conceptualising itinerancy: Lessons from an educational program designed for the children of the Showmen's Guild of Australasia

**P. A. Danaher**

BEd(James Cook), BA(Qld) (Hons) (Deakin),  
MLitt(NE), GradDipTertiaryEd(NE)

This paper deals with a specific aspect of continuing research by a group of staff members in the Faculty of Education at the University of Central Queensland into the educational experiences of children of the Showmen's Guild of Australasia. This aspect is concerned with issues in conceptualising the lives of the Showmen's Guild families. In particular, the paper considers whether terms such as "itinerant", "mobile", "transient", and "nomadic" can appropriately be applied to these families, or whether some alternative descriptor is needed to encapsulate their distinctive lifestyles.

In 1992 and 1993 a number of semi-structured interviews have been conducted with children, parents, home tutors, and teachers involved in a program established by the Queensland School of Distance Education. The researchers have used techniques of grounded theory within an interpretive theoretical paradigm, in order to record the participants' perceptions of the educational needs and opportunities of the Showmen's Guild children.

The paper presents the main findings of the study to date, then recasts them in terms of conceptualising itinerancy. The strengths and limitations of the itinerant stereotype in aiding understanding of the Showmen's Guild are addressed. Finally, a tentative statement is developed about the lifestyles of Guild members. In the process, a corollary statement about the relationship between schooling and other elements of those lifestyles is put forward.

## Introduction<sup>1</sup>

When strangers meet, one question that they ask each other is likely to be "Where do you live?"—or possibly its variant, "Where do you come from?" (Winning 1990, p. 246).

Ascertaining the location of the new acquaintance, with its presumption of a fixed residence by which she or he can be classified and fitted into some pre-existing community framework, is a pervasive and effective mechanism for regulating social relations. Permanent residence is also a means for constructing one incarnation of "the other"—the shiftless wanderer whose address at "no fixed abode" renders her or him at best unreliable and improvident, and at worst likely to be found in a court of law on some kind of property charge.<sup>2</sup>

1. This is a slightly revised version of a paper presented at the 2nd annual postgraduate symposium of the University of Central Queensland Postgraduate Student Association, held in Rockhampton on 21 August 1993. I acknowledge the helpful comments about the paper by participants in that session. I am thankful to my colleagues and mentors in the Faculty of Education at the University of Central Queensland for their diverse contributions to and interests in the project on which this paper reports. Their companionship has shown me that this kind of collaborative research is a boon rather than a bane. My supervisor, Professor Leo Bartlett, has provided sound advice on incorporating into my doctoral research what was initially an unrelated study. The willing co-operation of members of the Showmen's Guild of Australasia and staff members from the Queensland School of Distance Education is also gratefully acknowledged. Interviews were transcribed by Mr Geoffrey Danaher, Ms Bonita Frank, and Ms Pam Gale. The project was funded by a University of Central Queensland Research Grant (ER/U/399). I accept responsibility for the views expressed in the paper.
2. The stereotype of the gipsy encapsulates much of the ambivalence of this attitude. An extreme version of this stereotype is the myth of Ahasverus, the Wandering Jew, whereby the charge of lacking a fixed home is a key ingredient of particular forms of antisemitism. See Rose (1990, chap. 2) and Rose (1992, 37–39).

Yet the “reliable resident/feckless itinerant” dichotomy on which this manifestation of “the other” is based is highly problematic. In particular, the equation between spending a large part of each year travelling from one place to another and limited educational opportunities is not sustainable, at least in reference to the Showmen’s Guild of Australasia. A small group of Guild members have emerged as a well organised and articulate lobby group, whose concerted actions led to the establishment of an educational program designed specifically to address the perceived needs of their children.

This paper seeks to problematise the notion of itinerancy, especially educational itinerancy, by detailed reference to an on-going research project into the educational program created for the Showmen’s Guild children by the Queensland School of Distance Education in Brisbane. The paper refers in turn to relevant background information about the program and the research project investigating it; selected findings from the 1992 and 1993 stages of the project; the adequacies of the itinerant stereotype for interpreting these findings; and implications for the lifestyles, including the contribution of schooling, of Guild members.

## Background information

There are a number of “runs” or circuits throughout Australia connected by the annual agricultural shows. In addition to the local committees, there are various groups involved in organising these shows. These groups include members of the Showmen’s Guild (“the showies”), “the itinerants”, “the horsy people”, and “the workers”. Although distinctions among groups are clear to show people, interaction is strong and membership sometimes overlaps. Previously members had to be born into the Guild; now people can apply for election if they have completed at least three years working on local shows. The extent to which this has resulted in the introduction of large amounts of “new blood” remains to be established.<sup>3</sup>

In 1989, largely in response to active lobbying by members of the Guild, the Queensland Department of Education established a program for children connected with the show circuit. Teachers from the Brisbane campus of the Queensland School of Distance Education oversee the children’s completion of correspondence lessons, which are supplemented by various technological aids. The teachers travel to several shows in Queensland, and work directly with the children in local schools. Some parents employ home tutors to work with their children when the teachers return to Brisbane.

The research project examining aspects of this unique learning situation is being conducted by staff members from the Faculty of Education at the University of Central Queensland.

Working largely within an interpretive paradigm and using a qualitative orientation, the researchers are following the grounded theory methodology propounded by Glaser and Strauss (1967). The pilot study, carried out in July 1992 at the Mackay show, involved five researchers conducting general, semi-structured interviews with sixteen children, seven parents, and three home tutors. In June 1993, seven researchers attended the Bundaberg show and completed semi-structured interviews, focussing on curriculum, participant roles, social networks, and work and play, with twenty-eight children, sixteen parents, five home tutors, and eight teachers.

The presentations reporting this research have concentrated on several specific elements of the lives of participants in the Queensland show circuit. These elements include the background to the program (Wyer, Danaher, Woodrow, Kindt, Hallinan, Moran, Rose, Purnell, Duncum & Thompson 1992); links among social networks, itinerant education, and program evaluation (Danaher, Rose & Hallinan 1993); relationships between parents and teachers, children and teachers, and parents and children (Thompson, Wyer, Kindt & Danaher 1993; Wyer, Thompson, Kindt & Danaher 1993); work and play (Rose 1993); recreation and the construction of meaning (Rose, Wyer & Danaher 1993); connections between language and power (Danaher 1993); and the constitution of a disadvantaged group (Rose, Moriarty & Danaher 1993).

## Selected findings

This section of the paper presents the results of an examination of the interview transcripts resulting from the 1992 and 1993 stages of the research. The various ways in which respondents referred to “home” were interrogated, with a view to elaborating a diversity of opinions held about residence and itinerancy by people connected in different ways with the show circuit.

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3. This paper, like the research project to date, is concerned with members of the Showmen’s Guild. It is accepted that different conceptions of itinerancy might apply to other groups connected with the show circuit. However, the researchers have yet to resolve the methodological difficulties of establishing contact and rapport with members of these groups.

Many children, parents, home tutors, and teachers referred easily to the Guild members' caravans as their "homes". A twelve year old girl explained how she helped her parents to sell food bags from a canteen at the show: "I do about an hour a day when I come home from school, working in there". A seven year old boy commented, "I've got a big stack of books that I like at home". A preschooler said, "What I do is things at home—school work". A mother stated, "My children come home from school, they're allowed to go and play", and she was pleased that "the kids come home bouncing and happy...". She added:

For me, what I do, I take works with the children at home, when we get to Victoria, and that works for me again...I work in the home doing book work or whatever I have to do...

Another mother explained how she taught her daughter to read:

I tried as hard as I could to make everything familiar for her. So we did a lot of work at home. And she actually learnt to read and write travelling from school to school.

Another parent said explicitly, "Because your caravan is home...". One mother referred to the close contact between at least one School of Distance Education teacher and show children and their families: "And she's been in our homes, like years ago they never did".

A home tutor, describing her work with the child of her employer, referred to "[t]he things I can't provide for him at home". One of the School of Distance Education teachers said that, when his colleagues and he worked with the show children at local schools, "We often look at a project for the week...so we can finish the documents at the end of the week that they take home...".

Show children made varying responses to the question "Where is home?". An eleven year old boy answered, "Probably where I'm like living now. Dayborough". A ten year old girl, after identifying "home" as Bangholme in suburban Melbourne, added, "Every time we come home..., we go there for about four weeks after every set of runs we do". Many of the nuances in discussions of "home" were encapsulated in the following exchange with a ten year old boy:

- I. But if I said to you, "Where is home to you?", what would you say?
- J. Brisbane.
- I. Brisbane. You've got a house in Brisbane?
- J. Oh, it's not really mine, it's my aunty's, but we usually live there.

A similarly aged girl reported a variation on this residential situation:

...we have a house in Brisbane, and my nanna, sometimes, because she's getting too old now, so she just stays at home, and she tries to help me in school work, so I stay home with her most of the times.

A ten year old girl identified home as being "in Queensland". One boy provided a novel response when asked what he said if someone questioned him about where he lived:

We just say we're new in the town if we go shopping somewhere, because people sort of nag us saying, "Will you give us a free ticket?" and all.

Adults connected with the show circuit also responded to the question "Where is home?".

One parent replied, "Here. Here this week. We just travel all year round". Another parent said, "Yes. Sort of. Off and on" in answer to the question, "So is Melbourne home to you?". A home tutor stated, "Most of the time we are on the road...[A home town is] Only at the Gold Coast".

Several comments illustrated an overlapping of where and what "home" was for show people. A father indicated about his youngest daughter: "...we left her at home, we were lucky enough to stay at home with my mother-in-law and father-in-law, but she went to school locally up until Easter". A thirteen year old boy said, "After this run we just go home for a while". A mother, who wanted her son, once he was of high school age, to attend an independent school close to where her sister and brother-in-law lived, explained, "I think it's more family, because they're there and if he's boarding he can go home for the weekends".

Some respondents commented on the relative benefits of completing school work "at home" and in the local schools. One boy explained:

It's better at home for one reason, because there's not as many people so it doesn't take as long. So you start about 9.30 and finish at about one o'clock. But at school you meet different people and make friends. So I like them about the same really.

A seven year old boy commented, "...when you're doing it at home you can hardly get anything done...there's a lot of noise and all that. But at school there's not". A ten year old girl demurred: "Sometimes it's better to go home because you can get more done sometimes than at school". A mother said that, although "...we've got a very mobile home which is quite lovely, with everything that opens and shuts, and that's not a problem", difficulties arose when she tried to supervise her daughter's correspondence lessons while her husband and his friends wanted to use the same space for socialising.

She said, "It all goes together" in response to the interviewer's suggestion, "So it's home being school room as well". Another mother referred to her son "working in a sort of classroom atmosphere at home". Another parent believed that a separate caravan, as a dedicated space for show children to complete their lessons when not attending local schools, would serve a purpose: "Not like the home van that you're in there and your husband's coming and getting spare parts out of..."

Certain other references to "home" by participants in the show circuit were revealing.

When asked where he did most of his school work, a seven year old boy responded, "Sometimes we do it at home, but we really do it at proper school". One parent expressed a sense of the caravan being a temporary home, albeit for a number of years, before a "proper" home could be established. When questioned how she answered people who ask her "Where's home?", she replied:

I say that we spend a lot of time at the Gold Coast and that we travel twelve months of the year, and one day we'll have our own home base. But at this stage we are still putting our business together and once we're established there, the next step is a home.

She acknowledged that this goal could take several years to attain: "That's why we make our homes here as elaborate and with whatever you can think of that spins and turns or whatever". Yet in the same interview she explained that she had previously opposed sending her son away to boarding school, "as in leave our business and our home and his father".

## The itinerant stereotype and the interpretation of findings

At this point, it is helpful to consider a recent description of the essential characteristics of the nomad:

Nomads belong to different cultures. They come from different periods of history. From different time periods, they constantly incorporate and evolve a unique variation of spiritual, artistic, and cultural expression. There are as many different lifestyles and aesthetic norms in the nomadic form of social organisation as there are cultures and peoples in the world. Nomads are known to be rooted in myth, legend, and folklore...

The impact of their art and their way of life has two important aspects:

1. The fundamental idea that all life, experience, and existence is without frontiers or boundaries.
2. The foundational idea of not glorifying fulfilment in terms of territory or resources.

(Gabriel 1990, p. 396)

The question here relates less to the appropriateness of this conceptualisation than to its utility in interpreting the findings presented in the previous section. The two "fundamental" and "foundational" ideas can be shown to be inapplicable. Show people's lives have definite frontiers and boundaries. The circuits are highly organised events, with the equivalent of a small town moving itself from one place to another every week that the shows are operating. Some show people are also very successful in material terms, owning properties in desirable residential areas in addition to well appointed mobile homes, and having the resources to send their children to exclusive independent schools.

In other respects, Gabriel's conceptualisation is helpful in interpreting the references to "home" reported in this paper. Rather than confirming that "all life, experience, and existence is without frontiers or boundaries", some show people's comments suggest that demarcations between "home" and "school", and between "mobile home" and "residential home", shift in response to the contexts in which they are discussed, and the participants in and the audiences of those discussions. This claim is re-inforced by some of the contradictions, even tensions, evident in some respondents' descriptions of their homes.

Similarly, underlying several references to "home" is a largely—but not entirely—unconscious agreement with the cliché "Home is where the heart is". Many respondents indicated the importance of the strong social networks unifying different families and groups involved in the circuit. These networks were constituted both "on the run" and in the permanent residences inhabited by many show people when the shows were not in progress. This belies any simplified depiction of these people as heartless capitalists obsessed with the acquisition of material wealth.

These two assertions find support in the diverse understandings of “home” delineated in this paper. Many show people talked readily about coming “home” from school to their caravans. On the other hand, most responses to the question, “Where is home for you?” referred to a particular town, rather than to “my caravan”. Some blurring of the “home/school” distinction was also revealed, in that school work (rather than homework) was described as being completed both at the local schools and in the caravans. Rather than suggesting inherent contradictions that require resolution, these varying responses indicate the range of experiences and understandings that make up the particular form of itinerancy in which the show people engage.

## Implications for understanding guild members’ lifestyles

Elsewhere some of the researchers involved in the project reported here commented thus:

Members of the Guild are not nomadic, at least in Gabriel’s terms, but neither do they conform to the settled residence patterns characteristic of most Australians. The question to be explored in future studies is whether itinerancy may be conceptualised in terms of the degree of structure, with groups such as gipsies and reindeer herders living a relatively loosely transient lifestyle, and other groups such as barge children or Showmen’s Guild children living a fairly tightly structured transient lifestyle. Alternatively, issues of itinerant identity might emerge as far more fluid and idiosyncratic than a dichotomy (or even a continuum) suggests.

(Danaher, Rose & Hallinan 1993, p. 6)

While this is not the place to answer this question definitively, it is appropriate to remark that the evidence presented here inclines the writer to the second of the two alternatives.

For one thing, a rigid dichotomy or continuum would not readily accommodate the range of experiences of many of the participants in the study. It would have difficulty in dealing with people’s widely varying patterns of involvement in the show circuit. It would be almost impossible for it to reflect the diversity of sometimes apparently contradictory understandings of “home” revealed in interviewees’ transcripts.

Finally, the place of schooling (both literally and metaphorically) in the lives and lifestyles of these show people is similarly difficult to delineate definitively. The schooling of children connected with the show takes place in local schools, in caravans, and in boarding schools. Schooling is regarded instrumentally, as a pathway to a career with the Showmen’s Guild or in other arenas. At the same time, schooling is prized as an intrinsically worthwhile set of experiences for show children.

## Conclusion

Just as the “reliable resident/feckless itinerant” dichotomy alluded to at the beginning of this paper has been shown not to refer to people connected with the Showmen’s Guild, so an attempt to characterise educational itinerancy as conforming rigidly to a single and simplistic conceptualisation fails to gain credence. Instead, itinerancy—including educational itinerancy—emerges from this discussion as a multi-layered, contextualised, negotiated phenomenon. This might create difficulties for others—such as educational policy makers and the researchers involved in this study—but it does considerably less violence than a more homogeneous depiction to the complexity, diversity, and variety of the lives of the Showmen’s Guild of Australasia.

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# Plant pollinator relationships in the papaw: Ecological insights

Anne Garrett  
DiplAgrIng

## Abstract

As an introduced fruit bearing plant species to Australia, the papaw *Carica papaya* has been believed to be wind pollinated on this continent, a view unchanged in Australian literature since the 1950s and until today widespread amongst the farming community. Here I document that hawk moths (Lepidoptera: Sphingidae) are the sole pollinators of papaw in Australia. Species involved in the transfer of pollen exclusively belong to the subfamily of *Macroglossinae*, which take in the bulk of the Australian sphingid fauna. The individual species are *Theretra oldenlandiae firmata* (Walk.), *Macroglossum hirundo errans* (Walk.), *Macroglossum micaceum* (Walk.), *Nephele subvaria* (Walk.) and *Hippotion velox*. The possibility of further species involved in the pollen transfer is indicated from observational studies.

## Introduction

*Carica papaya* (*C. papaya*) was introduced to Australia from the South American continent more than a century ago and virtually all its cultivation spreads along the eastern seaboard of Queensland. Centres of papaw production in Queensland are areas around Innisfail in North Queensland, around Yarwun and Yeppoon in Central Queensland and around Gympie and the Sunshine Coast in South Queensland. The success of the industry relies not only on cultivation management but also on how well as an introduced species it “fits” into the Australian environment with its unique fauna and flora. At present the papaw industry contributes an annual value of \$A 13 mill (1992) (Macleod, pers. comm.) which places it amongst the major tropical fruit income earners in Queensland.

Pollination is only one of a number of aspects of the ecology of tropical crops that has been inadequately studied (Mc Gregor 1976). Exotic plants such as the papaw are of special interest particularly if they are dependent on insect pollination. Studies on the pollination mechanism of *C. papaya* have been based predominantly on assumptions that it is wind (anemophilic) and/or insect (entomophilic) mediated (Storey 1969; Free 1970). According to Baker (1976) the pollination agents of *C. papaya* in its indigenous surrounds in Costa Rica are sphingid moths. The pollination vector in Australia is unclear and suggestions ranging from wind (Agnew 1968; Prest 1955) to bee involvement (based on observations by the papaw farming community) have been made. Identification of pollination vectors and their mode of activity is of high priority in the papaw industry, if the crop is to be managed optimally and returns are to be promised.

Hawk moths are of worldwide distribution and 850 species of 190 genera have been recognized. The Australian fauna consists of 59 species of 25 genera of which the *Macroglossinae* incorporate 50 species in 15 genera. Of these almost all are of Oriental and Australasian distribution; a minority extends to the Old and New World (Common 1990). Adult moths rely exclusively on nectar as a food source, for which foraging takes place during virtually all the dusk period, as only a minority of hawk moths are diurnal (Common 1990). Papaw cultivars are almost all dioecious, that is, sexes are separated on individual trees. The plant species itself has been readily accepted as a nectar food source of Australian adult sphingids, which these insects obtain from staminate flowers only, as pistillate flowers are nectarless. Flower anthesis, nectar onset and floral scent release coincide with the dusk foraging time of sphingids. Hawk moths imbibe nectar while hovering in front of the open flower; hence only the proboscis comes into immediate contact with the pollen releasing anthers which are inserted on the apex of the funnel shaped corolla tube. Baker (1976) described the pollen transfer to the stigma of the pistillate flower as “mistake” pollination, as the only attractant noticed by observers is the similarity in scent of both sexes of flowers. Bawa (1980) suggested a different view in explaining a similar pollination system for the related genus of *Jacaratia dolichaula*

(Caricaceae). Apparently hawk moths are visually misled by the shape and size of the stigma of the pistillate flower, which resembles the size and shape of the petal outline of the staminate flower.

