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FACTS AND FALLACIES OF ABORIGINAL NUMBER SYSTEMS[1]

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0. INTRODUCTION

'ugg uggugg ugguggugg uggugguggugg'

Thus, suggests Trewin (1971:36), primitive man may have first counted. In his book for teaching mathematics in Australian schools, Trewin then proceeds not only to suggest that children should 'invent a primitive man's set of number names', but also that they should specifically apply this suggestion to 'present day primitive tribes, e.g. Australian Aboriginals'. This view, that associates Aboriginals with so-called 'primitive' number systems, is widespread, founded not on fact but on misconceptions about the nature of human cognition held by generations of white Australians and perpetuated in the literature and therefore by those who teach. The sequence of events which has led to the retention of these misconceptions in the literature can be set out as follows:

1. Late in the eighteenth century and early in the nineteenth century, the first lists of words in Australian Aboriginal languages became generally available to the scholarly world in travelers' tales, in diaries and in papers presented to learned societies. These very haphazard lists, often of purely random words, tended, if they included any reference to numbers at all, to list only those words supposed to be the Aboriginal equivalents of one, two and three.

2. Early anthropologists, such as Tylor, took these lists at face value and saw in them the evidence they were seeking of the

cognitive inferiority of 'the lowest of living men' (Tylor 1871:242). A similar point of view was adopted by a number of writers last century who gathered information on Aboriginal people from various sources (e.g. Mathew 1899). Among the more substantial of these publications was Curr's four-volume compilation in 1886. Crawfurd, in his influential paper in 1863, actually used numbers as indicators of 'progress in civilization', the Aboriginal numbers being 'examples of the rudest numerals of the lowest savages of which we have any knowledge' (Crawfurd 1863:102).

3. Significant mathematical historians such as Conant (1896), Smith (1923) and Dantzig (1930) quoted the earlier anthropological data as examples of primitive mathematics. Dantzig, for example, used Curr while Smith used Tylor and Crawfurd. Their books became standard texts, regularly republished as recently as the 1950s and 1960s.

4. Mathematics educators such as Taylor and Mills (1955), Swain and Nichols (1965), Jones (1969) and Polis and Beard (1973), writing materials for the training of mathematics teachers, continue to cite Australian Aboriginal number systems as examples *par excellence* of the 'inept' counting abilities of 'backward' people (Swain and Nichols 1965:1). The illustrations they provide are drawn from the standard texts on the history of mathematics. Taylor and Mills cite Conant, as does Jones, while Swain and Nichols cite both Dantzig and Smith.

5. Classroom teachers and those who write materials for classroom use, such as Trewin (1971), having absorbed this information, pass it on to their students and thus the misconceptions continue to be perpetuated.

Regrettably, the situation has not been helped by a number of modern linguists. Although they are not necessarily guilty of the kind of social Darwinism which sees the degree of cultural evolution reflected in number systems, they nevertheless make unqualified statements concerning Aboriginal number systems which are misleading in their simplicity, if not demonstrably incorrect. In this regard, Blake 1981 is of particular concern because it is intended for the general public. (See quotation from Blake in section 1.1.)

With respect to number systems, there are three distinct but interrelated misconceptions. The first is the belief that no Aboriginal languages have number words which extend beyond two or three; the second is the belief that these words mark the limits to counting; and the third is the belief that the absence of extended number systems indicates some kind of cognitive inadequacy. These three misconceptions will be treated separately.

1. ABORIGINAL NUMBER SYSTEMS

1.1 RETHINKING TRADITIONAL MISCONCEPTIONS IN THE LITERATURE

There are a significant number of Aboriginal languages in which the number words extend beyond the limits which are normally claimed in the literature. The most frequently encountered statement is that numbers above three are lacking in most Australian languages:

Spencer and Gillen 1899:25
O'Grady et al. 1966:133
Wurm 1972:63
Vaszolyi 1975:8
P. Harris 1980:13

or in all Australian languages:

Holmer 1963:14
Abbie 1969:167
Von Brandenstein 1970:13

Other frequently stated limits are the numbers four or five:

Tylor 1871:242
Porteus 1931:306
Montagu 1969:215
King-Boyes 1977:41
Ellegard 1981:99
Blake 1981:4

or the number two:

Crawfurd 1863:170-81
Hallpike 1979:243
Dixon 1980:107-8

or even the lack of any numbers at all: deLemos 1966:85.

The real situation is that there is considerable variation in Aboriginal number systems; that whereas some systems may appear to have only two, three or four of what Wurm terms 'monomorphemically signalled numerals' (1972:63), many have words for five and for ten, while some have words for higher numbers, examples of which will be discussed later in this paper. In the light of the data available last century, some of the earliest generalisations concerning the limits of Aboriginal number systems are, if not pardonable, at least explainable. It is, however, becoming increasingly difficult to understand why these misleading generalisations should continue

to be made, particularly by competent and noted linguists. The following quotations are some of the more recent examples:

> . . . nor is their counting comparable to our elaborate numerical system. Indeed, it never exceeds 3 . . . (Von Brandenstein 1970:13).

> The one obvious gap in Australian vocabularies is the lack of any system of numbers. It is usually said that there are only numbers 'one', 'two', 'several' and 'many'; some languages appear also to have 'three', although this is frequently a compound form. (Dixon 1980:107-8).

> No Australian Aboriginal language has a word for a number higher than four. (Blake 1981:3-4).

These statements should not be left unchallenged. Before examining the reasons why such statements continue to be made, it must be shown that some Australian Aboriginal languages do have words for numbers higher than two or four. The three examples in Table 1 have been purposely selected from literature spanning a century of reporting in order to emphasise the long-term availability of this data.

Table 1. Examples drawn from the literature on Aboriginal languages with number names greater than four[2]

Language:	Kokata	Anindilyakwa	Tiwi
Locality:	western S.A.	Groote Eylandt, N.T.	Bathurst and Melville Island, N.T.
Literature Source:	Taplin 1879:97	Tindale 1925:128	Osborne 1974:passim
one	*kuma*	*auliaba*	*natinga*
two	*kutthara*	*ambilima*	*jirara*
three	*kabu*	*abiakalpia*	*jiraterima*
four	*wima*	*abuiabua*	*jatapinti*
five	*ngerla*	*amukugle*	*punginingita*
ten		*amambaruku*	*wamutirara*
fifteen		*amabwukuale*	
twenty		*ogripulung*	

There are numerous other word lists showing Aboriginal words for five or ten (e.g. Spencer 1914, Tryon 1970, Hughes 1971, Chadwick 1975); some general references to such words (e.g. Tyler 1871, Capell 1958, Wurm 1972, Hale 1975, Tindale 1978); and even a few references to 'regular quinary systems of numerals which seem to extend indefinitely upward' (Wurm 1972:64, Capell 1958:27). In other words, unqualified claims such as Blake's statement that no Aboriginal languages have words for numbers above four are, in fact, false.