Reproduction of sphingids is linked to the native dry and wet rainforest, as their larval development relies on plant species indigenous to this environment. Some hawk moth species are more host plant specific than others, as is for instance *Nephele subvaria* (Walk.) which, so far as is known, depends exclusively on *Carissa ovata* (Apocynaceae) for its larval development. The majority of papaw pollinating hawk moth species have got a broader host plant choice, which ranges from a number of plant species specific to one family, as for instance the family of Rubiaceae for *Macroglossum hirundo errans* (Walk.), to selecting host plants of various plant families including species in the Rubiaceae, Vitaceae, Onagraceae, Dilleniaceae, Balsaminaceae and others in the instance of *Theretra oldenlandiae firmata*. (Walk.). Introduced ornamental and agricultural plant species have also been recorded as larval host species, especially of sphingids of wider geographical distribution, see for details Moulds (1981; 1984). The larval host plant records are far from complete, for example the host is entirely unknown for *Marcoglossum micaceum* (Walk). On the whole, of all sphingids listed, the majority of larval food plants are within the families of Rubiaceae, Vitaceae and Apocynaceae, except for larval food plants of *Hippotion velox* which belong to the Convolvulaceae, Nyctaginaceae and Araceae; see for details Common (1990).

## Materials and methods

A standard windspore trap (Burkhard, Herefordshire) was used to sample for the presence of pollen grains near male trees. These traps consist of a clockwork driven mechanism which moves the sampling slide past an orifice at fixed speed. Windborne particles are drawn past the slide by a vacuum pump granting a constant pressure difference of 1 bar. The spore trap was positioned at a height of 0.6 m and was in 1 m range to the nearest male tree. The trap was run for 24 hr periods over 30 days during summer in 1992.

Agamospermy (asexual seed set) was tested by bagging pistillate flowers with paper bags a few days prior to anthesis. Twenty (20) flowers bagged after hand pollination served as controls. The experiments were carried out during the main growing season, the summer of 1992. The sample size consisted of 50 flowers of randomly chosen fruit bearing trees.

A camera (Model: Pentax, 35 mm) containing 100 ASO negative film, fitted with a 100 mm macro lense and mounted on a tripod 1.2m from the flower, was used to photograph insect activity on flowers of both sexes. Insect activity on female flowers was difficult to observe, because of low attractiveness to insects. Pistillate flowers of various stages of opening, from petals just beginning to deflex until the late receptive phase were observed and the insect activity photographed. Lesser distances between photographic equipment and the flower appeared to disturb the insect forage pattern.

Sphingid larval stages were observed, collected and reared on their original food plant in gauzed plastic containers until the adult stage was reached. Adults were preserved as part of a reference insect collection. Larval food plants were recorded.

## Results

Sporetrap results indicate that papaw pollen was virtually absent from the air. The highest pollen number recorded was 26 grains/24 hr period while on 21 out of 30 days pollen numbers did not exceed 5 grains/24 hr period respectively. Grains were mainly of single distribution, although occasionally smaller clumps of two and four attached grains were present.

Tests conducted on asexually induced seed set indicate that of the 50 flowers tested the majority failed to set fruit. Developing fruitlets were regularly aborted and did not indicate signs of seed set. In ten cases seed formation was observed, which in those instances led to fruit development. Five fruits contained fewer than forty seeds while in one instance the number of ovules exceeded 700 per fruit cavity. All of the fully hand pollinated flowers successfully set fruit. Ovule numbers averaged 835 seeds per fruit, reaching numbers as high as 970 per ovary.

Observational studies on insect involvement in the pollination event in papaw indicated that on the whole most insects are rarely seen to come into contact with the female flower. Until midmorning in particular, honey bees (Hymenoptera: *Apis mellifera*) and native bees (Hymenoptera: *Trigona* spp.) could be observed collecting nectar from staminate flowers only. The nectarless pistillate flowers were generally avoided. Insect activity declined between midmorning until dusk when hawk moths were observed foraging on the nectar of staminate flowers and paying the occasional visit to pistillate flowers. These moths were mainly seen foraging between half an hour to one hour at dusk, coinciding with the time of flower opening and scent release in both sexes of flowers and the nectar onset in staminate flowers. Sphingids hovered while inserting the proboscis into the corolla tube to forage on the nectar. In the event pollen adhered to the proboscis and was transferred to the receptive stigma of the pistillate flower, to which moths are attracted by scent. Pollen was located predominantly on the

proboscis. This was confirmed with microscopic examination of the moths. As many as five sphingid visits to one individual pistillate flower over a ten minute interval were observed during February (summer) 1992. Moths spent approximately three seconds per flower visit; the proboscis was enrolled while flying in between flowers. *Theretra oldenlandiae firmata* (Walk.), *Nephele subvaria* (Walk.), *Hippotion velox*, *Macroglossum hirundo errans* (Walk.) and *Macroglossum micaceum* (Walk.) were observed and photographed coming into contact with both sexes of papaw flowers. All netted individuals were carrying pollen on the proboscis. Pistillate flowers visited, showed various stages of anthesis, from petals just starting to untwist until the later stages with fully deflexed petals.

The sphingid species which have been observed so far on staminate flowers only (which potentially are involved in the pollination process of *C. papaya*) are *Hippotion celerio*, *Hippotion scrofa*, *Hyles lineata livornicoides* (Luc.), *Cephanodes kingii* (Macl.) and *Cephanodes hylas cunninghami* (Boisd.). All species again belong to the subfamily of *Macroglossinae*. Except for both *Cephanodes* species and *Macroglossum micaceum* (Walk), which were observed foraging diurnally, all other hawk moth species were foraging nocturnally only. The daytime active species were observed foraging on *Murraya exotica* while *Cephanodes* species also were collecting nectar from flowers of *Aidia racemosa*; both Rubiaceae. While *C. papaya* offers adult hawk moths an additional food source, the reproductive stages of these moths in the majority are linked to native dry and wet rainforest scrub environments. One new record of *Aidia racemosa* (Rubiaceae) could be added to the larval food plant list of *Cephanodes kingii* (Macl.). All other collected larval stages were found on host plant species previously described by Common (1990) and Moulds (1981; 1984).

## Discussion

As the amount of airborne pollen was negligible and the rate of seed and fruit set minor of flowers tested for agamospermy, the role of insects, in particular of hawk moths, is undeniable as the pollen transfer agents in papaw. Pollen in numerous clusters remained adhered on the proboscises of preserved, captured moths, even when reexamined after a period of eighteen months. A clumped distribution of grains was in some instances also indicated from slides where small amounts of pollen were arrested during the wind pollination experiment. Viscous pollen is normally associated with insect pollination, while smooth, non-sticky pollen surfaces are signs of wind pollinating species.

The role of sphingids as pollinators of *C. papaya* was mentioned in an earlier report by Baker (1976) who studied the pollination mechanism of papaw in its indigenous surrounds in Costa Rica. He reported a sole hawk moth species, apparently a species of *Hyles*, as being involved in the pollination event. He presents few other details.

The sphingid species of *Theretra oldenlandiae firmata* (Walk.) and *Macroglossum hirundo errans* (Walk.) were observed to be constant foragers in the papaw planting during summer 1992, while in summer 1993 *Hippotion celerio* was the major species observed. As stated here, an Australian subspecies of *Hyles*, that is, *Hyles lineata livornicoides* (Luc.) was observed foraging to date on staminate flowers only, but on the basis of observations made by Baker (1976) the likelihood in taking part in a pollinator function is implicated.

Observations made on the foraging behaviour of sphingids, particularly in their role as pollen transfer agents, suggest that Bawa's (1980) explanation of moths being deceived by similar floral measurements between the petal diameter of the staminate flower with the stigma size of the pistillate flower in the related dioecious species of *Jacaratia dolichaula* is invalid in papaw. Hawk moths were observed to insert their proboscises into pistillate flowers, while still in the early stages of anthesis, before exposure of the stigma. As such, a foraging behaviour based on a similar scent perception which is emitted by both sexes of papaw flowers is sensible; see also Baker (1976).

As papaw plantations were initially established in existing dry and wet rainforest locations along the coastal strip of Queensland, pollination occurred but was taken and still is taken for granted by farmers. With monoculture, expanding agriculture and ongoing community development, remnant scrub sites are vanishing and hence breeding locations for essential pollinators are decreasing.

Further, recommendations of scrub clearance as a preventive measure of build up of Fruit spotting bug (*Ambypelta lutescens lutescens*), contributes to the progressive eradication of scrub sites. The host plant choices of Fruit spotting bug and of sphingid moths are quite different, although species can appear in the same locality.

The provision of natural scrub as a larval hawk moth breeding ground should ensure a consistency in pollinator numbers.

In studying the ecology of the interactions between crop plants and the requirements of the pollinator a major step has been accomplished towards sustained successful agriculture.

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# The naturalisation of gender roles in the Sciences

Judith Wooller  
BA(Hons), ALCM

Central to most theories of human nature produced by the Behavioural/Social Sciences are the categories male and female. In the main these naturalised and scientified roles have not been contested; on the contrary, evidence is continually being found to support and reify these positions. The feminist movement, however, has challenged the truth of these categories, demonstrating how these supposedly objective categories and roles have been politicised: how women have been tied to production and subordination by a society which is patriarchal, and by discourses that are masculinist.

This paper will examine aspects of the current debate on gender construction, and in particular the discourses which are brought to bear on this question from the perspective of biological determinism. Of particular importance in this discussion is the point that there is little recognition in socio-biological discourses that the body is a signifier, and that the signifieds which are ascribed to it are politically motivated.

How, then, have these gender roles and their differences been validated to such a degree that they have been seen as natural, given, and inescapable? Donna Haraway, for one, makes the point that:

the degree to which the principle of domination is deeply embedded in our natural sciences, especially in those disciplines that seek to explain social groups and behaviour, must not be underestimated. (8)

This view is shared by Sandra Harding who states:

science today serves primarily regressive social tendencies; and that the social structure of science, many of its applications and technologies, its modes of defining research problems and designing experiments, its ways of constructing and conferring meanings are not only sexist but also racist, classist, and culturally coercive. (9)

Both these theorists make the point that the naturalisation of gender roles serves specific economic ends: that the sciences are not disinterested and objective but are androcentric and that bodily differences have been used to position people in society to produce and reproduce gendered subjects.

According to Elizabeth Grosz and Marie de Lepervanche “science has become the source of all knowledge” (5). It now acts as the “paradigm for *disinterested*, *objective* and *proven* knowledge, incontestably providing our most secure sources of truths about the world” (5); and one of those “truths about the world” concerns the naturalisation of gender. “Science claims, it is true, observer-neutral, unbiased, repeatable and thus ‘objective’” (5) and divorced from socio/political issues (5). But is it?

Margarita Bowen suggests that:

the sociobiology of science—the study of how the scientific community operates—was considered irrelevant to the philosophy of science according to the positivist school, since in their view valid scientific research is impartial and therefore does not reflect the values or bias of individual scientists. (214)

But as Sandra Harding argues, natural science which presents itself as “the paradigm of critical, rational thinking, tries to suffocate just the kind of critical, rational thought about its own nature and projects that it insists we must exercise about other social enterprises” (35). According to the positivists, therefore, science considers itself above self-analysis because of the objectivity of its methodology and techniques. This position can only be adopted, however, in ignorance and disavowal of the notion that individuals are constructed by ideology, and that meaning and knowledge are contingent on various language codes.

An example of this naturalisation of gender differences can be found in the work of Charles Darwin who declared: “man is more courageous, pugnacious and energetic than woman and has more inventive genius” (562), and again:

woman seems to differ from man in mental disposition—chiefly in her great tenderness and less selfishness ... the chief distinction in the intellectual powers of the two sexes is shown by man's attaining to a higher eminence. (qtd. Degler 34)

In his article "Darwinians Confront Gender; or, There is More to it than History", Carl N. Degler argues that Darwinian theory improved the status quo for women, and after going through a period of rejection has returned in the guise of Sociobiology (38).

Woman's biological function, he argues, is to produce children for the continuance of civilisation, and this separates the roles of man and woman. Degler argues that there is a human core (45) which reinforces the naturalness of gender roles, and this case is predicated upon the reproductive function of the body.

Just as Darwin and the biological sciences focused on this 'natural' differentiation between the sexes, Sigmund Freud's work in the field of psychoanalysis was largely predicated on the notion that women were inferior to men because of their lack of a penis. Freud tied gender construction firmly to the body: "when you say 'masculine', you usually mean 'active' and when you say 'feminine', you usually mean 'passive'" (147–148). This can be seen during intercourse in that "the male sex-cell is actively mobile and searches out the female one, and the latter, the ovum, is immobile and waits passively (148). The reduction of the human body to a genetic system thus links psychology to biology, reinforcing the gender roles.

According to Lesley Rogers: "two related paradigms of thinking underscore all biologism viz reductionism and division into dichotomous categories" (43). The body is thus reduced to an automated system based on the differences between the male and the female "on the basis of genital sex", that is "the presence or absence of a penis" (44), and this is the criterion by which the sciences construct theories about sex and gender categories. The genetic units are then used to analyse society as a whole. As Donna Haraway states: "modern biology constructs theories about the body and the community as capitalist and patriarchal machine and market" (44). Haraway's work shows the progression that occurred in the life sciences, specifically biology, from the pre-second World War theories of R.M. Yerkes to the post-second World War dictates of E.O. Wilson. She suggests that:

between the First World War and the present, biology has been transformed from a science centred on the organism, understood in functionalist terms, to a science studying automated technological devices, understood in terms of cybernetic systems. (45)

In other words, while Yerkes focused on the organic system and related it to the whole, Wilson moved from physiology to systems theories. The move here, in biology, is from a "science of sexual organisms to one of producing genetic assemblages" (45), which, as Haraway suggests, controls "the mass through sophisticated communication systems" (46).

Through analysis of primates Yerkes propounded the naturalisation of human history, thus "making human nature the *raw* material rather than the *product* of history" (47). According to Ruth Hubbard, human nature is a "normative concept that incarnates historically based beliefs about what human beings are and how they should behave" (63). So when the biologists did their studies on primates they took with them preconceived ideas about behaviour based on sexual differences, which they failed to put in context. As Harding says "the philosophy, sociology and history of the natural sciences have been dominated by empiricist philosophies" (34) which refuse to recognise the part gender construction has played in theorising their knowledge.

Carl Degler states the "social scientists who are willing to consider biology as affecting human behaviour often wonder why biology must be the sole explanation of a pattern of behaviour" (42). He goes on to acknowledge that culture plays a part in determining behaviour and criticises E.O. Wilson for grounding human ethics and values solely on biology. However, despite this, his concurrence with Mary Midgeley "that the human core is something beyond a cultural creation" (45) reveals his biodeterminism.

Most biologists reject the idea that culture plays a significant role in determining gender differentiation. Degler uses the sociologist and feminist Alice Rossi to expose that "'cultural determinism' has gone too far"; this active feminist states that adherents to this have been "forced to deny that there are any physiological differences between men and women" (40).

When Degler critiqued determinists for "reduc[ing] human being[s] to empty slates upon which history or experience writes what it will" (45), he is actually reiterating Jacques Lacan's belief that children, in the main, are born genderless: "that at the moment of its birth the child is like a 'hommelette'—a little man and also like a broken egg spreading without hindrance in all directions" (qtd. Coward & Ellis 101); which led Elizabeth Grosz to suggest that Lacan believed that the individual was "socially, linguistically and libidinally *constructed*" (24). Although to a large degree Lacanian theory is androcentric, it has been used by feminists to expose gender construction.

According to Judith Butler "social scientists refer to gender as a 'factor' or 'dimension' of an analysis; it is also applied to embodied persons as a 'a mark' of biological, linguistic, and/or cultural difference" (9). The body has been taken as the

signifier for the denotation of the genders, but Butler sees the body itself as a construction and cannot “have a signifiable existence prior to the mark of ... gender” (8). What Butler is referring to here is the fact that everything is constructed by language and that nothing has significance outside of the language system.

When Ferdinand Saussure exposed the arbitrariness of the relationship between the signifier and the signified he exposed how language systems construct identity, reality and meaning. The body was given signification in order to distinguish between the sexes: to give gender differentiation. This representation, then, became symbolic and naturalised the gender differences which became embedded and perpetuated by the language system. According to Susan Hekman: “the linguistic practice forges a connection between personal identity and gender identity” (31). She quotes Barbara Fried who argues that “language does not simply communicate the link between one’s sex and one’s gender identity; it constitutes that link” (31).

Elizabeth Grosz points out: “the ... differences between the sexes are not a function of anatomical differences, but of the *meaning* of anatomical differences, of male and female sex organs” (20). The representation of these anatomical differences has solidified within society and is promoted by the capitalist system of production. Judith Butler suggests:

the notion that gender is constructed suggests a certain determinism of gender meanings inscribed on anatomically differentiated bodies, where those bodies are understood as passive recipients of an inexorable cultural law. (8)

As a cultural determinist Lacan acknowledges the exclusion of women within the symbolic order because of bodily differences, however, he universalises the construction of gender as being global. He does not contest or allow for the influences of different societies, cultures, classes or races. To a large degree this is a critique that can also be levelled at sociobiology.

The emergence of sociobiology as the inheritor of biology would appear, on the surface, to adopt the thesis that both society/culture and biology are active determinants, working together in the construction of gender. Yet Ruth Hubbard believes that sociobiology is “the most pervasive and comprehensive of contemporary biodeterminist theory ... which has as its project ‘the systematic study of biological basis of all human behaviour’” (44). One of its major adherents, E.O. Wilson, stated that “sociobiology is the biological understanding of *groups*—societies and populations” (qtd. Haraway 59). Donna Haraway, in her critique of the biological sciences, cites a number of projects which, in her view, show how continually the patriline is the major focus, how the hierarchal dimensions of gender are still reinforced, and how female biologists are still working within the masculine discourse of the sciences. She also declares that “sociologists ... still view dominance hierarchies as patterns co-ordinating a social group” (99), but in her view the:

basic logic is different. All biological structures are expressions of genetic calculus of interest, that is, the best possible (not perfect) resolutions of fundamental conflict when all the elements in the system need each other for their own reproductive success. (99)

Again the behaviour of human beings is universalised. As Hubbard states, “sociobiologists claim that the fundamental elements of human nature can be identified in traits that characterise all people (and selected animals as well) irrespective of their cultural or historical differences” (65).

While sociobiology does acknowledge that the energies women and men devote to procreation are different, it still ties this to the idea that all women are maternal, thus universalising and overdetermining biology as value. Interestingly enough in field projects, according to Donna Haraway, women scientists refused to examine females and babies within groups because “too much attention to females pollutes the observer” (96). So for some reason it is acceptable for males to observe the aggression and domination of their counterparts without losing so-called objectivity, but the same cannot be said of females who, in order to be accepted, must look at male behaviour also.

I have argued in this paper that, whilst there is a difference between the bodies of males and females, that difference has been politicised to place women in an inferior position. This denigration via gender has been perpetuated by the biological sciences which are most biodeterminist. On the other hand, the cultural determinists tend to universalise, and do not take into account different societies, classes, or races. The promise of Sociobiology has not been fulfilled as it too reifies inequality and refuses to give value to anything but patrilineal research.

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# Fuzzy linguistic approach for decision making and estimation

**M. Mohammadian**

BSc(Flinders) EngDipElect(Tu)

## Abstract

Determining a suitable price for used vehicles involves many factors. While some of the factors are objective and easy to quantify, many factors such as state and condition of a vehicle, are subjective and not easy to quantify. This paper presents the usage of the fuzzy linguistic approach to quantify subjective factors which are considered in estimation of price of used vehicles. Applications of the fuzzy linguistic approach for price estimation of used vehicles are considered.

## Introduction

There exist a number of objective and subjective factors that must be considered in deciding an estimate price for used vehicles. These objective factors may be evaluated in monetary terms. Subjective factors provide qualitative information. There are many subjective factors in forecasting and price estimation.

In this paper I show how fuzzy sets and the fuzzy linguistic approach can be used to help car dealers to make decisions about the price of used vehicles.

Fuzzy sets and the fuzzy linguistic approach were introduced in 1965 by Lotfi Zadeh [5] as a new way to represent vagueness in application. It allows the existence of a type of uncertainty due to imprecision and vagueness rather than to randomness alone. They can be used to evaluate subjective factors, and are a generalisation of sets in conventional set theory.

## Conceptual bases for linguistic approach

A linguistic variable differs from a numerical variable in that its value can be found in terms in a natural or artificial language, rather than numbers. Terms such as “good”, “fair”, or “bad” are readily used by people to describe the condition of a vehicle. The totality of possible terms of a linguistic variable “ $x$ ” is said to constitute its term,  $T$ .

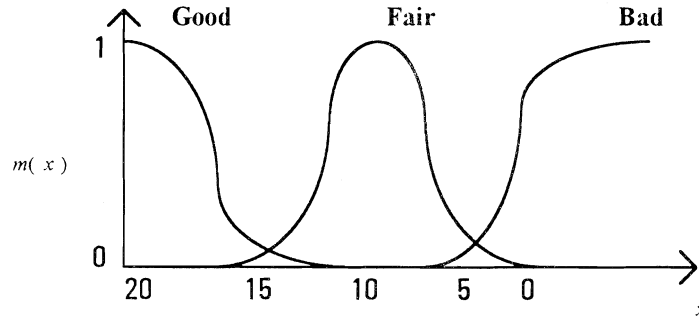
A linguistic variable  $x$  is associated with a base variable  $X$ . For each linguistic term  $L$ , there is a membership function  $m_L(x)$ . The membership function associates with each value of the base variable  $X$  a number in the interval  $[0, 1]$ , identifying the value’s membership with a linguistic term. Figure 1 shows the membership functions for good, fair and bad of the linguistic variable condition in term set  $x$ .

The fuzzy set underlying the linguistic term  $L$  and its membership function is defined below [5]:

The fuzzy set  $A$  of the universe of discourse  $U$  is defined by a membership function  $m_A : U \rightarrow [0, 1]$  which associates with each element  $u \in U$  a real number in the interval  $[0, 1]$ . The value of  $f_A(u)$  represents the “grade of membership” of  $u$  in  $A$ . Formally  $A$  can be written as:

$$A = \{(u, m_A(u)), u \in U\}$$

A fuzzy set in a most basic sense can be described as a set in which the objects have gradual, rather than crisp, transition from membership to non-membership.



**Figure 1:** Membership function for good, fair and bad.

Methods for developing membership functions have been suggested by Mohammadian [1]. Methods for tuning membership functions are also suggested by Mohammadian et al. [2] and Civanlar and Trussel [3].

First, the primary linguistic terms and associated membership functions are specified. The translation rules can then be applied to generate additional items and related membership functions. The labels of these posterior terms, if generated, contain a modifier or connector used in combination with the primary term labels. Some posterior terms are generated below by using hedges, modifiers, and connectors.

Some of the primary terms would be: “Good”, “Fair” and “Bad” with membership functions  $f_G$ ,  $f_F$ ,  $f_B$  respectively.

The posterior terms of these primary terms would be:

Extremely Good	$f_{EG} = (f_G)^3$	(1)
Very Good	$f_{VG} = (f_G)^2$	(2)
More or Less Good	$f_{MLG} = (f_G)^{1/2}$	(3)
Not Good	$f_{NG} = 1 - f_G$	(4)
Not Good and Not Fair	$f_{NGF} = \text{Min}[(1-f_G), (1-f_F)]$	(5)
Good or Fair	$f_{GOG} = \text{Max}[f_G, f_F]$	(6)
Bad or Fair	$f_{BOF} = \text{Max}[f_B, f_F]$	(7)
Not Bad and Not Fair	$f_{NBF} = \text{Min}[(1-f_B), (1-f_F)]$	(8)
More or Less Bad	$f_{MLB} = (f_B)^{1/2}$	(9)
Very Bad	$f_{VB} = (f_B)^2$	(10)
Extremely Bad	$f_{EB} = (f_B)^3$	(11)

Now let us define a fuzzy set “Good” which defines the status of condition of a used vehicle. The set “Good” has boundaries that indicate the condition of the vehicle. One boundary indicates that the vehicle is in a good condition while the other boundary indicates that the vehicle is not in a good condition. These conditions are indicated by a response membership value equal to 1 for good condition and 0 for not good condition, in the fuzzy set “Good”.

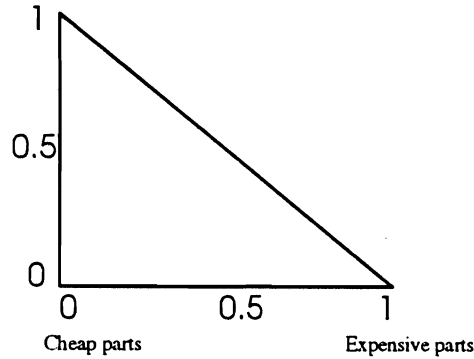
Now let us define the universe  $U = \{X_1, X_2, \dots, X_n\}$  where  $X_1, X_2, \dots, X_n$  are the  $n$  measures of  $n$  variables constituting the elements of  $U$ . For example element  $X_1$  may represent the condition of the body of a vehicle,  $X_2$ , the condition of interior,  $X_3$ , the condition of engine and  $X_4$ , popularity of the vehicle in the market. The set “price” of a used vehicle of a universe of discourse  $U$  is characterised by a membership function  $u_{\text{price}} : U \rightarrow [0, 1]$ . A number in the  $u_{\text{price}}(X)$  in the closed interval  $[0, 1]$  is associated with each element of  $U$ . If a value of  $u_{\text{price}}(X)$  is closer to 1, then it indicates that the proposed price is desirable; if the value of  $u_{\text{price}}(X)$  is closer to zero then the proposed price is not desirable.

The set “price” can be represented by:

$$\begin{aligned} \text{price} &= \{u(X_1)/X_1, u(X_2)/X_2, \dots, u(X_n)/X_n\} \\ &= \int u_{\text{price}}(X)/X \end{aligned} \quad (12)$$

where the integral sign represents the union of  $n$  fuzzy singletons of ( $n$  condition measures) (Mital [4]).

Some of the elements in the above set may represent objective factors, for example the availability and price of the parts for a vehicle. In such cases, the membership function would represent the price and availability of the parts of a vehicle in the market and can be modelled as a linear function. The vehicles with expensive spare parts would be assigned a membership value of zero while the vehicles with cheap spare parts are assigned a membership value of one (Fig. 2).



**Figure 2:** Membership function for spare part price and availability

The membership value of the factors which yield qualitative information is determined differently. For example, the popularity of a vehicle is hard to measure qualitatively. It can be expressed by linguistic descriptors such as favourite, neutral and un-favourite. These linguistic descriptors can be defined by giving each a fuzzy representation on a universe of discourse  $V$ , where  $V = [0, 0.1, 0.2, \dots, 0.9, 1]$  with the membership intervals  $[0, 1]$ .

The three linguistic descriptors of the popularity of a vehicle in the market with the membership  $[0, 1]$  can be defined as follows:

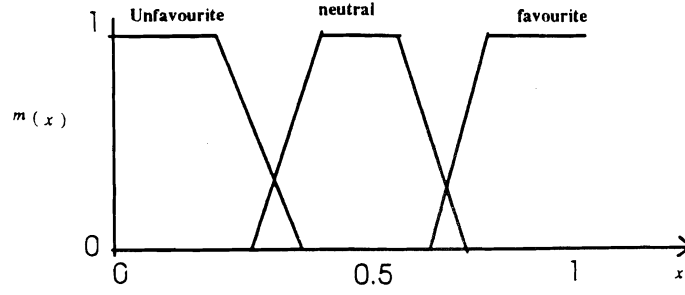
$$\text{favourite} = [0/0.1, 0/0.2, 0/0.3, 0/0.4, 0/0.5, 0/0.6, 0/0.7, 0.2/0.8, 0.7/0.9, 1/1] \quad (14)$$

$$\text{neutral} = [0/0.1, 0/0.2, 0/0.3, 0.15/0.4, 0.9/0.5, 1/0.6, 0.9/0.7, 0.15/0.8, 0/0.9, 0/1] \quad (15)$$

$$\text{un-favourite} = [1/0.1, 0.7/0.2, 0.2/0.3, 0/0.4, 0/0.5, 0/0.6, 0/0.7, 0/0.8, 0/0.9, 0/1] \quad (13)$$

The numerators show the degree of membership and the denominators show the desirability of the vehicle in the market with respect to the linguistic descriptors, favourite, neutral and un-favourite. The definitions of these primary terms (favourite, neutral, un-favourite) are subjective and are obtained by statistical data experimentally.

If a large range of people favour a kind of vehicle then that vehicle is favourite. In this case the membership function associated with popularity of a vehicle is close to 1. Conversely, if only a few people favour a vehicle, then it is very likely the vehicle is un-favourite. Figure 3 shows the membership function for favourite, neutral and un-favourite of a vehicle.



**Figure 3:** Membership function for favourite, neutral and un-favourite

The primary terms “Good”, “Fair” and “Bad” in conjunction with the hedges given by Equations (1)–(11) can be modified as follows:

$$\text{Very favourite} = [\text{favourite}]^2 = [0/0.1, 0/0.2, 0/0.3, 0/0.4, 0/0.5, 0/0.6, 0/0.7, 0.04/0.8, 0.49/0.9, 1/1] \quad (16)$$

Other primary terms can also be defined mathematically. For example, the definition of the linguistic variable “Good” can be derived for the linguistic descriptor “Bad” by complementary arithmetic.

The membership function of the descriptor “Bad” is defined as follows:

$$\text{Bad} = [1/0.1, 1/0.2, 1/0.3, 1/0.4, 1/0.5, 0.9/0.6, 0.8/0.7, 0.4/0.8, 0.02/0.9, 0/1] \quad (17)$$

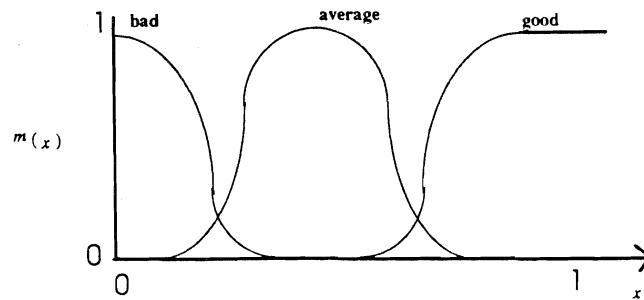
The primary term “Good” can be defined as:

$$\text{Good} = 1 - \text{Bad}$$

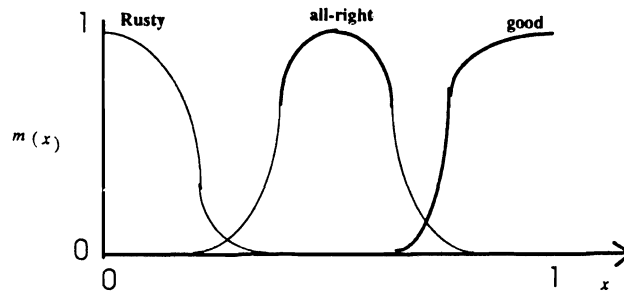
That is:

$$\text{Good} = [0/0.1, 0/0.2, 0/0.3, 0/0.4, 0/0.5, 0.1/0.6, 0.2/0.7, 0.6/0.8, 0.98/0.9, 1/1] \quad (18)$$

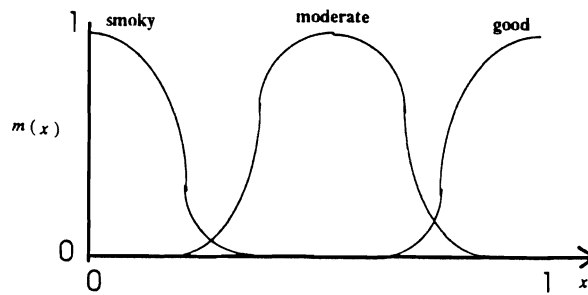
Other primary linguistic terms such as quality of the interior of a vehicle and condition of the body and engine of the vehicle can also similarly be defined. Figures 4–6 show primary linguistic terms for quality of interior, body and engine condition of a vehicle.



**Figure 4:** Membership function for quality of interior of a vehicle



**Figure 5:** Membership function for condition of body of a vehicle



**Figure 6:** Membership function for condition of engine of a vehicle

All these primary terms, including popularity of a vehicle in the market, can be verified experimentally.

## Estimation of the price of used vehicles

Vehicle dealers and (insurance) assessors estimate the price of used vehicles by the previous knowledge and experience they have obtained during years of trading. The experience, however, is very hard to define numerically and cannot be found in the “textbooks”. Dealers and assessors make judgements and price estimates based on intuition. In recent years there have been published dealers’ guide books. The purpose of these books is to be a guide to help dealers and assessors to estimate the price of vehicles. These books give only an indication of what a vehicle worth. Table 1 shows the approximate price for a few cars from a dealers’ guide book.

**Table 1:** Approximate price of few cars from a dealer’s guide.

Year	Model	Make	Accessories	Price to buy	Price to sell
1982	929	Mazda	5Spd/Ps/Air Cond	5000	6800
1982	929	Mazda	Auto/Air Cond	5800	7500
1983	929	Mazda	5Spd/Air Cond/Lim-edition	6200	8000
1983	929	Mazda	5Spd/Air Cond/Ps/Lim-edition	6700	8500

It can be seen from Table 1 that these guides only provide prices for a vehicle (i.e. the price to buy and the price to sell). However, the condition of vehicles differs from one to another. Therefore, the dealers have to make judgements and decisions on their own. The dealer’s guide book gives only an indication of the price of the vehicle. The dealers make the judgements and decisions with consideration of many subjective factors. A few of these factors are the condition of body,

engine and interior of a vehicle. The price estimate by dealers substantially differs from the dealer's guide book. A dealer assigns a weight to the different subjective factors. They then use all these weights in their mind to make an estimate.

In this paper, I assign a weighting to three subjective factors (body, engine and interior of vehicle) for estimation of price of a vehicle. The weights are obtained by conducting a survey with a few vehicle dealers. The survey was designed to gather information regarding these three factors. These responses were used to draw Figures 4–6. Equations (1)–(11) have been used to produce some primary term definitions.

An example of an estimate of correctness of price can be obtained through mixed fuzzy numerical set (Mital [4]). Now assume that we would like to estimate the price of a car with the model specification given in row 1 of Table 1. Assume also that a dealer has assigned the following linguistic variable to that vehicle: the importance of each factor is expressed using a 0 to 1 scale. Substituting the value given in Table 2 in Equation (22) the estimated price of the vehicle under consideration can be calculated by Equation (23).

**Table 2:** The weighting factors

Factor	Linguistic Descriptor	Grade of weighting	Membership factor
Interior	average	0.6	0.8
Body	all-right	0.5	0.9
Engine	moderate	0.6	0.9
Market-popularity	neutral	0.5	0.89

The weighting factor in column 4 of Table 2 is the weighting or importance of different factors to that dealer. These weighting factors can also be calculated by conducting a survey with different dealers. They can be different from vehicle dealer to another vehicle dealer but only slightly.

$$\begin{aligned} \text{Estimate of correctness of price} &= [( \text{condition of Body} )/Y_1, ( \text{condition of Engine} )/Y_2, \\ & ( \text{condition of Interior} )/Y_3, ( \text{popularity in the market} )/Y_4] \end{aligned} \quad (19)$$

$$\begin{aligned} \text{Estimate of correctness of price} &= [(0.7/Y_1, 0/0.1, 0/0.2, 0/0.3, 0/0.4, 0/0.5, 0/0.6, \\ & 0/0.7, 0.2/0.8, 0.7/0.9, 1/1)/Y_2, (0.6)/Y_3, (0.5)/Y_4] \end{aligned} \quad (20)$$

$$\text{That is, estimate of correctness of price} = [(0.7)/Y_1, (0.9)/Y_2, (0.6)/Y_3, (0.5)/Y_4] \quad (21)$$

This gives almost an equal weighting to all factors. All factors however do not have equal importance. The above equation for estimate of correctness of the price can be modified as suggested by Mital [4] to:

$$\text{Estimate of correctness of price} = [(W_1)u(Y_1) + (W_2)u(Y_2) + \dots + (W_n)u(Y_n)/(W_1 + W_2 + \dots + W_n)] \quad (22)$$

where  $(W_1 + W_2 + \dots + W_n)$  are the weighting factors (see Mital).

$$\text{Estimate of correctness of price} = [(0.6 + 0.5 + 0.6 + 0.5)/(0.8 + 0.9 + 0.9 + 0.89)] = 0.63$$

This means that the price given for the vehicle corresponding to the first row of Table 1, in conjunction to the inspected vehicle with weighting and grade of membership function in Table 2, is correct to 63%.

That is, the price to buy, corresponding to the vehicle of the first row of Table 1, is \$5 000. The estimate of correctness of this price with the vehicle at hand is 63% and the estimated price of the vehicle is \$3 150. It is calculated as follows:

$$\begin{aligned} \text{Estimated price} &= [(\text{Dealer's Guide Price to Buy}) * 100/(\text{Estimated correctness of the price})] \\ &= [(5000) * 100/(63)] = 3150 \end{aligned} \quad (23)$$

## Conclusion

This paper has demonstrated the application of fuzzy set theory and fuzzy linguistic variables in making decisions regarding the estimated price of used vehicles. Since many more factors can be used to describe the nature of qualitative factors, this method is more reliable and sensitive than the other methods. A more sophisticated approach using a fuzzy expert system is under consideration.

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# Effects of grout on the compressive strength of clay block masonry

**Mlinder Kumar**

BScEngineering(Civil), PUChandigarh(India)

**Dr Manicka Dhanasekar**

BE(Civil) (Madras), MTech(Struct) (IIT, Madras),

PhD(Ncle), MIE(India), MIE(Aust), CPEng, MTMS(USA)

## 1.0 Introduction

Compressive strength of masonry is an important parameter in the design of masonry. Masonry is a composite material composed of brick and mortar in the case of solid masonry and block and mortar in the case of hollow block masonry. Hollow block masonry is usually faceshell bedded and sometimes partially grouted and reinforced. The grouted masonry due to the flow of grout into the webs would behave as if it were fully bedded. The merits and demerits of full bedding and faceshell bedding are reasonably well documented in the literature (1, 6, 7) and will not be repeated here. However, the effect of grout on the strength of masonry is not well researched. With a limited number of experiments, Scrivener and Baker (13) suggested an equation to predict the axial load carrying capacity of grouted prisms as a function of masonry strength and the square root of grout strength. This equation is included in the recent edition of AS3700 (12). This paper critically reviews the equation with particular reference to clay block masonry.