Why do Dixon, Blake and others continue to ignore this information? Although, as Tindale pointed out (1978:158), there is a surprising lack of attention to number in the literature on Aboriginal language and culture, the dearth of information is not such that serious scholars could be unacquainted with it. Indeed, Dixon refers to a statement by Hale found in a paragraph in which Hale also refers to the Gunwinggu conventions for five, ten and fifteen (Dixon 1980:108; Hale 1975:295). The possibility, therefore, that these scholars are unaware of Aboriginal languages with numbers greater than two or four must be dismissed, and it can only be presumed that they have consciously avoided reference to them. It would be unfortunate indeed if these numbers were known about but considered too insignificant to mention. If for no other reason, they are signigicant because the languages having these numbers are the possession of some of the largest remaining groups of vernacular-speaking Aboriginal people in Australia including Tiwi, Anindilyakwa and, quite possibly, all the related 'Yolngu-matha' languages of northeast Arnhem Land. Generalisations about Australian Aboriginal languages which exclude these large, viable language groups are misleading generalisations indeed.

The failure to acknowledge these may, however, be due to preconceptions about what constitutes a number. These preconceptions include the notions that number terms based on body parts are not numbers, that linguistic innovations are not numbers, and that compound terms analysable into other numbers are not numbers. It will now be argued that these preconceptions are misconceptions.

1.2 NUMBERS AND FINGERS

It is obvious in the works of many writers of the last century such as Tylor 1871 and Crawfurd 1863 that Aboriginal words for five and its multiples which are derived from words for fingers, hands or feet were not then regarded as proper numbers. This view persists, being evident in more recent literature, and may explain why Dixon and others ignore their existence. Wurm, for example, makes a point of distinguishing between the 'two or three numerals' and the 'few isolated instances' of terms indicating 'hand', 'foot' and 'person' (1972:63-4). Contrary to what these linguists say, it must be

emphasised that there are Aboriginal languages in which the number-words for five, ten and so on are not readily analysable to mean 'hand'. The examples given in Table 1 all have words for five which differ from the word for 'hand' and from anything locally recognisable or generally reconstructible as 'hand'.[3]

It is also true that the word for 'five' is etymologically related to the word for 'hand' in a large number of Australian languages. The practice is not isolated, as Wurm suggests, but very common. Nevertheless, even modern linguists such as Yallop (1982:145) continue to question the status of 'hand' and other body-part terms as numbers.

The view that body-part terms can not properly be regarded as numbers is difficult to substantiate in a universal context, for the phenomenon is extremely widespread. The acceptance, as legitimate numbers, of only those number words which are not etymologically related to body parts seems a very shaky proposition. It would necessitate discounting certain numbers in most of the world's counting systems. The word *lima*, for example, as pointed out by Lumholtz as long ago as 1889, means both 'hand' and 'five' in 'many languages from the Sandwich Island [Hawaii] to Madagascar' (1889:333). It would also cast suspicion on the validity of the English word 'five' which can be shown to be etymologically related to 'finger' (Klein 1971) and to 'fist' (Onions 1966). Indeed, digits ('numbers') are almost universally related to digits ('fingers'). It seems strange, therefore, in recent generalisations about Aboriginal number systems not to find at least some reference to the Australian occurrences of this universal phenomenon.

1.3 RECENT INNOVATIONS IN NUMBER SYSTEMS

Another attitude evident in the literature is that number words for five and above are recent inventions and, apparently therefore, invalid (e.g. Williams 1976:320). Certainly it is possible that some number innovations are recent. O'Grady et al. (1966:133) claim that the use of 'hand', 'foot' and 'person' to signify higher numbers in the Ngulibardu dialect of Nyangumarda is 'an elaboration that developed recently - almost certainly since the end of World War II'. Given the widespread occurrence of this convention, such a claim needs to be treated with caution. Saying that a researcher has observed a particular event for the first time is not the same as saying that the observation marks the first occurrence of that event. With respect to numbers, there has been a long tradition of attributing anything beyond two or three to European influence (e.g. Dixon 1980:108)—to settlers or missionaries or, in at least one case (Spencer 1914:466), to buffalo hunters.

An even longer tradition, as noted by Macknight (1972:291), attributes any alleged 'innovation' in Aboriginal culture,

particularly in coastal North Australia, to the Macassans who annually visited there for some centuries prior to 1907 and whose language had a considerable influence (Walker and Zorc 1981).

Wurm's comments on the existence of 'an Indonesian-type numeral system employing Australian morphemes' are in this tradition (1972:167). One might well ask how long an innovation from another culture remains an innovation or how much time must elapse before such an innovation is considered worth mentioning. These questions, however, are only hypothetical because there is little evidence of any substantial connection berween the Macassans and the base-5 number systems of eastern Arnhem Land. Although there would seem to be even less justification to claim, as Yallop does, that numbers 'have been borrowed, in northern coastal areas, from Macassan' (1982:145), Yallop and Wurm recognise that the numbers exist.

The Anindilyakwa language of Groote Eylandt, for example, has a number system with specific 'monomorphemically signalled' numbers up to 20. Some of these have been given in Table 1 using Tindale's spellings; a fuller table is given below using a more recent orthography. The Macassarese numbers are listed for comparison.

Table 2. Groote Eylandt Number Words

English	Anindilyakwa	Macassarese
one	*awilyaba*	*sere*
two	*ambilyuma*	*rua*
three	*abiyakarbiya*	*tallu*
four	*abiyarbuwa*	*appa'*
five	*amangbala*	*lima*
ten	*ememberrkwa*	*sampulo*
fifteen	*amaburrkwakbala*	*sampulo-lima*
twenty	*wurrakiriyabulangwa*	*ruampulo*

Although Worseley has suggested that Macassan influence is evident in the Groote Eylandt number system, the evidence, if any, seems minor (Worseley 1954:368; cf. Macknight 1972:296). The oldest Groote Eylandters who remembered the Macassans and who were well able to indicate which words in the Anindilyakwa language were of Macassan origin told the author that the number names themselves were not of Macassan origin (J. Harris 1979:117). Further weight is added to these statements by the fact that some of these informants understood and

recalled Macassan numbers. Macknight has already recorded the specifically Macassan numbers remembered by an Elcho Islander (1972:297). The fact that the memory of Macassan numbers is incomplete as noted by Macknight on Elcho Island (and confirmed by the author on Groote Eylandt)[4] is significant. Macassan numbers have not been used since the last Macassans left over 70 years ago and so are imperfectly recalled, but the number system of the local language which was used for purposes other than communicating with the Macassans is still in use.

The leader of the Gumatj clan of northeastern Arnhem Land, Galurrwuy Yunupingu, has recently provided some striking evidence of this in the detailed information he provided to Sobek. There is a word, ***bothurru***, which is widely used in northeastern Arnhem Land to mean 'count'. Possibly derived from Macassarese *botoro* 'to gamble' (Macknight 1976:89), the term could be adduced to prove that the concept of counting did not exist prior to the Macassans. On this point, however, Galarrwuy said,

> **. . . the proper Gumatj word for counting-- like when you have to know how many warriors there were or how many tutle eggs you got--is *dambuyangu*. That's our word, not *bothurru* really. That belongs to anybody . . . (Galarrwuy quoted in Sobek 1981:13)**[5]

Galarrwuy then proceeded to detail the Gumatj counting system which, it transpires, is a base-5 system utilising the term ***rulu*** as the number base, the essential meaning of ***rulu*** being a 'bundle', specifically a 'bundle of five' in counting contexts. (The Gumatj number system is described in section 2.3.)

It is interesting to note that Aboriginal people of east Arnhem Land repeatedly associate their counting systems with the distribution of turtle eggs (J. Harris 1979:117) and of crocodile, seagull and magpie-goose eggs (Sobek 1981:18). Turtle eggs, in particular, are found in hundreds at one time and their distribution in multiples of five using traditional counting systems has been observed in Anindilyakwa (see Stokes, this volume), in Nunggubuyu (Burbank 1981, pers. comm.) and in Gumatj (Sobek 1981:18). The gathering of turtle eggs is women's activity of which Sobek has detailed descriptions (1981:34-5). This is no doubt why Groote Eylandt men, when questioned about numbers, generally suggest that difficult questions be resolved by talking to the older women. Trading with the Macassans was men's activity and it would seem logical that they should be the experts on number matters if Macassan trading activities were the origin of the number systems.

It is not claimed that the Macassan number system never influenced any Aboriginal number system. Rather it is argued that Aboriginal

number systems were in use between Aboriginal people at the same time as Macassan numbers were being used in communicating with the Macassans. There is every reason to presume that Aboriginal number systems were in use prior to the Macassan contact era and it can certainly be demonstrated that they have been in use since. As Macknight has pointed out, in attributing a cultural innovation to the Macassans, it is necessary to identify the model which the Aborigines are supposed to have imitated (Macknight 1972:291). The Macassan number system was a regular base-10 system and since Aboriginal number systems are not, attributing them solely to Macassan influence appears unwarranted. Capell, in reference to Nunggubuyu, seems to have been the only linguist to have made this point:

> On Groote Eylandt, however, and at Rose River, a system of counting by fives was developed, that could potentially extend as far as it was needed. The words used were not Indonesian words - for then the system would of course have been decimal - nor were the Indonesian words borrowed. It was just a quinary system that was built up out of purely native materials, and I do not know of anything similar elsewhere in Australia. For actual daily use the words are just impossibly long - though perhaps not to a people lacking clocks or even calendars! In Rose River language the counting is 1 - *anjbadj*, 2 - *wulawa*, 3 - *wulanjbadj*, 4 - *wulalwulal*(cf. ordinary Australian), 5 - *marangandjbugidj* (where *marang* - hand); but after that a unit called *maralibalibala* comes in, with *mari* 'and': 6 - *maralibalibala mari anjbadj*, and so on up to 10 - *wurumulumara ngandjabugidj;* 15 is *wurumulumbulanbadj*- apparently 5 x 3; 20 is *wurumulumbulalwulal* - 5 x 4. A full analysis of these numberals requires a considerable study of the structure of one of the most complicated languages in Australia . . . (Capell 1956:68)

The foregoing discussion of so-called innovations in number systems raises two significant issues. The first is that some 'innovations' may not be innovations at all in the sense in which those who use the term intend. The second is the rather more complex question of what an innovation is, particularly with respect to the arbitrary selection of dates or events after which linguistic changes are to be considered innovations.

1.4 COMPOUND NUMBERS

For well over a century, a vast body of anthropological and mathematical literature has contained virtually predictable references to the 'scanty as well as clumsy numerical systems' of Australian Aborigines

(Tylor 1871:243). Where such claims are exemplified, they are invariably shown to refer to a small, oft-quoted set of languages from which linguistic data are often provided to demonstrate the lack of 'special words' (Tylor 1871:242) or 'distinct terms' (Crawfurd 1863:103) for numbers above two, that is, the supposed lack of Wurm's 'monomorphemically signalled numerals' (1972:63).

It has already been shown in section 1.1 that some Aboriginal languages do have unanalysable terms for numbers higher than those generally claimed as the limit. There is, however, another issue involved in the persistent citing of Aboriginal languages as examples of languages supposedly lacking 'special' or 'distinct' number terms; it is an issue which, with respect to numbers, dates specifically from Crawfurd's 1863 paper but which in general terms dates from much earlier. This is the question of the legitimacy of compund numbers, the making of higher numbers by combining words for lower numbers.

All languages indicate higher numbers by the combination of words for lower numbers. Seventy two, for example, is a combination of seventy and two while seventy itself is derived from a combination of seven and ten. In an intellectual climate in which the superiority of the European culture was believed indisputable, it was easy for Crawfurd to argue that the point at which it became necessary to combine lower numbers to make higher numbers was an indicator of the progress of a particular culture toward 'civilisation'.

> Among rude tribes with scanty series of numerals, combination to make new numbers is very soon resorted to. Among Australian tribes, addition makes 'two-one', 'two-two', express 3 and 4 ... (Tylor 1871:264)

In view of the intellectual climate of the times, it is possible today to dispute Tylor's implications yet to understand how he was able to make them. It is far less acceptable to find Crawfurd and Tylor's views still pervading mathematical and even linguistic literature:

> A tribe living along the Belyando River in Australia counts like this:
>
> 1. Wogin
> 2. Booleroo
> 3. Booleroo wogin (=2+1)
> 4. Booleroo booleroo (=2+2)
>
> Had a tribesman occasion to count beyond four, he might continue with 'booleroo booleroo wogin, booleroo booleroo booleroo'... These schemes are scarcely worthy of being termed numeration systems ...