## 2.0 Background

Construction of reinforced masonry dates back to the early part of the twentieth century. Large numbers of flexural members have been made up of reinforced masonry and tested in the period (8). Design calculations of these structures were based on the principles of reinforced concrete. Even to date no significant advancement has been made to the scenario. The lack of advancement may be attributed to lack of research and education (4, 11), non-availability of proper constituent materials which allow the positioning of reinforcing bars at their most desirable location (2), and lack of design aids and manuals (3).

However in the past three decades there has been a renewed interest in masonry research in general and reinforced masonry in particular amongst researchers and academics (4). The availability of hollow blocks, both in concrete and clay, allow the positioning of reinforcing bars close to the desired location. With this availability, particularly reinforced walling has become more popular in cyclonic areas of Australia including the North and Central Queensland coasts (3). The major parameter in the design of reinforced masonry is the compressive strength of grouted masonry. The compressive strength of reinforcement is disregarded in the estimation of the load carrying capacity of reinforced masonry walling due to the absence of lateral reinforcements tying the main reinforcement (12).

As part of the on-going research programme at the Structures Laboratory of the University of Central Queensland, several masonry prisms were tested for strength and stiffness. In this paper the influence of the quality of grout on the strength of grouted masonry prisms is reported. The quality of grout mix includes both workability and compressive strength. Both factors of grout are found to have significant effect on the strength of masonry.

### 3.0 **Experimental investigation**

Several units of masonry, grout cylinder and grouted masonry were tested as reported in this section.

#### 3.1 **Testing of units**

Hollow clay blocks of size  $150 \times 310 \times 76$  mm with 34.4% core area were tested for compressive strength. Capping 4 mm thick was used for full and faceshell bedding. Ten numbers of hollow blocks were chosen randomly from different stacks of blocks and each unit was tested using 4 mm plywood capping for faceshell bedding and full bedding to ensure full contact between specimen surface and platen. The specimens were placed in the Avery Compression Testing Machine of 1800 kN capacity. A constant load of 360 kN/min was applied and crushing failure values were recorded.

#### 3.2 **Manufacturing of prisms**

The prisms were constructed by an experienced mason. Aluminium level, steel trowel marked MS straight angle and plumb bob were the masonry tools used. On completion prisms were wrapped in wet hessian cloth and left undisturbed for 28 days.

##### 3.2.1 *UngROUTED prisms*

Stack bonded prisms of height 334 mm with height to least width ratio greater than two were constructed. Faceshell and full bedded prisms were constructed. A minimum of three specimens were constructed in each type.

##### 3.2.2 *Grouted prisms*

Masonry prisms were constructed first and the surplus mortar removed on each joint from the external face of the prism. Mortar droppings were cleaned from the cores. The grout mix with the proportions shown in Table 4 was prepared in the concrete mixture of capacity 0.033 m. Each core of the prism was grouted by hand equally and compacted by rodding. The cores were overfilled to 25 mm from the top surface of the specimen to allow for the shrinkage of grout. After an hour surplus grout was removed and the top surface levelled. The specimens were wrapped in wet hessian cloth and left undisturbed. On each mix three cylinders were casted for quality control. To estimate the effect of water absorption on the strength of grout, three grout prisms were casted using two high block moulds.

#### 3.3 **Testing of prisms**

All prisms were tested under monotonically increasing load in an Avery Compression Testing Machine of 1800 kN capacity. Demac gauge points were pasted on the stretcher faces of the prisms at 150 mm gauge length in the axial and lateral directions. A load increment of 50 kN was used to take the readings of the Demac gauge points. Near the ultimate load level it was difficult to keep the load constant for the duration of reading all Demac gauge points and hence the strain measurement was stopped prior to failure.

### 4.0 **Test results**

The results of the compression tests on prisms are presented in Tables 2 and 3 and Figures 3 and 4. The modes of failure are shown on the photographs in Figure P1 and Figure P2.

## 4.1 Modes of failure

The failure modes are illustrated in Figure 1 and Figure 2 for hollow and grouted masonry respectively. Generally masonry prisms split in a direction parallel to the direction of load application. Stretcher and header faces of prisms failed by developing vertical cracks. At ultimate load level, the shells of the grouted prisms exhibited spalling by exposing the infill grout. The failure mechanism of two types of prism is explained in the section.

### 4.1.1 *Hollow masonry*

Hollow masonry is either faceshell bedded or full bedded. Failure of both types of prisms differ significantly in principle.

#### 4.1.1(a) *Faceshell bedded prism*

Faceshell bedded prisms failed by developing vertical cracking at the header face followed by some minor cracks at the stretcher face. The failure mode could be explained using Figure 1(a). Under the compressive load the stretcher face (which is loaded) deforms, while the header face, spanning between the stretcher faces acting like a deep beam, develops cracking due to the deformation of its support. Several publications on concrete masonry including reference 9 elaborate this phenomenon.

#### 4.1.1(b) *Full bedded prism*

Full bedded prisms failed by the development of major vertical cracking at the faceshell followed by minor vertical cracks at the webshell. The failure mechanism of this type of prism is illustrated in Figure 1(b). Axial stresses are uniformly distributed across the cross-section of full bedded prisms. Mortar is confined by the block shells of the prism. Larger tensile stresses are developed in the faceshell of the prism causing major vertical cracking on the stretcher face and minor vertical cracks on the header face. The resulting tensile stresses are due to differences in Young's modulus and Poisson's ratio of mortar and block.

### 4.1.2 *Grouted masonry*

Grouted masonry failed by first developing cracks on the shells (both stretcher and header faces) followed by the spalling of the shells by exposing the grout. Grout, due to the confinement of the shells, did not exhibit shear failure as that of the cylinder. However, due to higher Poisson's ratio (0.2 for the grout and 0.15 for masonry), under uniform axial strain, grout develops fluid-like internal pressure. Masonry is therefore subjected to axial compression and internal pressure and develops cracking of shell at a reasonably lower level of loading itself.

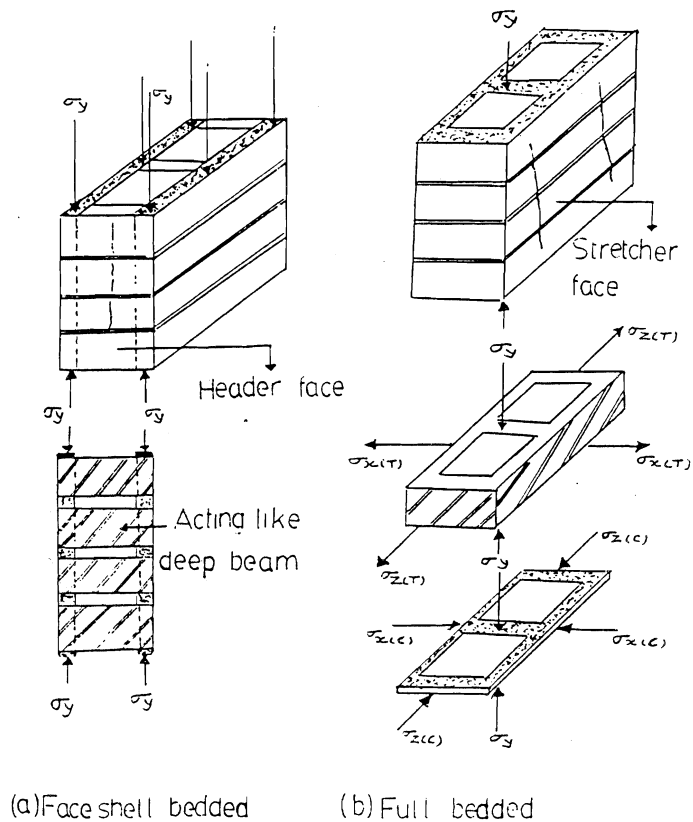


Figure 1: Hollow masonry

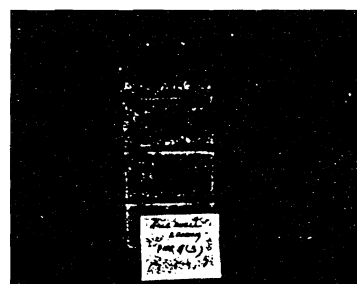


Figure P1

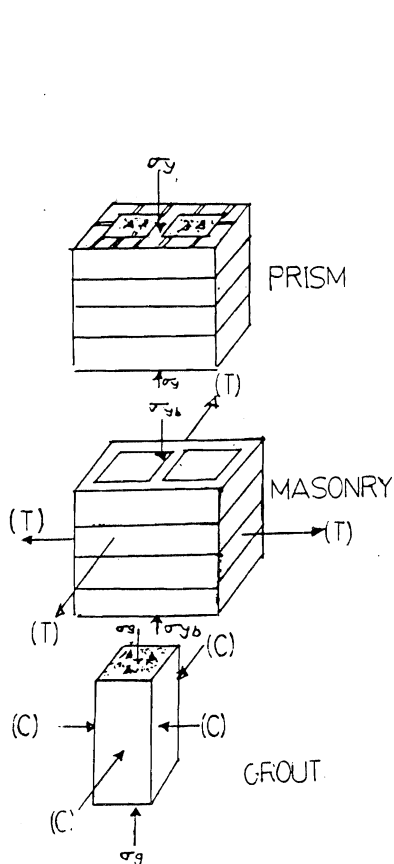
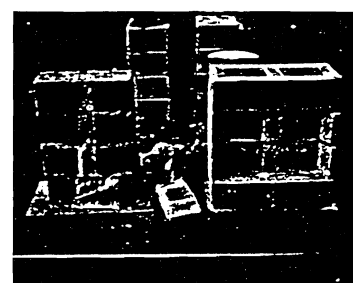


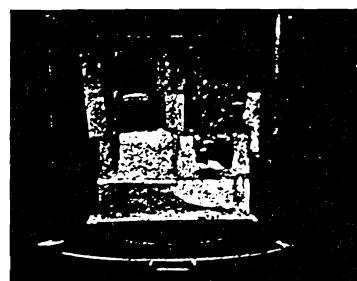
Figure 2: Grouted masonry



M15



M20



M25

Figure P2

## 4.2 Ultimate strength

The ultimate strengths of the hollow clay block, hollow masonry and grouted masonry are given in Tables 1 to 3.

### 4.2.1 Block strength

The ultimate compressive strength of the block is calculated by dividing the ultimate load by the bearing area, the bearing area being the area of the unit covered by plywood capping. The strength of the faceshell bedded unit is marginally higher than that of the full bedded unit. The characteristic compressive strength of the units under the two systems of loading has been worked out using the formula:

$$\bar{x} - 1.65\sigma \quad \text{where } \bar{x} = \text{mean strength} \\ \text{and } \sigma = \text{unbiased standard deviation}$$

The characteristic compressive strength  $f'u$  of the faceshell bedded unit is again marginally higher than that of the full bedded unit.

By pooling the results of all 20 tests the mean compressive strength of units may be worked out to be 36MPa. The corresponding coefficient of variance (COV) is 5.9% and the characteristic compressive strength is 32.45MPa.

**Table 1:** Ultimate compressive strength of block

Type	No. of Tests	Mean Strength ( $\bar{X}$ ) {MPa}	COV%	$f'u$ {MPa}
Faceshell Bedded	10	36.31	4.9	33.23
Full Bedded	10	35.73	6.9	31.65

### 4.2.2 Hollow masonry strength

Hollow prisms were tested under both faceshell bedding and full bedding. The results are given in Table 2. Faceshell bedded prisms failed at lower load in relation to the full bedded prisms and exhibited more variability as reflected by the higher coefficient of variance (COV). It may therefore be suggested that the use of full bedded masonry should be practised to gain higher strength and better uniformity in performance. The other interesting point emerging from the last column of Table 2 is that the method of assessing compressive strength of masonry based on the prism test results is significantly higher than that based on the AS3700 Table 4.1 method. The following suggestions may be made based on the findings:

1. Designers may resort to the prism test rather than Table 4.1 of AS3700 for evaluating  $f'm$  value.
2. The values of Table 4.1 of AS3700 may be improved.

**Table 2:** Ultimate compressive strength of hollow masonry

Type	No. of Tests	Mean Compressive Strength {MPa}	COV%	Characteristic Compressive Strength {MPa}(b)	As per AS3700 Table 4.1 {MPa}(a)	$\frac{b-a}{a} \times 100$ %
Faceshell Bedded	3	19.20	11	12.60	8.00	57.5
Full Bedded	3	22.00	7.3	15.00	8.25	81.8

Characteristic Compressive Strength is calculated as per Appendix B of AS3700.

### 4.2.3 Grouted masonry strength

Grouted masonry prisms were tested using different grades of grout. A total of seven grades of grout ranging from M10 to M30 have been used. Four grades of grout (Type-I) were designed to a slump of 180 mm to 210 mm (water content: 275 kg/m<sup>3</sup>) and the other three (Type-II) were designed to a slump of 150 mm to 180 mm (water content: 275 kg/m<sup>3</sup>). All the test results were found to be consistent within 10% COV. The characteristic strength of the prisms has been calculated using Appendix B of AS3700 which is based on a COV of 15% for a three specimen test. Grout mix of grade M20 (Type-I) seems to be optimum ensuring maximum compatibility with block masonry and hence giving higher strength of grouted masonry. Grouted masonry failed due to the higher Poisson's ratio (0.2) of grout which resulted in bursting fluid-like pressure on the shells of the block masonry. A photographic view of this failure mode is shown in Figure P2.

**Table 3:** Compressive strength of grouted masonry.

Grout Grade	No. of Tests	Mean Compressive Strength {MPa}	COV %	Characteristic Compressive Strength {MPa}
M10				
TYPE-I	3	14.30	2.80	12.07
M15				
TYPE-I	3	18.20	4.00	12.54
TYPE-II	3	17.70	1.80	12.54
M20				
TYPE-I	3	24.40	4.70	15.17
TYPE-II	3	22.29	8.70	15.17
M25				
TYPE-II	3	16.30	8.90	10.53
M30				
TYPE-I	3	19.00	9.80	12.60

Note: Characteristic Strength of Prism is calculated as per Appendix B of AS3700.

## 5.0 Effect of grout quality on prism strength

Grout quality is defined on the basis of its strength and slump. These two parameters are found to affect the strength of a grouted prism. Lower and higher strength grout with low slump were found to give lower strength masonry. The medium grout strength with high slump was found to increase the strength of grouted masonry.

### 5.1 Quality of grout

It is important to design the grout mix as both its strength and slump are found to have significant impact on the strength of masonry. In designing the mix, cement content was kept to a minimum of 300 kg/m<sup>3</sup> conforming to AS3700. Varying grades of grout mix M10, M15, M20, M25 and M30 were designed with varying W/C ratios from 0.5 to 0.89. A slump range of 180 mm to 210 mm was used in Type-I mix and a slump range of 150 mm to 180 mm was used for Type-II mix. Design mix of grouts is given in Table 4 and test results of grout cylinders is reported in Table 5.

**Table 4:** Mix design of grout for 1 M<sup>3</sup>

Grout Type	Grout Grade	Cement (kg)	Aggregate 10 mm (kg)	Coarse Sand	Water (kg)	W/C	Density of Grout kg/m <sup>3</sup>
TYPE-I	M10	310	768	860	275	0.89	2163
	M15	340	768	787	275	0.81	2170
	M20	390	768	747	275	0.71	2180
	M25	444	768	700	275	0.62	2187
	M30	550	768	610	275	0.50	2203
TYPE-II	M15	340	768	882	240	0.71	2230
	M20	390	768	837	240	0.61	2240
	M25	444	768	798	240	0.54	2250

## 5.2 Influence of grout strength

In grouted masonry, under uniform strain, the stress induced in grout is always more than that of masonry. This difference in stress level is due to difference of the stiffness (E values) of both materials. Grout, being stiffer than masonry, is always subjected to higher levels of stress. As the E value of grout increases with the strength of grout, higher strength grouts usually develop more stress also. It is believed that at some higher ratio of E grout/E masonry, the stresses in grout would so increase as to develop internal micro cracks. The cracks in grout subsequently increase the lateral strain and finally increase the pressure on the shells. This hypothesis is believed to explain the reason for the reduction in strength of grouted masonry with the strength of grout increasing to a level not compatible with the strength of masonry. Further theoretical and/or numerical reasoning is required to fully explain the behaviour of masonry with higher strength grout.

For the particular type of masonry used in testing, the optimum strength of grout is determined to be less than the characteristic compressive strength of block and greater than 85% of block strength, that is,

$$85\% \text{ characteristic compressive strength of block} < \text{optimum grout strength} < \text{characteristic compressive strength of block}$$

**Table 5:** Compressive strength of grouted prism and grout

Grout Grade	Mean Compressive Strength {MPa} of Grouted Prism	Characteristic Compressive Strength {MPa} of Grouted Prism	Mean Compressive Strength {MPa} of Grouted Cylinder	Characteristic Compressive Strength {MPa} of Grouted Cylinder
M10				
TYPE-I	14.30	12.07	16.63	16.10
M15				
TYPE-I	18.20	12.54	20.45	18.50
TYPE-II	17.70	12.54	30.00	27.20
M20				
TYPE-I	24.40	15.17	34.00	29.00
TYPE-II	22.29	15.17	39.00	37.65
M25				
TYPE-II	16.30	10.53	44.90	42.78
M30				
TYPE-I	19.00	12.60	47.00	42.00

Note: Characteristic strength of masonry prisms has been calculated as per Appendix B of AS3700.