> Where the extent of man's mastery over nature is slim, his number system relects his ineptitude.
>
> 1. Neecha (1)
> 2. Boolla (2)
> 3. Boolla Neecha (2+1)
> 4. Boolla Boolla (2+2)
>
> A primitive chant? The sequence furnishes a fine accompaniment to the boom-boom drone of the tom-tom *(sic)*. Yet is is actually the complete counting system of a native Australian tribe... We can scarcely imagine what it would be like to face the world around us with mental tools so crude and blunt. (Swain and Nichols 1965:1, 29)

Only recently have attempts been made to refute the claims which underlie these points of view. With respect to East African cultures, Zaslavsky (1973) has provided sound evidence which argues convincingly against ascribing low and arbitrary limits to the arithmetical thought of so-called 'primitive' African tribes. Among mathematics educators, Gelman and Gallistel (1978) appear to be the first to have taken up Zaslavsky's material. Barnes (1980) takes Crawfurd's notions to their absurd conclusions, showing that the French *quartre-vingt-dix* (4 x 20 + 10) must be evidence of a lower degree of civilisation than the English *ninety* (9 x 10) while an even lower status on the scale of civilisation must be accorded the Danes to whom ninety is *halvfemsindstyve* ($\frac{1}{2}$ [of 20] from 5 x 20).

> By Crawfurd's standard French culture is more primitive than that of the Kédang in Indonesia; for the French use a mixture of methods to name multiples of ten, while the Kédang language, like English, applies a single procedure consistently from ten to ninety. Judging by their cumbersome numbers, the Danes stand at the very threshold of civilisation. (Barnes 1980:197)

Barnes goes on to describe two Kédang number systems, one of which is used exclusively by Kédang children, the other by the adults. There are compund numbers in the adult number system such as *lemé - apaq* (5 + 4) for nine. The word for nine in the children's number system, *sukoq*, is not a compound number.

> According to Crawfurd's principle, Kédang children obviously have attained a more superior state of civilization than have Kédang adults, since the children use a separate name for each of the first ten numbers. (Barnes 1980:199)

Compound numbers are, after all, legitimate linguistic labels for a numerical concept. Barnes' insightful paper serves to highlight the absurdity of trying to make inferences concerning cultural superiority and inferiority from the nature and extent of compound numbers in a particular language. The compounding of lower numbers to create linguistic labels for higher numbers is a universal phenomenon. Aboriginal languages abound with interesting compounding techniques, a considerable variety of which have been recorded in the literature over a long period of time. There has, for reasons already discussed, been emphasis on the use of compound forms for three and four in a number of languages but there are many other compound forms recorded in the literature. Dawson, for example, records compound numbers up to 100 (Dawson 1881:xcvii-xcix).

It is a pity that Australian linguists have failed to give due emphasis to this compounding aspect of Aboriginal languages. Had they done so they would have helped to demonstrate the universality of the number-naming techniques which Aboriginal people share with the whole of humanity.

2. THE LIMITS TO COUNTING

2.1 THE NATURE OF COUNTING AND NON-VERBAL COUNTING

What are the limits to counting? In section 1 it was argued that many Aboriginal number systems have words for numbers which extend far beyond the limits generally ascribed in the literature. There is, however, another associated misconception that not only are the number words 'scanty' or 'meagre' but that they also represent the limits to counting.

A detailed discussion of the nature of counting itself is beyond the scope of this paper, but modern scholarship recognises that counting is a process which may be verbal but may also be non-verbal.

> The use of unique tags to mark or tick off the items in a collection is intrinsic to the counting process. Further, the tags must be used in a fixed order. Finally, the tags must have an arbitrary status; they cannot be the names or descriptions of the items in the collection being counted. The set of count words meets these criteria, but then so do other sets of tags. One obvious candidate is the alphabet, and it is noteworthy that many languages have used the alphabet as count words (Greek and Hebrew, for example). But the tags need not be verbal. They may be any of a host of entities, including short-term memory bins. (Gelman and Gallistel 1978:76)

Non-verbal counting techniques have been and still are in frequent use by Aboriginal people. Scoring the ground is still a common method although, predictably, it tends to be associated in the literature with inferences of cognitive inferiority. No such inferences seem to be drawn about the widespread use of tallying marks by modern European people in such diverse contents as scoring cricket runs or counting the sheep passing through a gate.

Non-verbal techniques are obviously necessary for the reliable communication of numbers over long distances. A variety of examples has been noted in the literature, the most frequent being the use of carved message sticks. Howitt (1904:691-710) describes a number of message sticks in detail, as does Mountford (1956:466-475). Among other things, these sticks could be notched to indicate information such as 'X is six camps to the west; he has eight others with him. They will visit you in twelve days time'.

Body-marking techniques have also been widely noted in the literature (Dawson 1881:xcix; Howitt 1904:697; Dixon 1980:108). One quite widespread system marked the phases of the moon with 28 successive positions on the body. Message bearers could have their actual bodies marked to indicate, for example, that a particular event was planned for a specific day in the lunar cycle. Dawson described such a system in 1881. The author has recently had one described to him by Pigeon Rankin, a member of the Ngalkbon language group. As long ago as 1904, Howitt was claiming that such techniques did away with the often-repeated statements about the low limits to Aboriginal counting (1904:698).

2.2 INDEFINITE DETERMINERS AND BASE-2 NUMBER SYSTEMS

Most of the discussion in the literature relating to the inadequacy of Aboriginal number systems refers to their verbal manifestations, holding to the narrow perspective that counting must involve the use of linguistic labels - counting words - to mark each successive item in a collection. It must be emphasised that the words themselves do not denote the limits to counting. Wurm (1972:63-4) tries to distinguish between Aboriginal number systems which 'extend indefinitely upward' and those which he claims do not. The limits to counting, however, are not discovered merely by examining sets of words. <u>All number systems extend indefinitely upward</u>. When, for example, a base-10 number is fed into a computer, it is transposed into a base-2 number because the internal computer language has only two numerals, one and two. This set of words does not impose any limit on the computer's internal counting system. The discovery, however, of a similar phenomenon in some languages has long been discredited as counting at all:

> The natives can count only to three, then use feet and hands or repeat the word *mundroo* many times. (Gason, in Taplin 1879:77)

A person could say *mundroo* as many times as the situation warranted and this activity would be, in every respect, counting.