### 5.3 Comparison with AS3700

Experimental values of grouted prism strength are compared with the calculated values of the grouted prism strength as per AS3700. Significant difference between the two values is observed. Calculated prism strength of grouted masonry is found to be only 52% to 60% of the measured prism strength of grouted masonry. This difference is due to the presence of the square root of the grout strength as a term in the formula for the estimation of grouted masonry strength given in AS3700. This causes underestimation of the strength of the grouted prism. Based on the experimental results the following formula is suggested to estimate the compressive strength of masonry.

$$f'_{mg} = f'm (\% \text{ masonry area}) + (f'c)^{0.72} \times (\% \text{ grout area})$$

where  $f'm$  = characteristic compressive strength of the masonry prism as per AS3700 Appendix B

$f'c$  = characteristic compressive strength of the optimum compatible grout

**Table 6:** Comparison of measured strength of grouted prism vs calculated strength

Grout Grade	Characteristic Strength of Grout {MPa}	Measured Strength of Grouted Prism {MPa}(B)	Calculated Strength of Grouted Prism {MPa}(A)	$\frac{B - A}{A} \times 100$ %
M10 TYPE-I	16.10	12.94	6.73	92.27
M15 TYPE-I	18.50	12.54	6.81	84.14
M15 TYPE-II	27.20	12.54	7.14	75.60
M20 TYPE-I	29.00	15.17	7.20	101.00
M20 TYPE-II	37.65	15.17	7.46	103.35
M25 TYPE-II	42.78	10.53	7.61	38.37
M30 TYPE-I	42.00	12.60	7.59	66.00

Note: Compressive strength of grouted masonry is calculated as per AS3700 Clause 6.3.1.

$$\text{Compressive strength} = f'm A_b + 1.2 \sqrt{\frac{f'c}{1.3}} \times A_g$$

where  $f'm$  = characteristic compressive strength of masonry as per Table 4.1 of AS3700 in N

$f'c$  = characteristic compressive strength of grout in MPa

$A_g$  = Area of grout in MM<sup>2</sup>

$A_b$  = Bedded area of masonry in MM<sup>2</sup>

Note: Characteristic compressive strength of grouted masonry as per Appendix B of AS3700

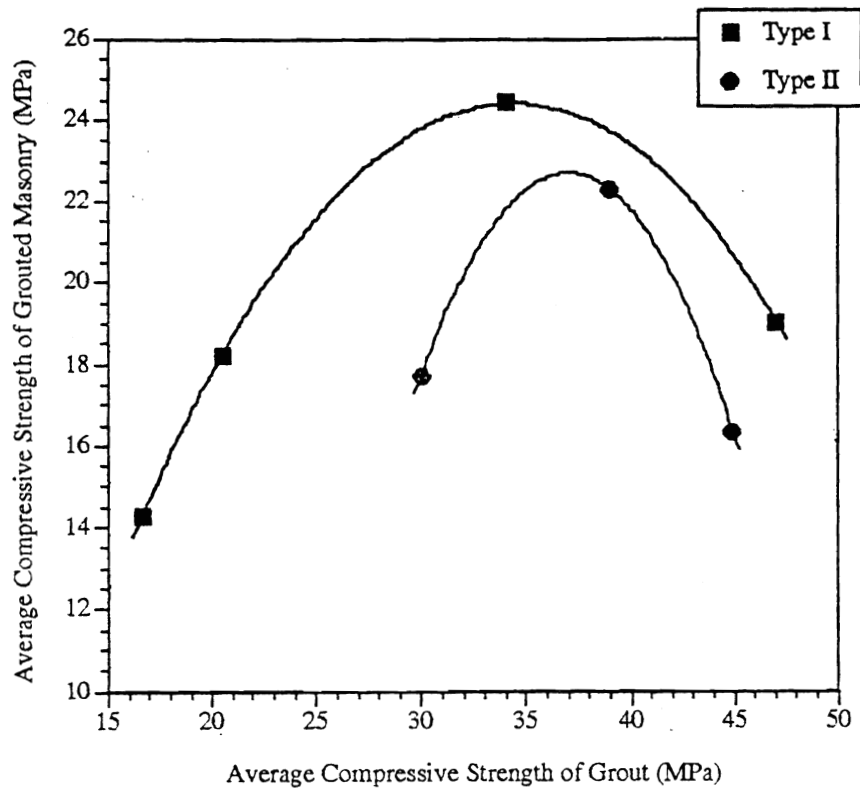


Figure 3

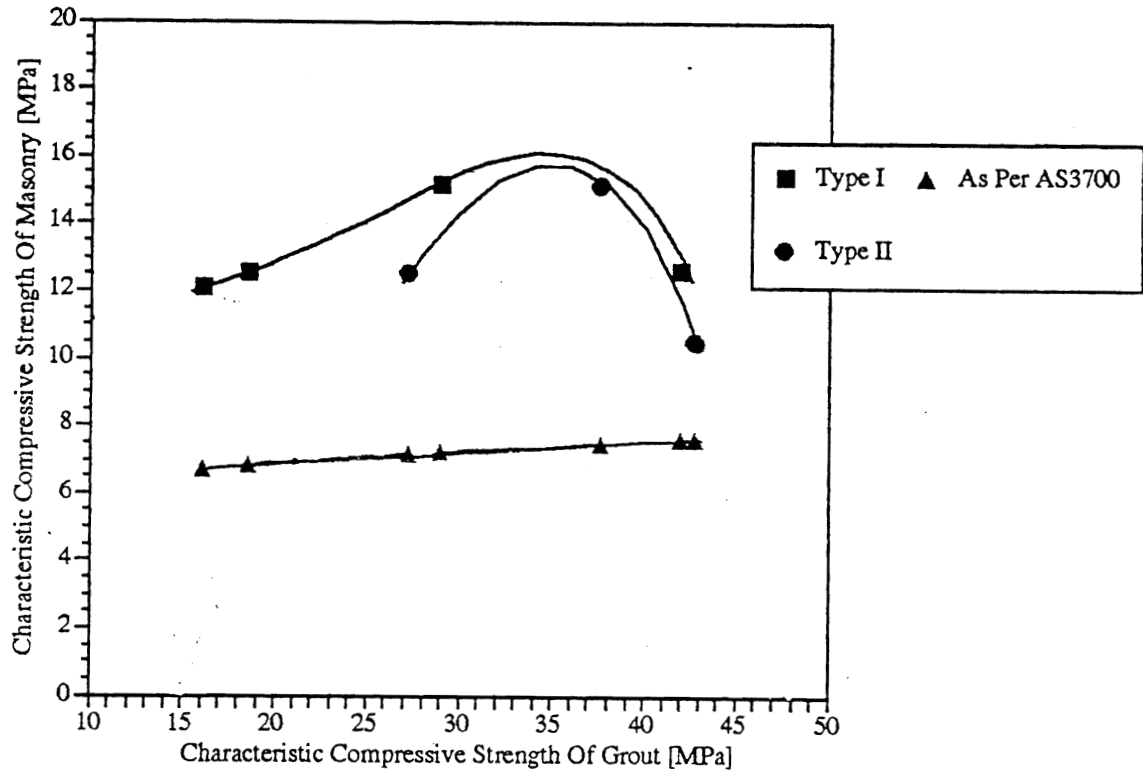


Figure 4

## 6.0 Conclusions

1. The prism strength of masonry, faceshell or full bedded, is significantly higher than the strength of masonry worked out on the basis of strength of units and strength of mortar using AS3700. It may therefore be suggested that designers may use the prism test for  $f'm$ . Alternatively it may be argued that the compressive strength values of Table 4.1 of AS3700 should be modified.
2. The strength of grouted masonry is significantly affected by the strength of the grout. Incompatible grout mix lowers the strength of the masonry below the hollow masonry strength level. Compatible grout mix slightly increases the strength of masonry above the hollow masonry strength level.
3. The strength of the grouted masonry predicted by the AS3700 formula is significantly lower than that observed in experiment.
4. The strength of grouted masonry could be estimated by given formula for compatible grout mix:  
$$f'm_g = f'm (\% \text{ masonry area}) + (f'c)^{0.72} \times (\% \text{ grouted area})$$
5. Grout strength should be compatible and slump should be as high as practicable to gain higher strength of masonry.
6. For the type of masonry tested it may be suggested that the compatible grout strength should be less than the characteristic compressive strength of the block and should be greater than 85% characteristic strength of the block.

## Acknowledgements

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# Mass culture of *Dero sp.* (Family Naididae) used in *Cherax quadricarinatus* feeding trials\*

Primitivo S. Aceret  
BSc, MSc



## Abstract

Two experiments were conducted in an indoor aqua-shed with transparent roofing materials which allowed sufficient sunlight to the experimental area. The first was the culture of an aquatic oligochaete worm, *Dero sp.*, in different substrates, followed by a preliminary evaluation of their potential as live food for red-claw crayfish, *Cherax quadricarinatus*.

*Dero sp.* showed good survival, growth and reproductive rates in cowdung substrate, a mixture of mud and cowdung, in pure mud and even in containers without substrates. The highest growth rate was observed when cultured in 100% cowdung substrate, followed by 50–50% cowdung and mud, then in 50–50% cowdung and millmud. *Dero sp.* reared on 100% millmud have a lesser growth rate than those cultured in 100% cowdung. *Dero sp.* cultured in containers without substrate are easier to harvest, as compared to those with substrate. The worms were harvested when they formed “balls” on the surface of the substrate.

Survival and growth rates of *Cherax quadricarinatus* fed on live *Dero sp.* were studied in a small-scale bioassay system. Juvenile crayfishes weighing 0.1–0.2g were cultured in plastic containers with 350ml of freshwater coming from a recirculating water system. *Cherax quadricarinatus* fed with live *Dero sp.* achieved the greatest weight increase followed by those fed on 50–50 *Dero sp.*/commercial feed combination. Survival rates of crayfishes in all treatments were 100%. Cultures using live *Dero sp.* showed better water quality and required less maintenance than those cultures fed with commercial feeds.

The small size, high growth and reproductive rates of *Dero sp.* make it ideal as a supplemental live feed for the juvenile stages of crayfishes. The ease by which *Dero sp.* can be cultured using different substrates and the large numbers produced could potentially support hatchery operations of fish and other crustaceans.

## Introduction

Commercial aquaculture production (including the ornamental fish industry) is dependent on fish meal as a major source of food. Shortage of inexpensive and readily available feed for fish is a constraint for the development of aquaculture systems suitable for small-scale production in various developing countries. This prompted researchers to look for alternative sources of cheap and easily available food for the ever-growing aquaculture industry.

Freshwater and marine fish/crustacean hatcheries aim to produce the healthiest possible fingerlings/young for the lowest possible cost. A major influence is the larval feeding process, which remains the most important, difficult, costly and high risk process of the hatchery operation. In addition, a number of factors must be considered which are pertinent in the feeding requirements of the fish/crustacean larvae to culture. Firstly, there is economy at the minimal level for feeding requirements and secondly, there is live food, which plays a vital role in supplying much needed nutrients especially in the early life stages of fish or crustaceans and can seriously affect larval viability. The use of live food, especially in an intensive condition,

\* Part of Ph.D. in Applied Science (Biology) research at the Department of Biology, Faculty of Science, University of Central Queensland, Rockhampton, Queensland 4702.

reduces hygiene problems, as the water quality is very much manageable. Aquaculturists consider that live food remains the most suitable for larval fish and crustaceans and until now, the intensive culture of these organisms is the most predictable method of supply.

Although microalgae (Wilkenfeld et al. 1984; Landau 1992), cladocerans (Landau 1992), rotifers (Mock et al. 1980; Emerson 1984; Samocha et al. 1989), and brine shrimp (Sorgeloos & Persoone 1975; Sorgeloos 1980; Wilkenfeld et al. 1981; Grabner et al. 1981; Chu & Shing 1986; Samocha et al. 1989; Bengtson et al. 1991) are the most common cultured live feeds for aquaculture hatcheries, others have been explored or studied.

Larvae of some invertebrates (Juday 1943) chironomids (Grigyalis 1980), free-living nematodes (Kahan & Appel 1975; Fontaine et al. 1982; Biendenbach et al. 1989) and the small aquatic oligochaetes, *Tubifex tubifex* (Brinkhurst and Kennedy 1965; Grigyalis 1980; Poddubnaya 1980; Kaster 1980; Bonomi & Dicola 1980; Marian & Pandian 1984), and *Branchiura sowerbyi* (Aston & Milner 1982; Aston 1984) have been also considered for this purpose.

Aquatic oligochaetes are extremely important as food for benthophages (Grigyalis 1980) and agitators in the rotation of materials in rivers, lakes, dams and reservoirs (Brinkhurst & Kennedy 1965; Timm 1980), and even serve as accelerators of the mineralization of organic matter (Chekanovskaya 1981; Timm 1980) as they feed on them constantly. However, the aspect of oligochaetes as food for fish (Ghabbour 1966; Yaroshenko et al. 1980; Edwards & Densem 1980) and crustaceans has not yet yielded its potential in the development of low-cost hatchery and commercial aquaculture systems. Only few quantitative data are available on the culture of *Dero sp.* (Hyman 1941) as well as its acceptability as a live food supplement for fish and crustaceans especially on the juvenile freshwater crayfish, *Cherax quadricarinatus*.

This paper reports on the mass culture of *Dero sp.* (Family Naididae, Oligochaeta). The first experiment deals with the culture of *Dero sp.* using different types of substrates and feeds, and determining the different environmental conditions affecting their growth and survival. The second experiment was designed for preliminary evaluation of *Dero sp.* as food for the juvenile stages of *Cherax quadricarinatus*.

## Materials and methods

### (a) Culture of *Dero sp.* (Family Naididae)

*Dero sp.* was collected from the lagoon at the Palmetum park, Townsville, Queensland, and cultured at the James Cook University, Department of Zoology aqua-shed. Plastic containers (17cm (length) × 12cm (width) × 4cm (height)) were used as culturing containers and submerged continuously in bigger containers (150cm (length) × 50cm (width) × 22 cm (height)) and continuously aerated by means of an air pump. Water in the containers was changed every week to avoid fouling and growth of algae, and to maintain the pH level of the water.

Five grams (wet weight) of *Dero sp.* were inoculated in each culturing containers with an estimated number of a thousand individuals per 5 grams of *Dero sp.*

### Types of substrate

These worms were maintained on eight types or combinations of substrates with four replicates each. The compositions were: (i) 100% cowdung, (ii) 50:50 mud/cowdung, (iii) 100% fine sand, (iv) 100% millmud, (v) 50:50 millmud/cowdung, and (vi) sandy muddy soil, which served as the control. Oxygen was maintained with a supplemental aerator.

### Estimation of culture growth

The initial weights of each batch of inoculum was noted and the final weight of the culture was determined at the end of the experiment after 60 days.

In order to separate the worms from the different substrates used, the Marian and Pandian (1984) technique was implemented. In this method, the substratum containing *Dero sp.* was placed in a 500ml beaker filled with water. Anoxia developed within 24 hours, the worms appeared on top of the substrate as "balls" and were scooped or picked up by means of a pipette.

## **(b) Evaluation of *Dero sp.* (Family Naididae) as a supplemental live food for the juvenile *Cherax quadricarinatus***

### **Crayfish maintenance and acclimatisation**

The *Cherax quadricarinatus* specimens used were collected from the crayfish stock at the James Cook University aqua-shed culture tanks. The juveniles were taken from one single parent for a uniform genetic line and reared in the same environmental conditions. The water was changed every week, coming from the recirculating system of the JCU Department of Zoology aqua-shed water system. The crayfishes were acclimatised for five days before the feeding trials. Prior to the morning feeding, the containers were cleaned by siphoning excess feed and fecal matter which accumulated on the bottom. The water temperature during the experimental period varied between 10°C and 20°C. The pH and hardness of the water were maintained at a level required in the moulting process of the experimental animals.

### **Experimental design and feeding**

The juvenile crayfish (postlarvae) were weighed individually and randomly allocated to experimental plastic containers. Each container had a dimension of 90cm (length) × 90cm (width) × 85cm (height) with 350ml of freshwater. Supplemental aeration was provided for each container and all the plastic containers were painted with black to minimise the growth of algae.

The juvenile crayfishes were reared on dietary treatments carried out in four replicates. Treatments were based on freshly live *Dero sp.* from the new culture mentioned above, commercially available crayfish pellets which served as a control, a one hundred percent *Dero sp.*, a fifty–fifty percent *Dero sp.* and pellets as distributed in the following manner: 0–100, 50–50, 100–0. The *Dero sp.* were fed daily as required to maintain a density of 20–30 individuals/ml during feeding. The dry diets (control) were ground as small as *Dero sp.* and added on an equal volume basis. The crayfish were observed every week to monitor the physical parameters required and weights were taken every fifteen days to monitor their growth rates. Feeding requirements of the experimental animals were then adjusted accordingly. The feeding experiment was terminated after 90 days. The crayfishes were fed every day with feeding time at 0900 hours. The rations were 1–3% of body weight per day.

### **Statistical analysis**

The experiment was a 4 × 4 factorial in a completely randomised design with four replicates per treatment. Significant differences ( $P < 0.05$ ) in weight gain, survival and feed efficiency were tested using ANOVA (analysis of variance) and Duncan's multiple range test (Steel & Torrie 1960).

## **Results**

### **(a) Culture of *Dero sp.* using different substrates**

The highest growth rate was obtained in 100% cowdung. This may be due to the composition of the substrate. Cowdung can also serve as their food because *Dero sp.* by nature is a detritivore. The next highest growth of the worms was observed in 50%:50% cowdung/mud combination, and third was in 50%:50% cowdung/millmud. *Dero sp.* reared on 100% millmud substrate had lesser growth rates than those cultured in pure cowdung (Fig. 1).

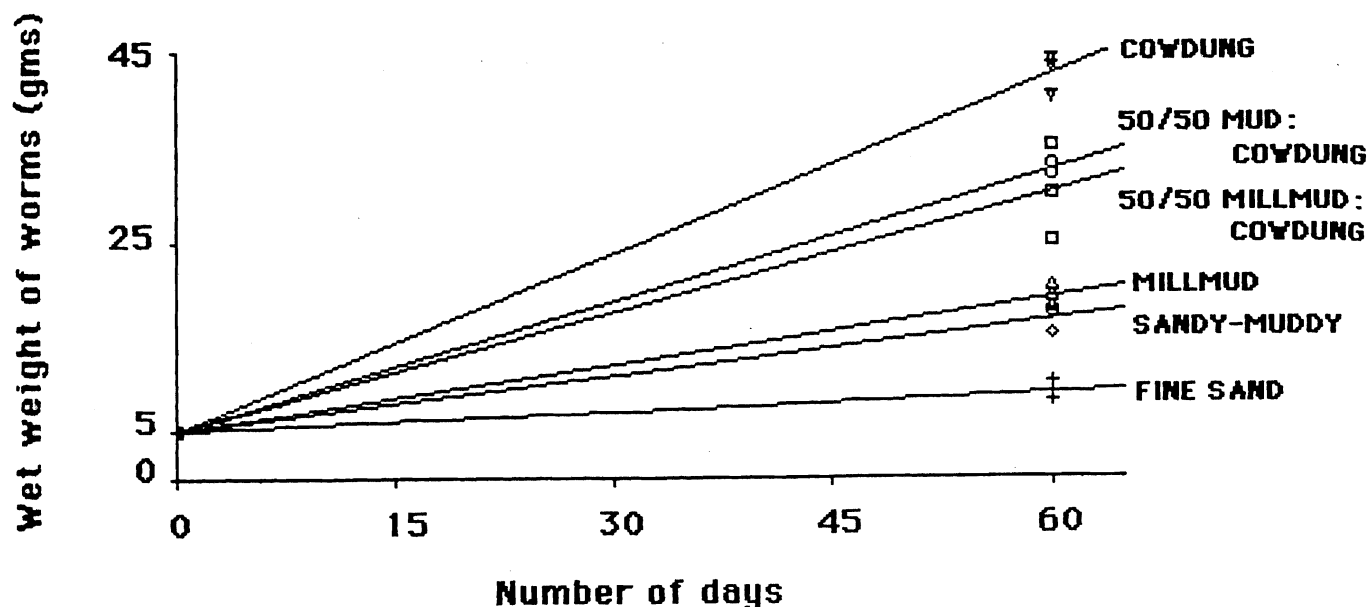


Figure 1: Growth rates of *Dero sp.* cultured in different substrates

### (b) Use of *Dero sp.* as live food in crayfish culture

The growth rate of any organism may be affected by diet quality in terms of size and type of feed particles to be eaten. In the case of the crayfish, *Cherax quadricarinatus*, a simple feeding trial of larval stages is considered critical to their growth and survival. In this experiment, live *Dero sp.* was used in combination with commercial feed pellets.

Figure 2 shows the growth rate of *Cherax quadricarinatus* fed on different diets containing various levels of *Dero sp.* and commercial feeds. Crayfishes fed with 100% live *Dero sp.* achieved the highest weight increase followed by 50%:50% *Dero sp.* and commercial pellet combination. It was observed however that algae grew abundantly in all the culture containers. Since the crayfishes ate algae as well, the growth rates could not be ascertained as due only to the type of food used in the culture. Survival rates in all the treatments were 100% present. This may be due to the small number of crayfishes used, which is 1 per container.