Hale has provided an insightful approach to this use of a few number terms (1975:295-6). He suggests that these words are not primarily counting numbers but grammatical numbers, even though some of them are legitimately used as precise counting numbers. Using the Warlpiri language as an example, Hale terms these words 'indefinite determiners' (like the English a or some), because of their exact correspondence to the definite determiners. They are:

tjinta	'singular, one'
tjirama	'dual, two'
wirkadu	'paucal, several'
panu	'plural, many'

Hale's point is that these are not a sequence of numbers for counting. One never says *tjinta, tjirama, wirkadu, panu* in the same sense that one says one, two, three, four. However, the first two members of the indefinite determiner paradigm refer to exact numbers and these can be used with precision to refer to numbers beyond two in accordance with a base-2 system, e.g.: *tjiramakari - tjiramakari - tjinta*('five').

Hale goes on to point out that although there is, theoretically, no upper limit to this number system, there is a practical limit beyond which the numbers become unwieldy or cumbersome. Hale argues that the process of counting is present even while conventionalised numerals are not, a view which is supported by the rapid acquisition of the English counting system by quite unschooled Warlpiri people as soon as they need to operate with money. Dixon (1980:108) cites Hale and emphasises that no particular significance attaches to what he terms 'the absence of numeral systems'; such absence is not due to lack of mental capacity, but a lack of need for such systems in traditional Aboriginal culture. Although Dixon's basic point about cultural need is quite valid, his use of the phrase 'absence of numeral systems in Australian languages' is misleading. What is culturally absent from some but not all Aboriginal groups is not so much the need to count but the need to count precisely. The demand for precision with high numbers came with Western money and Western activities.

Langlands (1982, pers. comm.) has provided some interesting infor-

mation on the Martu Wangka language at Jigalong, W.A. Its system of indefinite determiners is akin to Warlpiri:

kuju	'singular, one'
kujarra	'dual, two'
yupalpa	'paucal, several'
yarninga	'plural, many'

If absolute precision is required above two, the speaker will normally use non-verbal numbers such as fingers or marks on the ground. Only when absolute verbal precision is required will combinations of the two exact numbers be used, e.g.: *kujarra-kuju* 'three'. The word for hand, *mara*, is also used in combination with *kuju* and *kujarra*. Whereas, by analogy with many other languages, it would be reasonable to expect that these terms would normally mean 5 and 10, the need for verbal precision among the Martu Wangka people did not normally extend that far. Thus *marakuju* and *marakujarra* are normally non-specific and mean 'about 5' and 'about 10'.

Langlands' free translation is 'a few' and 'a small mob'. Another non-specific number term is *jina-mara* 'foot-hand' which is repeated several times to indicate a very large number. Langlands reports that the younger people are beginning to use *marakuju* and *marakujarra* as precise numbers, 5 and 10. It is the writer's view that the potential for this has long been present but the need for such verbal precision has been rare.

Many Western writers project a totally unrealistic need for precision onto non-Western cultures and build theories of number development upon quite absurd speculations. One of the more notable examples describes the dilemma of a 'primitive man' observing animals in a forest and finding himself unable to communicate the precise number he saw to his fellows:

> **. . . our primitive man ran into trouble. Can you imagine him staggering back to the tribe with 25 rocks, 87 rocks, or perhaps even 100 rocks in his hands to indicate that he had seen that many animals? (National Council of Teachers of Mathematics 1966:18)**

The answer to the question is, of course, no, we can't imagine it because no one in his right mind would want to count, rock by rock, all the animals in a herd (and then carry this huge pile of rocks back home to communicate what he had seen). Rather a person would use a descriptive phrase such as 'a huge herd' or 'a very big mob'. English speakers may use counting numbers in a non-specific fashion

such as 'about 90' or '80 or 90'. Many Aboriginal languages have number words which are used in non-specific ways. Strehlow (1944: 104) shows that Western Aranda has a set of number words like those of Warlpiri and Martu Wangka just described: *njinta, tara, urbutja, ntjara*. As well, there are words for 10 *(munuruta)*, 20 *(iloa)*, 30 *(inoa)*, and 40 *(intitjeritjera)*. Strehlow, however, tends to dismiss these numbers because 'they had only approximate numerical values'. Yet these were exactly the kind of non-specific number words which one would expect to find for situations where *ntjara* 'many' was too vague or ambiguous.

Sayers (this volume) shows that Wik-Mungkan, a Cape York language, has a similar range of non-specific number words. There is a set of words for small numbers *(thonam, kucham, ko'alam)* which are used with varying degrees of precision. As Sayers points out, problems arose when teachers at the school tried to use these as precise counting numbers. As well, Wik-Mungkan has various ways of expressing generalised higher numbers such as *thaa' wantanam*, meaning a large group or number. The use of body-part terms can add a degree of precision when that is necessary, e.g. *ma'kucham* (two hands) - 'about ten' and *ma'yotam tha' thampang* (all hands and feet) - 'about twenty'. Aboriginal people, in common with all people, need from time to time to indicate numbers of things or the size of a group. Their languages enable them to do so, but there is no reason why any particular non-Western language should reflect the degree of numerical precision with which modern Western culture is preoccupied.

Gurindji is a language from the central region of the Northern Territory with a set of 'indefinite determiners' for small numbers like that in Warlpiri.

jintaku	'singular, one'
kujarra	'dual, two'
murrkun	'paucal, several'
jarrwa	'plural, many'

When precision in verbal numbers is needed, the two exact members can be combined as in the other languages. It has, however, recently been 'discovered' that the Gurindji have another distinct number system quite separate from these. McNair (1982, pers. comm.), a linguist working in the Gurindji language, described to the writer how Fracek, the local adult educator, was recently writing some English numbers on a blackboard for some of the old men. One of the old men told him that they had numbers of their own. McNair subsequently elicited the numbers one to fifty which, it transpired, were known by all the adults with whom they checked. They are all 'monomorphemically signalled' numbers and a portion of them are listed in Table 3.

Table 3. Gurindji counting numbers (portion)

English numeral	Gurindji number	English numeral	Gurindji number
1	*panturru*	12	*yanu*
2	*yurr*	15	*winimarl*
3	*kankunya*	18	*yirliji*
4	*parnti*	20	*yawarra*
5	*ngarra*	25	*marla*
6	*karni*	30	*ngarlka*
7	*yama*	35	*yawarta*
8	*murru*	40	*panana*
9	*tulu*	45	*kalijpa*
10	*ngamirri*	50	*lurr*

The old people were able to explain to McNair some of the circumstances under which the number system was used. Hunting was one context. Another was that it was used to count the number of warriors who went out to fight and the number who returned. Combining the use of the terms with tallies on the ground, one person carried out the operation 50-10=40.