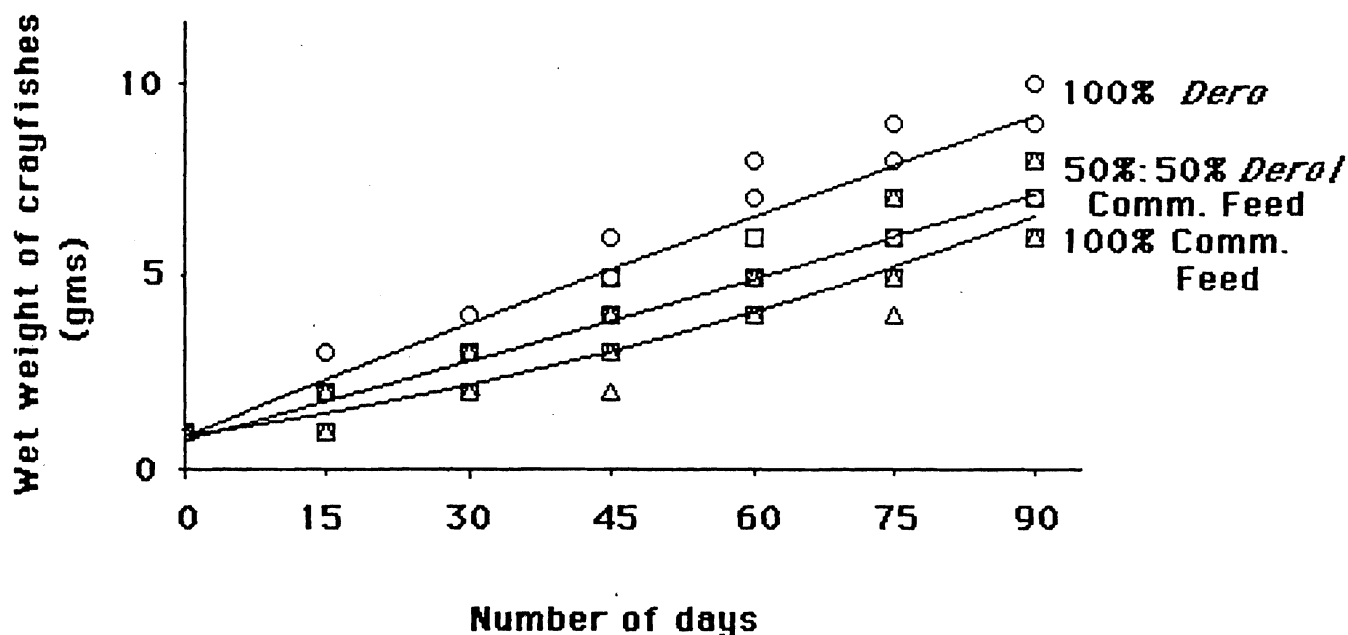


Figure 2: Growth rates of *Cherax quadricarinatus* fed with different diets containing various levels of *Dero* and commercial feeds

## Conclusion

*Dero sp.* has a good potential as a live food for crayfish culture. It is easy to mass produce and it can be cultured on different kinds of substrate, which are always available and inexpensive.

## Acknowledgements

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# Dresden, Hermannsburg and Neuendittelsau Lutheran Societies: Their missionaries' impact on colonial Aboriginal Australia

Roberta J. Bolton

BA, GradDipAboriginalStudies

## Lutheran societies: Their impact on colonial Aboriginal Australia

Edwards (1978) states that 'contact with Aboriginal groups was initiated largely by Church missions. This was generally approved, as in the Australian society there was sympathy with the missionary endeavour of the Church, and a recognition that the Church was the appropriate body to provide some comfort and support for a people with whom the majority of the population had little direct contact, and who were probably doomed to extinction as a race'. Perhaps this effort by the churches served as a salve for the Australian conscience (195). However, much blame is placed firmly on missionary efforts of the past for the disintegration of traditional lifestyle and the problems experienced by Aborigines today. In short, the Australian Missions and their administrators have become the scapegoats for Aboriginal societal dispersion, land dispossession and loss of traditional spirituality. But, is this a fair and just assumption?

With the British invaders came Darwinian theory and the Enlightenment ideologies, both of which allowed for acts of genocide, massacre, dispossession and death from alien diseases. If these conditions didn't successfully cause total destruction of traditional Aboriginal society, governments of that era certainly encouraged participation by the various missionaries in an attempt to continue the destruction.

Early missionaries appeared to have a common bond of concern and contempt of Aborigines and their traditional way of life. They objected to the indigenous child rearing methods, the marriage system, their nakedness, as well as their sacred initiation ceremonies, naming but a few areas of dissension. "Again and again in missionary literature we find writers denigrating the moral, spiritual and physical worth of Aborigines. Language such as 'lewd' or 'offensive' is used to dismiss Corroborees; Aboriginal ritual is characterised as 'sorcery' or 'demonic magic' and the spirit-ancestors as 'debil-debils'; Aboriginal customary law is attacked as 'outrageous', 'barbaric' or 'cruel'. Whilst a number of missionaries attempted to defend Aboriginal charges against the polygenists, their arguments, based on monogenesis theory, were often at best gauche (Scanlon 1986, 85).

There was some consensus among missionaries that Australian Aborigines were to be included in the inheritance of the curse of Canaan as applied to the descendants of Ham. "By extension, the curse was given universal application, not only to the black peoples of Africa, but to all black races of the southern hemisphere" (Harris 1990, 30).

All missionaries thought Aboriginal life was suffused with satanism, believing the power of Satan confronted them when beliefs, actions and behaviour patterns weren't in accord with Christianity. Because of these ideologies the Lutherans, together with all missionaries, must accept a high proportion of the blame for being one of the basic instruments in the destruction of traditional Aboriginal religious spirituality.

All missionaries believed that civilising Aborigines was only possible through Christianity. That meant Aboriginal conformity with European social and cultural practices, including Western morality, while never envisaging that Aborigines were capable of achieving such "heights". "Lutheranism is an evangelic faith, one which maintains that the essence of the Gospel consists of the doctrine of salvation by faith in the atoning death of Christ; it also lays more stress on faith than on sacramental grace and upholds the verbal inspiration of the Bible ... the individual is freer to follow the inclinations of his

personal, environmental and spiritual needs. There is also great emphasis on communal responsibility ..." (Voindra 1981, 160–161). With Aboriginal peoples this ideology seems to have lost its way, for the Lutherans didn't allow Aborigines of Hermannsburg or Hopevale to follow their own inclinations; they expected that Lutheranism would be the inclination that appealed to all their mission dwellers.

In pre-colonial times Aborigines were deeply religious peoples rich in spiritual meanings; theirs was a natural spiritual oneness with nature. Put simply, as an example, a tree was seen by some as brother. Aboriginal spirituality depended on society beliefs, attitudes and values, beliefs that were based on religious philosophy, obedience and reverence based on their culture. In 1931 anthropologist S.D. Porteus summed up Aboriginal spirituality, when discussing the sacred churinga of the Arunta people, in the following words; "to the casual observance they were nothing but a collection of rudely scored sticks and hardly worthy of all this secrecy and care, yet they represented the sole symbols of the ancient spiritual life of these Aborigines. Centred round this rude bundle was all that they possessed of myth and legend, all their social inheritance. What the household gods were to other people, what altars and ikons and fanes, shrines and crosses are to the religious of other races, these carved sticks are to the Aborigines. They are the concrete symbols of belief" (37–38).

Hendriks and Hefferan (1993) state "Aboriginal Spirituality is the heart of a supernatural belief .... It is the Dreaming (32); ... The identity that is the spirituality of Aborigines, a spirituality that relies on identity to channel self-worth to being 'whole'" (33). The advent of the missionaries destroyed this self-worth, mainly through their ignorance of the Aboriginal holistic lifestyle.

It is the intention of this paper to demonstrate that the Dresden, Hermannsburg and Neuendittelsau Lutheran missionaries through their administration of the missions at Hermannsburg in Central Australia and Hopevale in Northern Queensland were more than destroyers of culture, and the soothers of pillows for a "dying race", but, that they were also instrumental in the salvation of these of peoples. "... the Hermannsburg Lutherans were a bulwark against the genocide of Aborigines widely practised by 19th century central Australian pastoralists. Aranda tribal elder the late Helmut Pareroultja states: "during Queen Victoria's time when the red-coats been shooting down our people like they been kangaroos—even the women and children—the Lutheran pastors at Hermannsburg they offer the Aranda shelter, sanctuary. We might been wiped out as a people except for them" (Raffle 1991, 92).

While it was the pastoralists who greatly dispersed and massacred the Aranda of the Hermannsburg surrounding district, it was a different story for the Hopevale area. There were farming and pastoral settlers who followed the goldrush to the Hopevale/Cooktown region but it was the fishing industry that interfered with the Aboriginal lifestyle (Haviland 1980, 121). Treatment of Aborigines within the fishing industry and their exposure to opium, as reported in the Meston report, resulted in the 1897 Protection Act. Meston's chief concerns for Aboriginal labourers in the beche-der-mer and pearling industry were echoed by Mr Muni, Pastor Georg Heinrich Schwarz, who "made formal application to have in the Reserve the parishes of Tayeto and Cape Flattery, not for the sake of the useless country but for the fishing rights along the foreshore", ... while doing so an application "for fishing rights along the foreshore up to Murdoch Point" was also applied for ... "He wanted to make it impossible for the crews of Japanese boats, to interfere in any way with Aboriginal people" (Pohlner 1986, 103–104). His application was successful in so far as having the parishes included, but the fishing rights application must wait. Muni didn't begrudge the Japanese the right to fish, but he was determined to stop and prevent exploitation of Aborigines in the area. It was with this determination that he reapplied for the fishing rights only to have his application denied again (Pohlner 1986, 104–105).

Fishing was a subsistence requirement, especially in drought or poor seasons for the Guugu Yimidhirr people of Hopevale, who had turned to farming at the urging of the missionaries once they were settled on the mission. Similarly Hermannsburg Aranda people did not now have the total benefits of seasonal hunting and gathering; encouraged as they were to remain in a settled environment, they were mostly reliant on what the garden plots of the missions yielded (Pohlner 1986, 105). Mission holdings were substantial; the South Australian Government had allocated 900 square miles to the Lutheran Missionaries for the Aranda people (Scherer 1963, 8). "In 1886 the Griffith Government of Queensland began a policy of supporting Christian missions, which subsequent governments continued" (Loos 1991, 73). By accepting the Colonial Government's assistance, the mission societies entered into a partnership through their various missionary bodies, and thus became important arms of government policy. "The advantage of this system was with the governments which obtained an Aboriginal social service and control agency on the cheap" (Loos 1991, 73). Control for the missionaries depended on how receptive Aboriginal people were to the handing out of government supplied rations which supplemented subsistence from the mission gardens and stock. The other side of the control coin was the spreading of Christianity, which was achieved through education. Missionaries from both settlements maintained the correctness of their original policy, insisting that Aborigines would benefit far more from learning and reading the truth of the Christian religion in their own language, than by pressing upon them an alien language. Lutheran missionaries recorded and translated sections of the Bible, prayers and hymns from German to the natural dialect of the Aranda and Guugu Yimidhirr peoples. The Lutheran aim in educational work was to make their proteges independent of charity, relying for the sustenance of themselves on their own exertions

(Austin 1986, 13). Clearly the purpose of schooling was mainly for discipline and control purposes. Discipline and control were achieved but the independence from charity was not. The results of early charity practices are seen today; Aboriginal peoples are heavily reliant on social welfare, and this is a legacy of the colonial partnership between the governments and the mission societies. However, because of the Lutheran insistence on learning the language, both settlements today have maintained and use their own dialects, which is taught as the first language in their schools, with Australian English as a second language.

While this paper has dealt briefly with the tip of the issue it has outlined both negative and positive areas of Lutheran missionary involvement within the sphere of Aboriginal traditional destruction and salvation. It is only fitting that the last word should come from the late Aboriginal writer Kevin Gilbert who stated:

The church missions certainly stopped a lot of the slaughter of the Aboriginal people. Equally, through ignorance of the spiritual values of the Aboriginal society and in forcing their own values, they have also killed in another way. They have killed the values, the wholesomeness and the growth potential of the people too ... [A] lot of well-intended people have tried to advance the Aboriginal cause. They have tried to protect the Aborigine, and they have done for the Aboriginal.

(Gilbert 1975 cited in Scanlon 1986, 102)

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# Genetic algorithm for optimisation of fuzzy control systems

**M. Mohammadian**

BSc(Flinders), EngDipElect(Tu)

## Abstract

This paper presents an automated system to tune the membership function of Fuzzy Logic Controllers (FLC). We suggest Genetic Algorithms (GAs) as a new method to tune the membership function of FLC system. The concept is general and can be applied to many different applications.

## 1. Introduction

Fuzzy Logic (FL) provides a mathematical framework for dealing with uncertain, ambiguous and approximate information in a control system. As an alternative to binary logic, FL has proved to be better suited to solving complex, real-world problems (Pedrycz [5]).

In fuzzy set theory, abstract or subjective concepts can be represented with linguistic variables such as Big, Medium or Small. These linguistic variables then are used in the rule sets to control physical systems. FLC are rule-based systems that use fuzzy linguistic variables to model human rule-of-thumb approaches to problem solving. They have been successful for many problems (Evans et al. [6]). FLC feature rules that direct the decision process, and membership functions that convert linguistic variables into precise numeric values. The rule set is usually obtained from the human or sensors.

Defining fuzzy membership functions is usually very time consuming for FLC design. This chore is often accomplished by trial and error. One single change in the membership functions can significantly alter the system's performance and behaviour.

Mamdani and Procky [1] introduced an iterative procedure for altering membership functions. But in general, the development of methods for choosing functions that optimise FLC system's performance has received little attention. A standard method for determining the membership functions that produce optimal FLCs performance is needed. However, this goal poses a substantial search problem because a high degree of non-linearity can appear in the search.

GAs are a search technique drawing increasing attention in the field of optimisation. The simple mechanism and robust nature of GAs make them inviting tools for establishing membership functions of FLCs.

A simple GA uses three basic operations, namely: reproduction, cross-over and mutation on a population of bit-strings. A set of fuzzy membership functions of a FLC can be represented as such a string. Starting with a large population of random fuzzy membership functions, successive generations will produce optimal fuzzy membership functions. Such an evolutionary strategy has been suggested here to optimise fuzzy membership functions of FLCs.

Section 2 briefly discusses the properties of GAs for tuning of membership functions of FLC systems. Section 3 describes the implementation of GAs for tuning the membership functions of FLC systems. Conclusions are drawn in Section 4.

## 2. GAs for optimisation and tuning of membership functions of FLC systems

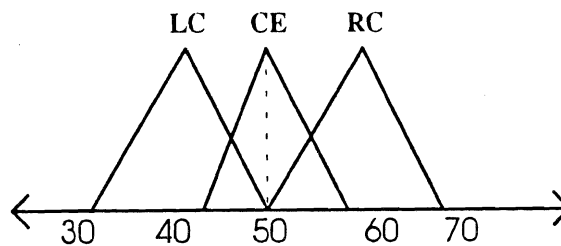
GAs have some properties that make them inviting as a technique for selecting high performance membership functions for FLC systems. Due to these properties, GAs differ fundamentally from conventional search techniques. These properties can be summarised as:

1. GAs consider a population of points, not a single point.
2. GAs work directly with strings of characters representing the parameter set, not the parameters themselves.
3. GAs use probabilistic rules to guide their search not deterministic rules.

Next we will discuss the implementation of GAs for selection of optimal membership functions for FLC.

## 3. Implementation of GAs for tuning membership functions of FLC systems

The design and development of robust and optimal FLC systems can be achieved by establishing a fuzzy rule set and using GAs to find an optimal membership function. These membership functions can be represented either by triangular or trapezoidal shaped membership functions. In this study triangular fuzzy membership functions are used. However, the method does not constrain the use of trapezoidal shaped membership functions. These triangles can have variable based width and shift along the x-axis freely. Therefore, each triangle requires the definition of only one point to fix it. Figure 1 shows a set of triangular shaped fuzzy membership functions.



**Figure 1:** A set of triangular shaped fuzzy membership functions

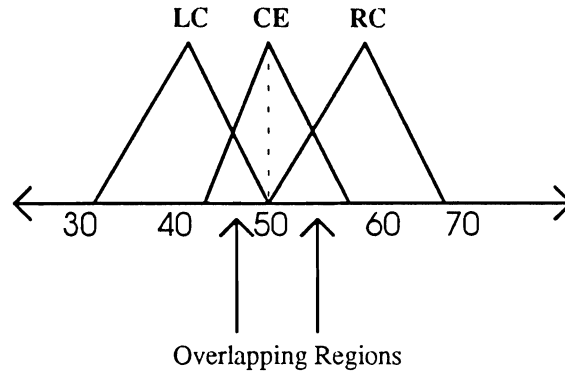
There are two ways to achieve optimal membership functions:

1. to choose the entire membership functions as variables to be optimised
2. to choose only the overlaps between membership functions as variables to be optimised.

In the first case the entire set of fuzzy membership functions for an FLC system must be represented as bit strings (of 0 and 1). This can become very complicated, as the coding and decoding of all membership functions are very difficult and complicated. To do this the best choice is to use a method called concatenated mapped, unsigned binary coding [2].

In the second case the overlaps between different fuzzy membership functions are considered as the parameters to be optimised. Unlike the first case, all the fuzzy membership functions are not needed to be coded into bit strings. This makes utilisation of GAs for fuzzy membership optimisation much easier and efficient. Figure 2 shows the overlap between the fuzzy membership functions of a FLC system.

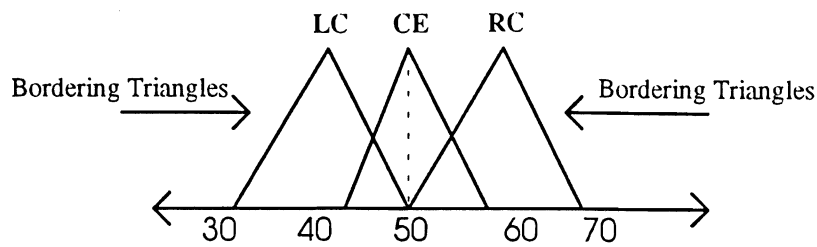
The only constraint placed on the individual triangles of membership functions is that the triangles bordering the extreme limits of the action or control must not be changed. This is because, for almost all applications of FLC systems, the membership functions have two extreme limits (i.e. upper bound and lower bound of the fuzzy membership functions).



**Figure 2:** Overlapping regions of fuzzy membership functions of a FLC system

Therefore, the modification of the bordering triangle of the membership functions cannot exceed these two values. Figure 3 shows a set of membership functions of an FLC system and indicates the bordering triangle of the membership functions.

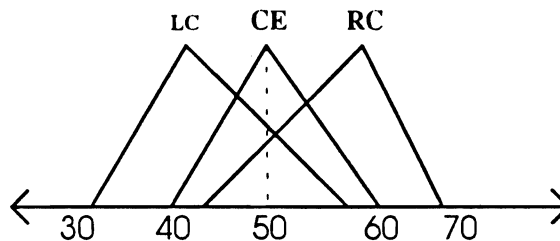
As it is shown in Figure 3, the two bordering triangles **LC** and **RC** have the upper and lower bounds of (30, 50) and (50, 70) respectively. Now let us assume that the membership functions in Figure 3, are the membership functions of an output variable of an FLC. Then the values of the output variables of these FLCs can only be between 30 and 70.



**Figure 3:** A set of membership functions of a FLC system with bordering triangle of the membership functions

Other than the bordering triangles, the triangles not bordering the extreme limits of the control variables can change their variable base and shift along the x-axis. Therefore, for the bordering triangles, only one point or base of the triangle can shift along the x-axis, whereas other triangles not bordering the extreme limits can shift any or both their bases along the x-axis. Figure 4 shows the membership functions in Figure 3 with different overlaps between the fuzzy membership functions.

We call the extreme bordering triangles *corner triangles* and the triangles between the two extreme bordering triangles *inner triangles* [3, 4]. Each corner triangle needs the definition of only one point to determine it, while each inner triangle needs the definition of two points to determine it.



**Figure 4:** The overlap between the two fuzzy membership functions changed

For optimisation of membership functions of a FLC we need only to code the overlaps between fuzzy membership functions of a FLC into bit strings. The bit strings representing the overlapping parameters then must be judged and assigned a fitness value, which is a score representing the degree to which they accomplished the goal of defining high performance of FLC system. The squared-error term can be evaluated to determine the fitness of the strings in a population. This error could be the distance between the set point and the state of the system. However, the development of fitness function that entices the GAs to locate high performance and efficient membership functions is application dependent.

## 4. Conclusions

In this paper GAs are used as an optimisation method for tuning the membership functions of FLC systems.

From the process of tuning the overlap parameter for the fuzzy membership functions, one can see that GAs consider many points from the search space simultaneously and, therefore, have a reduced chance of converging to local optima. The process of GAs is similar to a natural population of biological creatures in which successive generations of organisms are produced and raised until they themselves are ready to reproduce. GAs generate entire *populations* of points in coded strings and test each string independently. They combine qualities from existing strings to form new *populations* containing improved string. GAs use random choice to guide the search. Although chance is used to define decision rules, GAs are not random walks through the search space and they use random choice efficiently and effectively to locate optimal *solutions* very quickly.

Many search and optimisation methods require derivative information or complete knowledge of the problem structure and parameters. GAs are an inviting method as GAs may avoid convergence to local optimum and need only information about the quality of the solution by each parameter set.

This paper has discussed GAs for optimisation of single overlap of fuzzy membership functions for FLC systems. It is intended to use GAs to tune more than one overlap parameter to optimise the performance index of FLC systems. Furthermore, it is expected to extend the mechanism developed in this paper to tackle more complicated problems, such as fuzzy control of nonlinear systems.

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# The features and drawbacks of Internet

**Allan F. Ursinus**  
BAppSc(COMP), GradDipMgt



## Abstract

With the ever-increasing needs of academics to gather information and resources from further afield comes the ever-increasing need for faster methods of data exchange. In order to achieve this result, many academics are starting to use the international EDI and EMAIL facilities available on Internet. These facilities, however, do cause problems for systems administration staff of both Internet and Local Area Networks. This paper will discuss the features and problems associated with INTERNET and the possible future direction of Internet.

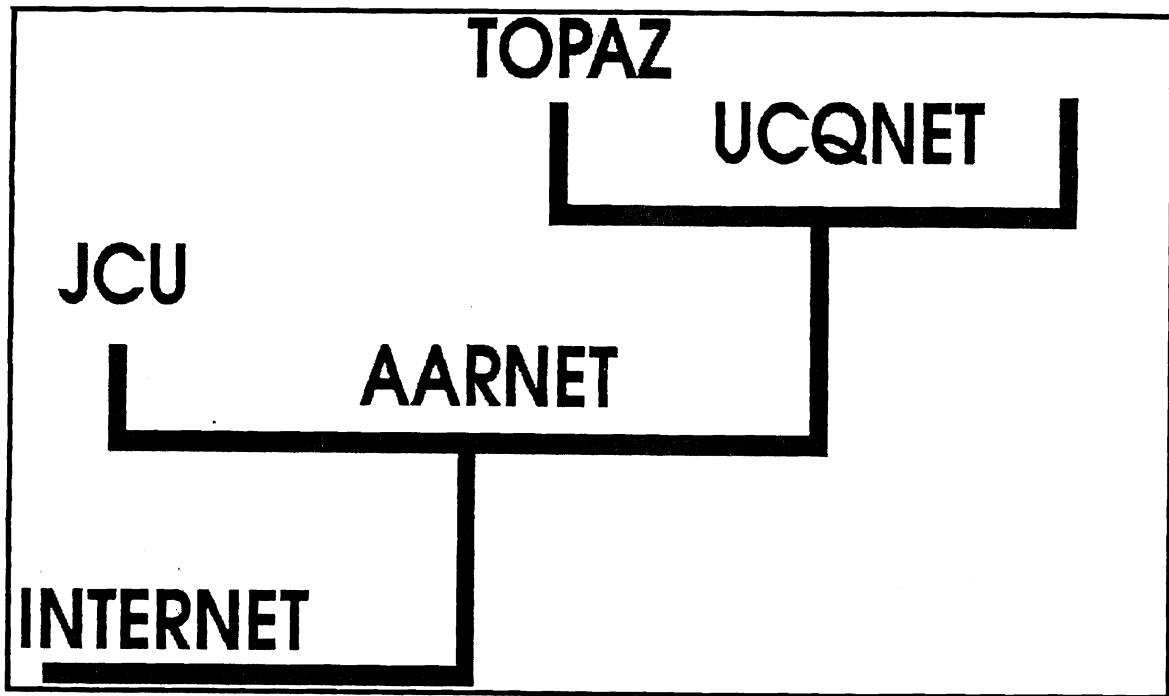
## Introduction

It is important that, in order to use Internet, the users have some understanding of what Internet is.

Gary Ray defines Internet as: "the Internet is a Global Network of thousands of host computers and probably a million or more users" (Ray 1993, p. 60).

Many people have misconceptions about Internet. John Quarterman (1993, p. 83) identified several misconceptions. The most obvious and widespread misconceptions are that Internet is Government owned and it is United States based. Both of these statements are false as Internet is really a privately owned conglomerate of different sources, including the military, NASA and universities, and is an international facility available in every major country, including Russia, India and Germany.

Internet works by having a series of layers, each layer covering a broader region. For example UCQNET is the University Of Central Queensland's Network; this then connects to AARNET, The Australian Academic Research Net; which then connects to Internet. This is depicted in Figure 1 over the page.



**Figure 1:** A diagram showing the nature of Internet connections

The management of the Network is based on the Administration of each site taking care of Administration of the Network in their local area. While there is a wider administration, not much is written about how this operates.

## **Features of Internet that are available on the University Network**

Internet has a lot of facilities for those within the system to use. These facilities have a great deal of potential, but are currently being abused by users. These facilities include Email; news; FTP; Telnet; Talk; IRC and Finger.

### **Email**

Email is a facility for sending messages from one system to another. Using Email, a user can send mail to a computer system overseas and if the receiver of the mail is logged on, then the sender may receive a reply in under five minutes. Email is one of the most widely used and abused facilities on Internet. This abuse is due to the fact that a lot of people get on the system and send Email to a person who is five feet away. It is treated by many as a toy. Security of Email is affected by it all being stored in a spool area on the computer; therefore, the System Administrator of the given computer, and sometimes other people, can read your mail.

### **News**

News is a facility for conducting long distance public discussions on a wide range of topics. A person can post and read a news group on particular topics. The user interface of news is a menu of different topics listed in alphabetic order. Below this user interface is a listing of postings in order of when they were posted. For an example of the user interface of news, refer to Figure 2 over the page.

## News

- 1 AUS.JOKES
- 2 COMPSYS.OS.LINUX
- 3 SOC.CULTURE.INDIA
- 4 SOC.CULTURE.RUSSIA

**Figure 2:** User interface for news

There are thousands of topics that have news groups associated with them, including cultural discussions on Russia and India. As a result of these cultural groups, it has been known to happen that, when a country has a media blackout, they fail to stop this outlet. As a result of this much information can be accessed through this mechanism during time of internal conflict in a country.

## FTP

FTP stands for File Transfer Protocol. It is a facility for transferring files from one computer on Internet to another. This facility is, in my view, potentially the most useful facility offered by Internet. At this stage, FTP is used mainly for transferring computer programs from one system to another. There is, however, no reason why it can't be used to transfer other types of documents, like the possible disseminating of research documents. As such, if people from other disciplines, apart from computing, start using the facility, it could become a very powerful tool for information gathering and research. This is especially true when you look at some of the data NASA makes available on its public sites.

## Telnet

Telnet is a facility for remotely logging onto another computer system. This facility is very widely used for accessing library catalogues and interrogating Archie Servers, which are discussed later. Figure 3 shows how to use Telnet in order to log in to TOPAZ from any other computer on Internet. Once you have executed the Telnet command, the active session, on the remote machine, behaves as if you were actually logged into the terminal directly.

**To Telnet to some location Type whatever appears bolded below**

**\$ TELNET TOPAZ.UCQ.EDU.AU**

**USERNAME: BLOGGSB**

**PASSWORD: some password that will not appear**

**Figure 3:** Using TELNET to Telnet to Topaz at the University of Central Queensland and log in as BLOGGSB

## Talk

Talk is a facility for setting up an interactive conversation between two users. It consists of a split screen where the message typed by one user is viewed on the top screen and the other user's message appears on the bottom screen as shown in Figure 4. The users who wish to instigate such a session must both be on the system at the same time. To use Talk you type TALK USERNAME, that is, TALK BLOGGSB@TOPAZ.UCQ.EDU.AU. You can run talk across universities and countries.

[CONNECTION ESTABLISHED]

Giday Mate, How are you going

---

Fine, how is the weather in L.A.

**Figure 4:** A demonstration of a Talk Screen. The top half is the local person and the bottom half is the person on the other end

## Finger

Finger is a facility for seeing who is on at remote sites, that is, if you are on Topaz and wish to see the user BLOGGSB on JASPER then you can type FINGER BLOGGSB@JASPER.UCQ.EDU.AU. This is a useful facility; however, Finger reveals more information than it possibly should. This is discussed more further on.

There has to be some degree of control placed on these facilities, as they do use quite a lot of resources on the host computer. These resources include CPU Time, the time that the CPU is active doing a task for the user, disk space and communications channels.

## Who has access to the University facilities

In order to conserve the limited resources of the UCQ's Internet machines, some degree of control needs to be established in order to limit user access on a need to use basis. In order to achieve this end, groups have been established where each group has different privileges on facilities. There are basically two levels of groups: Undergraduates, and Postgraduate/Projects and Staff.

The following Table shows what can be done by whom for each facility.

**Table 1:** Access to facilities

	EMAIL		NEWS		FTP	TELENET	TALK	FINGER
	LOC	GLOB	LOC	GLOB				
UND	X		X					
STAFF	X	X	X	X	X	X	X	X

UND – Undergraduate  
STAFF – Staff/Postgraduate/Project Students

As such, it is restricted as to who can contact the outside from the University of Central Queensland. The only people permitted to use Email to post to global international news groups are those who are either working on a particular project or postgraduate students and staff.

## Accessing remote computer facilities

An important feature of Internet is its ability to provide a facility for finding information. In order to achieve this, several special facilities have been established. The two most widely used facilities are Archie and Gopher Servers.

An Archie Server is a server that is interrogated for a particular string, that is, LOTUS, and then it returns a list of sites where information/software can be found. To get access to the Australian Archie Server type in \$TELNET ARCHIE.AU and log in as ARCHIE, no password is required. Then type in PROG LOTUS. To see the sample output refer to Figure 5 below.

**To link to the Australian ARCHIE SERVER, TYPE WHATEVER BELOW IS BOLDED**

**\$ TELNET ARCHIE.AU**  
USERNAME: ARCHIE

You are now in an Archie Server so type  
**PROG LOTUS**

Host aeneas.mit.edu (18.71.0.38)  
Last updated 01:24 19 Jul 1993  
Location: /pub/lpf FILE -rw-r--r-- 37392 bytes 01:00 10 Feb 1992 lotus-brief.government

**Figure 5:** Finding information on ARCHIE.AU

A Gopher Server fills a similar role as an Archie Server with the difference that it is menu driven and, therefore, more user friendly than an Archie Server.

As more and more information is disseminated by the Internet system, better facilities for information finding will be developed.

## Security issues that need to be addressed

With any computer system, care must be taken when one considers both security and the legal implications of a system. This care is even more necessary when the system crosses national and international borders. The issues include viruses, hacking/cracking and any government legislation pertaining specifically to copyright, privacy and freedom of information.

One of the largest problems at this stage in the software industry is viruses. A virus is a program written for the sole purpose of damaging a system, or parts of it. Whenever you are copying programs from Internet, it is important that you are aware of the risks of viruses.

Hacking is the process of trying to beat/circumvent the existing security mechanisms, in order to gain information/privileges which a user is not entitled to. Many computing people do this as a form of entertainment. Cracking refers to hacking with the intent to make criminal gains. Internet is renowned for the potential it gives to hackers/crackers and this has led to some organisations hesitating when thinking about joining Internet.

As Internet is an international system, legal questions are raised. If a hacker hacks a system in New York, but lives in Rockhampton, whose laws are being broken and, therefore, who prosecutes the criminal? This sort of scenario is just one legal predicate that has Internet administration worried. Who is responsible—the Internet administration or the user—for breaking copyright and privacy laws, which are fairly standard in all countries now?

Much has to be discovered as to the legal and civil liability of disseminating information using such systems as international media.

## Future directions of Internet

With the introduction of more advanced recording and transmission technologies, we will see the introduction of different methods of data storage, retrieval and manipulation. There is some work being done in using multimedia technologies to enhance some Internet facilities. There is also a problem that must be faced with regard to the Internet address space becoming full.

In order to make Internet more useful, work is being done in introducing multimedia technology. Some possible future trends for Internet could be Telemail, Teleconferencing and Telenews. These are facilities for Email, News and Conferencing on Internet, where picture and sound can be transmitted as well as text. Another possibility is storing and transmitting graphics from references.

A major problem with Internet, currently, is that it is running out of address space. This fact must be addressed if Internet is to continue to grow at its current rate of doubling every six months. This is due to the fact that although it is quite broad, the addressing protocol is still limited and running out of space.

## Conclusions

This paper has described just some of the future directions/issues that should be looked at in order to improve the quality of service provided by Internet.

As more people become aware of the capabilities of Internet they will be used more widely.

This is shown by the increasing usage of Internet: "usage of Internet is doubling every 6 months" (Anthes 1992, p. 55).

The facilities have so much potential that one day maybe all the universities in the world will have the capacity where any student can see what books are available on a far off campus and request to borrow them, with less involvement from library staff. As far as a facility like this is concerned, the limits are humankind's own ingenuity.

Facilities like these bring us all closer as a global community for research and development.

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# Spiders communities in mango orchards in Central Queensland

**Donna Rayner**  
BAppSc(Biol)

## Abstract

Spiders are ubiquitous predators which predate predominantly on insects. These spiders occur naturally in the environment and unlike introduced biological controllers offer fewer negative effects. These characteristics suggest that they may act as natural controllers of insect pests in many crops and orchards.

This preliminary study investigated spider abundance and diversity in Central Queensland mango orchards to establish the assemblages of species and the possible effects of pesticides on the spider community. Two sprayed and two unsprayed orchards were chosen to assess if there was an effect from pesticide use on the spider community. The diversity of spiders was particularly high, with a total of 84 species collected from the four mango orchards. The community as a whole was found to be a very dynamic system which changed to meet the demands of the environment. These preliminary studies indicate that the abundance and diversity of spiders may be affected by the use of pesticides. Only further studies will determine the degree of this impact.

## Introduction

There are many problems associated with the use of pesticides in agriculture. The broad-spectrum insecticides usually destroy the beneficial arthropods as well as the pest species. Many pesticides are slow to break down in the environment and residues accumulate in soils and leach into waterways causing many ecological disturbances. Many of these pesticides magnify in concentration as they move up the food chain. Insect resistance to regularly used insecticides is a common problem in agriculture. The more frequent use of these chemicals results in higher resistance of the target pest species.

One crop which has received little attention are mango orchards. High levels of pesticides are used for the control of the fungal disease Anthracnose and for insect pests such as Tip Borer Moth, Fruit Spotting Bug and scale insects (Cunningham 1989). The insecticides used have a broad-spectrum killing range which removes all the pest and beneficial species.

The alternative to this management strategy is the use of natural predators, parasites and other beneficial species. Integrated Pest Management (IPM) programs emphasise the use of beneficial species with minimal use of pesticides. Much success has been achieved using IPM in citrus orchards in Mundubbera and Central Queensland where the use of sprays is minimal (McLeod, pers. comm).

Among the most ubiquitous of the natural predators are spiders. This has been shown by Mason (1992) who surveyed the foliage of Douglas Fir and True Fir and found that the spiders outnumbered all other arthropods. Spiders are totally predacious animals and prey on a wide range of prey. Nyffeler, Dean and Sterling (1987) investigating Cotton and Woolly Croton Plants in East Texas, found that Green Lynx spiders preyed on medium sized prey while the Striped Lynx complemented this feeding habit by utilising large sized prey. Therefore, spiders as a community are important in utilising a wide range of prey. They have several types of predatory behaviour including foraging tactics by wanderer spiders and the use of specialised snares by web-spinning spiders. Several authors have revealed that spiders move into an area of pest outbreak and preferentially feed on the abundant insects present thereby delaying the pest outbreak (Mansour 1987; Bishop 1980). They showed a density-dependent phenomenon where the pests are suppressed by the spider community (Mansour 1987).

Spider populations are reduced in numbers in many crops during harvesting as the habitat is destroyed. In orchards, the habitat is established and sustained during harvest even though the habitat is disturbed. The use of pesticides appears to present the only problem for spider communities in this crop. Dondale, Parent and Pitre (1989) indicated that reductions in spider numbers in an apple orchard was due in part to the pesticides used.

In view of these studies, and due to the minimal research performed in tropical agroecosystems, a preliminary ecological study of spiders in sprayed and unsprayed mango orchards was performed.

## Methods and materials

Four orchards were chosen for this preliminary investigation. An unsprayed and a sprayed orchard, situated at Bouldercombe, represented Sites A and B, respectively. An unsprayed and sprayed orchard, situated at the Capricorn Coast, represented Sites C and D, respectively. Both Sites A and C had not been treated with insecticides for over three years, while Sites B and D (sprayed sites) had not been sprayed for three months prior to the commencement of this study. Each orchard was sampled once per month for three consecutive months to assess any difference in spider abundance and diversity. After this period, Site D was sprayed with Supracide and Diathane for scale insects, Tip Borer Moth and Anthracnose. The site was sampled four days after this spraying.

The spiders in each orchard were sampled from foliage, trunks and leaf litter of five randomly chosen trees. The trees were selected with the aid of a random number table (Freund 1992). The foliage was searched for thirty minutes beginning in the lower branches, in an anticlockwise rotation around the tree. The higher branches were then searched to a height of 2.5 metres from a ladder. The trunks were searched for five minutes by running a leaf over the tree trunk. This technique was very successful in disturbing *Tama sp.* which inhabit the mango tree trunks and have the habit of flattening their bodies against the trunks for camouflage while waiting for prey.

To assess the spider populations which utilise the leaf litter, four plastic containers were positioned under each of five randomly chosen trees in each orchard. These containers were buried until the container was level with the surrounding ground. It was then filled with leaf litter. These were collected once each month and replaced in the same positions to minimise disturbance in the leaf litter. Spiders are attracted to disturbed ground. This ensured a representative sample of the population was collected.

## Results

### Spider diversity

The total number of spider species collected in the five trees is summarised in Table 1. The abundance of these spiders was noted for each orchard at each sampling time. A total of 84 spider species were collected from the foliage, trunks and leaf litter of the four sites indicating a very diverse spider community compared to other agro-ecosystems. The leaf litter species were only found in that environment while all trunk species, except *Tama sp.*, were found in foliage as well as on the trunks.