Clearly, at some time prior to the coming of the Europeans, there arose a need among the Gurindji people to verbalise their number concepts and non-verbal counting procedures. Their response was the development of an alternate number system which was not based upon the combination of the members of the base-2 system, *jintaku* and *kujarra*, although these could still be used when precision was necessary in reference to small numbers. The system is now falling into disuse because most mathematical demands are now in Western contexts for which the English number system is perceived as the most suitable.

2.3 BASE-5 NUMBER SYSTEMS: THE GUMATJ EXAMPLE

The introduction of the word for 'hand' as a precise number enables a base-2 number system to become a base-5 system which is then able to express higher numbers in a less unwieldy manner. There are many examples in the literature. It was also shown in section 1.2 that many Aboriginal number systems do not express 5 or its multiples in terms of body parts. Of these, one particularly interesting

system is the Gumatj number system of northeastern Arnhem Land, outlined in Table 4. One of its more interesting features, the introduction of a new term at the modulus (base squared), is marked with an asterisk. The numbers in Table 4 are those given by Galarrwuy Yunupingu to Sobek (1981).

Table 4. Gumatj number system (portion)

Base 10 Numeral	Base 5 Numeral	Gumatj number
1	1	*wanggany*
2	2	*marrma*
3	3	*lurrkun*
4	4	*dambumiriw*
5	10	*wanggany rulu*
6	11	*wanggany rulu ga wanggany*
7	12	*wanggany rulu ga marrma*
8	13	*wanggany rulu ga lurrkun*
9	14	*wanggany rulu ga dambumiriw*
10	20	*marrma rulu*
11	21	*marrma rulu ga wanggany*
12	22	*marrma rulu ga marrma*
13	23	*marrma rulu ga lurrkun*
14	24	*marrma rulu ga dambumiriw*
15	30	*lurrkun rulu*
16	31	*lurrkun rulu ga wanggany*
17	32	*lurrkun rulu ga marrma*
18	33	*lurrkun rulu ga lurrkun*
19	34	*lurrkun rulu ga dambumiriw*
20	40	*dambumiriw rulu*
21	41	*dambumiriw rulu ga wanggany*
22	42	*dambumiriw rulu ga marrma*
23	43	*dambumiriw rulu ga lurrkun*
24	44	*dambumiriw rulu ga dambumiriw*

(Table 4 continued)

*25	100	*dambumirri rulu* [Base squared][6]
26	101	*dambumirri rulu ga wanggany*
⋮	⋮	
30	110	*dambumirri ga wanggany rulu*
31	111	*dambumirri ga wanggany rulu ga wanggany*
⋮	⋮	
35	120	*dambumirri ga marrma rulu*
⋮	⋮	
50	200	*marrma dambumirri rulu*
51	201	*marrma dambumirri rulu ga wanggany*
⋮	⋮	
60	220	*marrma dambumirri ga marrma rulu*
⋮	⋮	
75	300	*lurrkun dambumirri rulu*
⋮	⋮	
100	400	*dambumiriw dambumirri rulu*
⋮	⋮	
125	1,000	*dambumirri dambumirri rulu*
⋮	⋮	
130	1,010	*dambumirri dambumirri ga wanggany rulu*
⋮	⋮	
150	1,100	*dambumirri dambumirri ga dambumirri rulu*
⋮	⋮	
200	1,300	*dambumirri dambumirri ga lurrkun dambumirri rulu*
⋮	⋮	
250	2,000	*marrma dambumirri dambumirri rulu*
⋮	⋮	
300	2,200	*marrma dambumirri dambumirri ga marrma dambumirri rulu*
⋮	⋮	
375	3,000	*lurrkun dambumirri dambumirri rulu*
⋮	⋮	
500	4,000	*dambumiriw dambumirri dambumirri rulu*
⋮	⋮	
625	10,000	*dambumirri dambumirri dambumirri rulu*
⋮	⋮	

(Table 4 continued)

750	11,000	*dambumirri dambumirri dambumirri ga dambumirri dambumirri rulu*
:	:	
1,000	13,000	*dambumirri dambumirri dambumirri ga lurrkun dambumirri dambumirri rulu*
:	:	
1,250	20,000	*marrma dambumirri dambumirri dambumirri rulu*

It has already been informally proposed to the writer that Galarrwuy was engaging in language engineering or even inventing the system. It is therefore important that this question be considered. It is indeed possible, although by no means certain, that this may have been the first time that Gumatj numbers had been extended this far. In fact, Galarrwuy was quite specifically motivated to demonstrate that it could be done.

> **His enthusiasm stemmed in part from proving that his past teachers had been wrong in stating quite openly to him that the reason he experienced difficulty with mathematics was because 'Aboriginal people didn't have numbers or counting and that kind of thing before the *balanda* (Europeans) came.' (Sobek 1981:26)**

On the various occasions in which Galarrwuy explained the Gumatj number system, there were other Gumatj people present, some of whom were considerably older than Galarrwuy. These people understood what was happening and were involved in the procedure. They were able, for example, to construct a given number with concrete materials. On at least one occasion, Galarrwuy stopped to check his procedures with some older women who were not present (Sobek, 1982 pers. comm.).

There is little doubt that the majority of adult Gumatj-speaking people are familiar with this number system and find meaningful numbers in this system well in excess of one hundred (base 10). Generally speaking, numbers approaching and above about two hundred are less meaningful because they are not perceived to be functional. There is no traditional activity to which they could immediately be attached. On the other hand, those who were present with Galarrwuy obviously comprehended the construction of higher numbers and were most interested in the results. The procedures and concepts were familiar even though the formal naming of such high numbers may have been rare. Indeed, while conceding the rarity of the naming of these higher numbers in the Gumatj number system, the writer is not convinced that this instance necessarily marks the first occasion of their use. Admittedly, the system has not been reported until now in the liter-

ature but this reflects upon the anthropologists and linguists who were interested in more exotic things than numbers or who did not ask the right questions. This still does not excuse the modern linguists for ignoring the hints here and there in the literature. Tindale, as long ago as 1925, reported Groote Eylandters being able to handle 120 as a base-20 number.

3. NUMBERS AND COGNITION

Although the presentation of incorrect and misleading data on Aboriginal number systems has been a persistent feature of the literature, the inadequacy of the data is, perhaps, less serious than the contexts in which they are presented and the philosophical positions the data have been adduced to support. As has been shown, information on Aboriginal number systems has formed part of the literature which adopts the ethnocentric view that there are stages of development through which all societies pass on their way to that high degree of cultural development evidenced by European civilisation; progress towards these stages of development is accompanied by, if not prompted by, the evolution of 'advanced' mental capacities.