**Table 1:** Total number of spider species collected in four mango orchards at three sampling times

Trial Number	Site Number			
Foliage	A	B	C	D
T1	13	6	11	9
T2	11	12	15	23
T3	5	7	15	15
Trunk				
T1	4	4	6	5
T2	1	2	2	2
T3	2	2	3	2
Leaf Litter				
T2	8	5	10	4
T3	4	6	5	8
T4	7	3	7	4

## Spider abundance

The total abundance of spiders in the five trees sampled at each site is summarised in Table 2. As there were large variations in the numbers of spiders between each species at each site and at each sampling times, non-parametric Kruskal–Wallis analysis of variance was used. This statistical analysis was calculated for the foliage and leaf litter at each site from Table 2. The null hypothesis that the mean number of spiders were similar at each site was accepted for foliage. No significant difference was found between the number of spiders at each site in the leaf litter. There was insufficient data to perform statistical analysis of spider abundance on the mango tree trunks.

**Table 2:** Total number of spiders collected in four mango orchards at three sampling times

Trial Number	Site Number			
Foliage	A	B	C	D
T1	32	30	32	22
T2	41	31	46	59
T3	12	15	31	37
T5				3
Trunk				
T1	5	7	8	5
T2	1	4	1	3
T3	4	12	8	15
T5				8
Leaf Litter				
T2	20	8	21	18
T3	5	16	17	13
T4	10	7	12	8
T5				6

Species 10 was the most common spider species found in the foliage at each site. A Kruskal–Wallis analysis of variance was performed to determine if a significant difference existed between the sites. The calculations showed that there was no difference between the abundance of sp. 10 at each site. A similar calculation was performed on *Tama* sp. which was common on the mango tree trunk at each site. It was found that there was no significant difference in abundance of *Tama* sp. between each site.

## Effects of pesticides

To assess the changes in the abundance of species in Site D, (the sprayed orchard at the Capricorn Coast) a Wilcoxon Matched-paired Signed-rank test was performed. This test was used to compare the numbers of spiders in foliage, on trunks and in leaf litter before and after spraying. It was found that the null hypothesis was rejected in all three cases. Therefore, there was a significant difference in spider numbers in foliage, on trunks and in leaf litter after spraying had occurred.

## The spider community

Multivariate Analysis was performed to assess the effects of pesticides on the spider community and the difference between its use and non-use. The total number of individuals per species found at each site, at each sampling time were analysed by using Multidimensional Scaling (MDS) (Clarke 1993).

The codes for plots in Figures 1 and 2 were as follows:

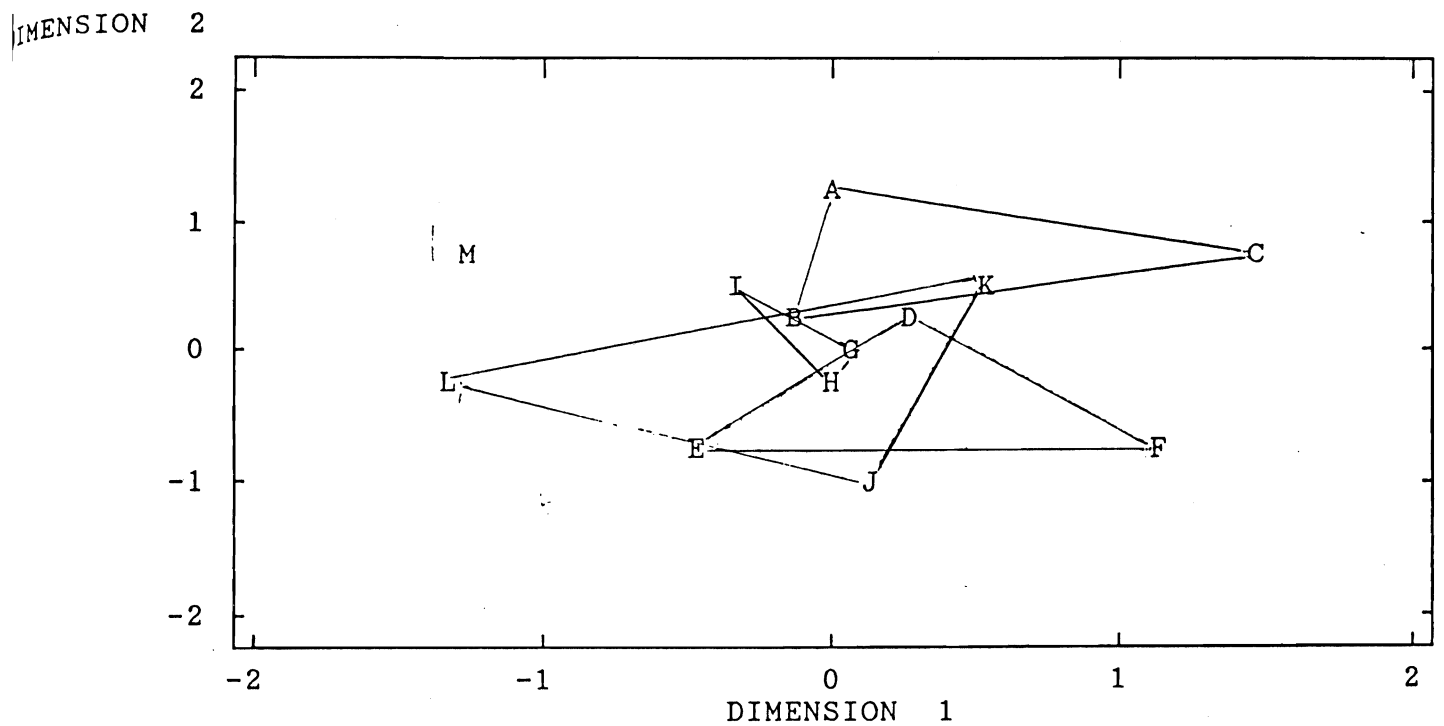
Codes	Sampling Times	Sampling Sites
A	T1	Bouldercombe Unsprayed
B	T2	Bouldercombe Unsprayed
C	T3	Bouldercombe Unsprayed
D	T1	Bouldercombe Sprayed
E	T2	Bouldercombe Sprayed
F	T3	Bouldercombe Sprayed
G	T1	Coast Unsprayed
H	T2	Coast Unsprayed
I	T3	Coast Unsprayed
J	T1	Coast Sprayed
K	T2	Coast Sprayed
L	T3	Coast before Spraying
M	T5	Coast after Spraying

The codes for plots in Figure 3 were:

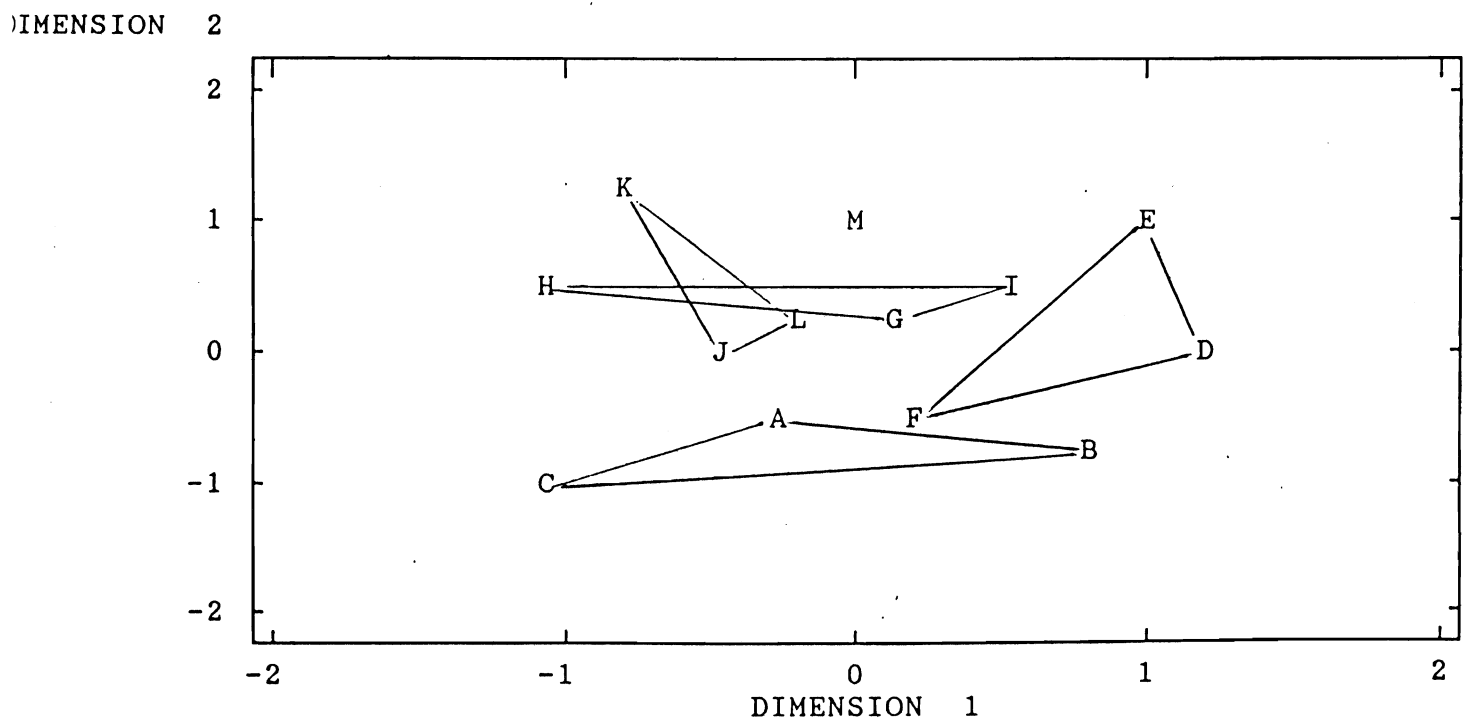
Codes	Sampling Times	Sampling Sites
A	T2	Bouldercombe Unsprayed
B	T3	Bouldercombe Unsprayed
C	T4	Bouldercombe Unsprayed
D	T2	Bouldercombe Sprayed
E	T3	Bouldercombe Sprayed
F	T4	Bouldercombe Sprayed
G	T2	Coast Unsprayed
H	T3	Coast Unsprayed
I	T4	Coast Unsprayed
J	T2	Coast Sprayed
K	T3	Coast Sprayed
L	T4	Coast before Spraying
M	T5	Coast after Spraying

The Euclidean distances in 2-dimensions on untransformed data of spiders in foliage are shown in Figure 1. The Kruskal Stress formula 1 value for this plot was 0.22330. A MDS 2-dimensional plot was performed on the untransformed data of the

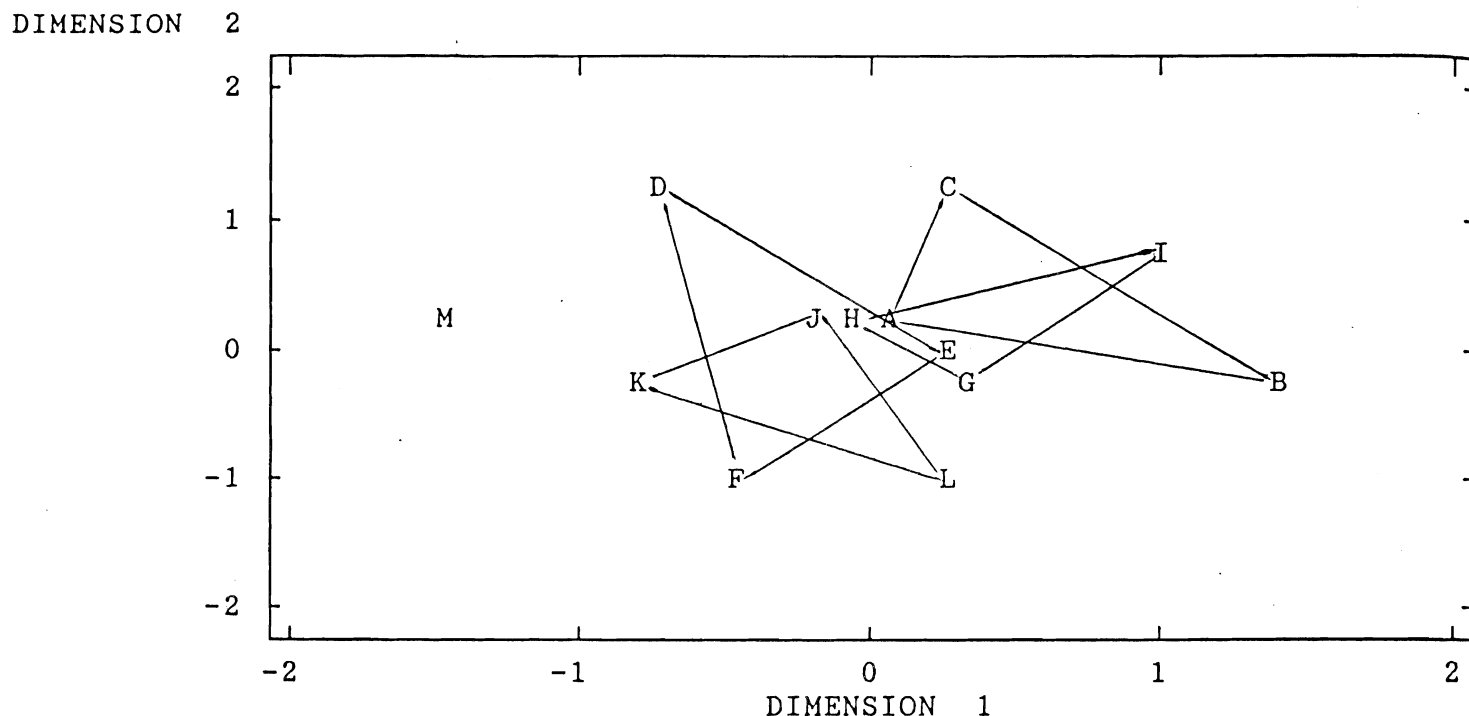
spiders present on trunks in the four orchards, as shown in Figure 2. The final Kruskal stress value was 0.26574. The leaf litter samples were also assessed by a MDS 2-dimensional plot. This is shown in Figure 3, where the final stress value was 0.23014.



**Figure 1:** The MDS 2-dimensional plots of the spider communities found in the foliage at the four sites



**Figure 2:** The MDS-2 dimensional plot of the spider communities found on the trunks at the four sampling sites



**Figure 3:** The MDS 2-dimensional plot of the spider communities found in the leaf litter at the four sampling sites

## Discussion

The species diversity appears to be high in mango orchards in the Rockhampton area. A total of 84 spider species were collected in the four sites. This indicates a high diversity of spiders when comparing these numbers to those reported by Dondale (1966) and Bishop (1980). Dondale collected 38 species in deciduous orchards in the ACT and Bishop collected 25 species in unsprayed cotton in two regions of South-East Queensland. These were collected by sweeping, destructive sampling of plants and pitfall trap techniques. As mango orchards are more permanent and stable habitats than cotton fields or deciduous temperate orchards a higher number of species would be expected. However, these numbers are over two-fold greater than for the temperate deciduous orchard and over three-fold for the cotton fields, including high diversity.

The diversity of spider species in the foliage, when comparing the total number of individuals in Table 2 to the total number of species, is high, as the ratio between the two is low in the foliage. The abundance of spiders on the trunks suggests a lower abundance and lower spider species diversity compared to the foliage. The number of individuals and the number of species present are much lower than in the foliage. A total of 27 species of spider were collected in the leaf litter between the four sites.

## Spider abundance

The results from the Kruskal–Wallis analysis of variance performed on the foliage data found that the abundance of spiders in the foliage between each site was not significantly different. Therefore, the abundance of spiders found in the foliage at each site did not differ. This was also the case for the abundance of spiders in the leaf litter. Thus, the spider abundance between the sprayed and unsprayed sites changed little once the population had re-established after effects of spraying. Neither of the two sprayed sites were sprayed with pesticides for three months previous to the first sampling time. Thus, it would appear that the abundance of spiders in sprayed mango orchards rejuvenates quickly and maintains a constant level of abundance resembling that of unsprayed orchards.

These results were confirmed statistically by the Kruskal–Wallis analyses performed on the most common species of spider collected in the foliage and on the trunk in the orchards. Both species, sp 10 and *Tama* sp. were not significantly different in abundance between sites. This indicates that the abundance of spiders does not change significantly between orchards.

The results from the Wilcoxon Matched-paired Signed-ranked test on the data collected before and after spraying at Site D (sprayed coastal site) indicates that there is a significant short term difference in the abundance of spiders between the two sampling occasions. These results indicate that the abundance of spiders in the foliage and in the leaf litter may have been reduced from the use of the broad-spectrum insecticide 'Supracide' in the mango orchard. These results are similar to those of Mansour (1987) who found that there was a decrease in spider abundance following intensive pesticide treatments. Dondale et al. (1979), suggested that a decline of two-thirds in the density of spiders in apple orchards was probably due to the use of broad-spectrum insecticides. This reduction in abundance may have also been due to the resultant starvation of the spiders after the insect abundance has been reduced. Thus, if a spider species is able to resist the direct effects of pesticides it may still disappear from the environment due to a decreased abundance of food. Further investigations into the effects of pesticides using a control orchard which has not been sprayed may establish a greater understanding of the effects of pesticides on spider populations.

The MDS two-dimensional plots for foliage, trunk and leaf litter do not show any significant difference between any of the sites. Clarke (1993) suggested that for an excellent representation of the Kruskal Stress formula 1, in multi-dimensional scaling (MDS) plot should be less than 0.05. If the data produces a stress value greater than 0.2, it is likely to yield plots which could be dangerous to interpret. In all of the MDS plots for foliage, trunk and leaf litter, the stress values are greater than 0.2. Thus, the interpretations from these results must be regarded as inconclusive.

The MDS plot of the spider community in the foliage in Figure 1, does not illustrate a common association between the sites or between sampling times. If the sites had some commonality then clustering would be evident. Site D after spraying at 'M' was plotted at (-1.2, 0.9) which was some distance from the other sampling times, although it was closest to 'L', the sampling time before the site was sprayed. This relationship indicates some degree of commonality between the two sites.

The MDS two-dimensional plot for the trunks shows similar results to that of the foliage. The sites and sampling times are very dissimilar, with no common associations. In this case, 'M' is also close to 'L', but is not segregated away from the remaining sampling sites and times.

Inspection of Figure 3 shows that the MDS plot for the leaf litter community for the sites at different sampling times showed a lack of clustering. These results are similar to the previous foliage and trunk samples, where little association between sites and sampling times was evident. The closest relationship to 'M' was 'K' which is the same sampling time of T3, as 'L' for the foliage and the trunk. However, the most recent sampling time, 'L', was a large distance from 'M'.

Further studies to investigate the interaction between the insect and spider communities may explain the non-clustering nature of these results. It may be possible that the spiders were tracking insect prey population as suggested by Mansour (1987), thereby playing a role in suppressing pest populations and delayed pest outbreaks early in the cotton growing season. Only a more detailed study involving both the spider and insect populations will produce a greater understanding of the dynamics of the spider community.

## Conclusion

Mango orchards in Central Queensland have a high diversity of spider species, particularly the unsprayed orchards which displayed very high diversity.

The abundance of spiders declined quickly after the use of the insecticide 'Supracide'. This reduction may be due to the resultant starvation of the spiders after the reduced abundance of the insect prey or to the direct use of this broad-spectrum insecticide. Further studies using a control area as a comparison between sprayed and unsprayed orchards may produce a greater understanding of spider communities.

The only inference that can be made from the MDS results from this study is that the spider community as a whole is a dynamic system and is changing constantly to meet environmental demands. Further studies to investigate the interaction between the insect and the spider communities may answer questions on the diversity and abundance of spiders as well as the community structure as a whole.

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