Although it can be argued, as Hallpike (1979) has done, that words like 'primitive' and 'evolution' are objective scientific terms without ethnocentric overtones, a survey of the literature relating to number systems suggest that this is not so. It appears to this writer that the term 'primitive' is used with ethnocentric connotations in anthropological, pseudo-anthropological, linguistic, historical and mathematical writings far more than it is used objectively. The association of 'primitive' and allied terms with ethnocentric philosophies is such that they have accrued connotations which are difficult if not impossible for the reader to avoid. Indeed Hallpike evidences this himself in his effort to argue the legitimacy and objectivity of the term 'primitive' in order to use it unambiguously in his writing.

The problem is really one of cross-cultural comparison; that is, with reference to the subject matter of this paper, the problem relates to the difference between studying the development of the number system of a particular culture and comparing the number systems of more than one culture.

The English number system, for instance, is a fascinating study in itself, showing considerable evidence of earlier non-decimal systems. The word 'eight', for example, is derived from an old compound number which was simply 4 x 2 and therefore possibly evidence of an earlier base-2 number system. It may be legitimate to call this earlier system 'primitive', in the chronological sense, although such

a label seems to contribute little to the understanding of the system.

It is, however, quite a different matter to compare the base-2 number system of a modern sociocultural group with the base-10 number system of another modern group and to label the base-2 system 'primitive', thus unavoidably labeling the people whose possession it is. It may be legitimate to make objective etic comparisons. It is not legitimate to use those comparisons to infer the cognitive superiority of one group over the other. Indeed, it is obvious in the literature on the subject that number systems are regarded as being peculiarly suitable as an index of cultural inferiority or cultural superiority. This rather remarkable logic (or lack of logic) would seem to be based entirely on the Western obsession with precision in number operations and the equating of mathematical skill with higher order cognitive ability.

In fairness to a few of the modern linguists who have been criticised in this paper, it should be acknowledged that at least in the cases of Dixon and Yallop, they were quick to point out that no particular significance attached to what they perceived to be a 'paucity' of Aboriginal numbers. They both stressed that other fields of Aboriginal knowledge and endeavour were elaborate, detailed, intricate, and demanding of a high level of intellectual skill. It is, on the other hand, regrettable that in so summarily dismissing the rich field of Aboriginal mathematical concepts, they, perhaps unwittingly, have helped to perpetuate misconceptions which should long ago have been laid to rest.

It is amazing that Stokes' paper (this volume) is, as far as the writer can ascertain, the first substantial discussion of the mathematical concepts of an Aboriginal group which has ever been published. It is to be hoped that many more will follow and that accurate information will begin to enter the linguistic, anthropological and mathematical literature and put an end to the misconceptions of the past.

FOOTNOTES

1. The author has been principal of several Aboriginal schools including Bamyili, Angurugu (Groote Eylandt), and Kormilda College. He is currently head of the Department of Education Studies at Darwin Community College. His particular interests are in Aboriginal knowledge and world view and their implications for education.

   In the preparation of this paper, valuable assistance was provided by a number of people who made available hitherto unpublished data from the following languages:

Gumatj	Galarrwuy Yunupingu and Vivienne Sobek
Gurindji	Norm McNair
Martu Wangka	Bill Langlands

   Vicki Burbank provided some information on the use of Nunggubuyu numbers in gathering turtle eggs.

2. The authors' original spellings have been retained in this table except that Osborne's spellings have been amended to use only English lettering. The modern Anindilyakwa spelling is given in Table 2.

3. | | | | | |
   |---|---|---|---|---|
   | Kokata | *ngerla* | 'five' | *murra* | 'hand' |
   | Anindilyakwa | *amangbala* | 'five' | *ayarrka* | 'hand' |
   | Tiwi | *punginingita* | 'five' | *wamuta* | 'hand' |

   Capell's common Australian wordlist gives *marang* for 'hand' (1956:88).

4. 'Old Charlie' Galiowa Wurramarrba recalled, for example, that the Macassan for 'five' was *lima*. In fact, the word has totemic significance to the Wurramarrba clan and is used as part of certain names and other important words.

5. *Dambuyama* 'to count'. Galarrwuy used the imperative form, *dambuyangu*.

6. The introduction of the term *dambumirri rulu* at the modulus is significant. The term for 5^2 or 25 would otherwise have been *rulu rulu*. *Dambumirri* also means 5 when standing alone. Galarrwuy, in fact, said it was an alternative to *wanggany rulu*

but was not preferred. The mathematical strength of its introduction is that *rulu* is thus freed to stand outside the conceptual brackets, being multiplied by the total of all numbers which precede it.

e.g. *(dambumirri ga wanggany)rulu*
= (5+1)5
= 30

(dambumirri dambumirri ga marrma)rulu
= (5x5+2)5
= 135

REFERENCES

ABBIE, A.A. 1969. *The Original Australians.* Sydney: A.H. and A.W. Reed

BARNES, R.H. 1980. 'Fingers and Numbers'. *Journal of the Anthropological Society of Oxford.* 11(3):197-206

BLAKE, B.J. 1981. *Australian Aboriginal Languages.* Sydney: Angus and Robertson

CAPELL, A. 1956. *A New Approach to Australian Linguistics.* Oceania Linguistic Monographs, 1. Sydney: University of Sydney

_____. 1958. 'Aborigines: Languages'. *The Australian Encyclopaedia.* Sydney: Angus and Robertson

_____. 1965. 'Early Indonesian Contacts with North Australia'. *Journal of the Oriental Society of Australia* 3:67-75

CHADWICK, N. 1975. *A Descriptive Study of the Djingili Language.* Canberra: Australian Institute of Aboriginal Studies

CONANT, L. 1896. *The Number Concept.* New York: MacMillan

CRAWFURD, J. 1863. 'On the Numerals as Evidence of the Progress of Civilization'. *Transactions of the Ethnological Society of London* 2:84-111

CURR, E.M. 1887. *The Australian Race.* 4 vols. Melbourne: Victorian Government Printer

DANTZIG, T. 1930. *Number: the Language of Science.* London: George Allen and Unwin. (4th edn, 1962)

DAWSON, G. 1881. *Australian Aborigines.* Melbourne: George Robertson

de LEMOS, M. 1966. The Development of the Concept of Conservation in Australian Aboriginal Children. Unpublished Ph.D. Thesis, Australian National University

DIXON, R.M.W. 1980. *The Languages of Australia.* Cambridge: Cambridge University Press

ELLEGARD, A. 1981. 'Stone Age Science in Britain?' *Current Anthropology* 22(2):99-125

GELMAN, R. and C. GALLISTEL. 1978. *The Child's Understanding of Number.* Cambridge, Mass.: Harvard University Press

HALE, K.L. 1975. 'Gaps in Grammar and Culture'. In D.M. Kinkade, K.L. Hale and O. Werner, eds., *Linguistics and Anthropology: In Honor of C.F. Voegelin*, pp. 295-315. Lisse: The Peter de Ridder Press

HALLPIKE, C.R. 1979. *The Foundations of Primitive Thought*. Oxford: Clarendon Press

HARRIS, J.W. 1979. Ethnoscience and Education in Traditional Aboriginal Communities. Unpublished M.Ed. Thesis, University of Queensland

HARRIS, P. 1980. *Measurement in Tribal Aboriginal Communities*. Darwin: Northern Territory Department of Education

HOLMER, N.M. 1963. *On the History and Structure of the Australian Languages*. Copenhagen: Ejnar Munksgaard

HOWITT, A.W. 1904. *The Native Tribes of South East Australia*. London: Macmillan

HUGHES, E. 1971. *Nunggubuyu-English Dictionary* (2 parts). Oceania Linguistic Monographs, 14. Sydney: University of Sydney

JONES, P.S. 1969. 'The History of Mathematics as a Teaching Tool'. In *Historical Topics for the Mathematics Classroom*, pp. 1-17. 31st yearbook of the National Council of Teaching of Mathematics, Washington, D.C.

KING-BOYES, M. 1977. *Patterns of Aboriginal Culture: Then and Now*. Sydney: McGraw-Hill

KLEIN, E. 1971. *A Comprehensive Etymological Dictionary of the English Language*. Amsterdam: Elsevier

LUMHOLTZ, C. 1889. *Among Cannibals: An Account of Four Years Travel in Australia and of Camp Life with the Aborigines of Queensland*. London: John Murray

MACKNIGHT, C.C. 1972. 'Macassans and Aborigines'. *Oceania* 42(4): 283-321

MATTHEW, J. 1899. *Eaglehawk and Crow: A Study of the Australian Aborigines*. London: David Nutt

MONTAGU, A. 1969. *Man: His First 2 Million Years*. New York: Cambridge University Press

MOUNTFORD, C. 1956. *Records of the American-Australian Scientific Expedition to Arnhem Land,* Vol. 1. Melbourne: Melbourne University Press

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS. 1966. *Mathematics for Elementary School Teachers.* Washington, D.C.: Natl Council of Teachers of Mathematics

O'GRADY, G., C.F. VOEGELIN and F.M. VOEGELIN. 1966. 'Languages of the World: Indo-Pacific Fascicle Six'. *Anthropological Linguistics* 8(2):1-197

ONIONS, C.T., ed. 1966. *Oxford Dictionary of English Etymology.* Oxford: Oxford University Press

OSBORNE, C.R. 1974. *The Tiwi Language.* Canberra: Australian Institute of Aboriginal Studies

POLIS, A.R. and E. BEARD. 1973. *Fundamental Mathematics for Elementary Teachers.* New York: Harper and Row

PORTEUS, S.D. 1931. *The Psychology of a Primitive People.* London: Edward Arnold (Quotations from 1972 Books for Libraries Press edition)

SAYERS, B.J. 1982. 'Aboriginal Mathematics Concepts: A Cultural and Linguistic Explanation for some of the Problems'. In S. Hargrave, ed., *Language and Culture.* Work Papers of SIL-AAB Series B, Vol. 8

SMITH, D.E. 1923. *The History of Mathematics.* New York: Dover Publications. (1951 edn)

SOBEK, V.C. 1981. The Imposition of Superimposition: The Gumatj Number System of North-Eastern Arnhem Land Exposed. Unpublished B.Ed. dissertation, Darwin Community College

SPENCER, B. 1914. *Native Tribes of the Northern Territory of Australia.* London: Macmillan

SPENCER, B. and F. GILLEN. 1899. *The Native Tribes of Central Australia.* London: Macmillan

STOKES, J. 1982. 'A Description of the Mathematical Concepts of Groote Eylandt Aborigines'. In S. Hargrave, ed., *Language and Culture.* Work Papers of SIL-AAB Series B, Vol. 8

STREHLOW, T. 1944. *Aranda Phonetics and Grammar.* Oceania Monographs No. 7. Sydney: The Australian Natl Research Council

SWAIN, R. and E. NICHOLS. 1965. *Understanding Arithmetic.* New York: Holt, Rinehart and Winston

TAPLIN, G., ed. 1879. *The Folklore, Manners, Customs and Languages of the South Australian Aborigines.* Adelaide: Government Printer

TAYLOR, E.H. and C.N. MILLS. 1955. *Arithmetic for Teacher-training Classes.* New York: Holt, Rinehart and Winston

TINDALE, N.B. 1925. 'Natives of Groote Eylandt and of the West Coast of the Gulf of Carpentaria'. Parts 1 and 2. *Records of the South Australian Museum* 3:61-134

_____. 1978. 'Notes on a few Australian Aboriginal Concepts'. In L. Hiatt, ed. *Australian Aboriginal Concepts.* Canberra: Australian Institute of Aboriginal Studies

TREWIN, A.H. 1971. *Mathematics with a Difference.* Melbourne: Macmillan

TRYON, D.T. 1970. *An Introduction to Maranungku.* Pacific Linguistics Series B, No. 15

TYLOR, E.G. 1871. *Primitive Culture.* London: John Murray

VASZOLYI, E. 1975. 'Language and World View in Aboriginal Australia'. *Newsletter* Department of Aboriginal Affairs, Western Australia, 2(3):6-13

VON BRANDENSTEIN, C.G. 1970. 'What Next in Aboriginal Australian Linguistics?' *The Etruscan* 19(2):11-15

WALKER, A. and R.D. ZORC. 1981. 'Austronesian Loanwords in Yolngu-Matha of Northeast Arnhem Land'. *Aboriginal History* 5(2):109-134

WILLIAMS, D. 1976. 'Ordinal Scaling of Prescriptions and Descriptions of Behaviour in an Aboriginal Community'. In G. Kearney and D. McElwain, eds., *Aboriginal Cognition,* pp. 310-23. Canberra: Australian Institute of Aboriginal Studies

WORSLEY, P.M. 1954. The Changing Social Structure of the Wanindiljaugwa. Unpublished Ph.D. Thesis, Australian National University

WURM, S.A. 1972. *Languages of Australia and Tasmania.* The Hague: Mouton

YALLOP, C. 1982. *Australian Aboriginal Languages*. London: Andre Deutsch.

ZASLAVSKY, C. 1973. *Africa Counts*. Boston: Prindle, Weber and Schmidt