Chapter 9
Testing the Diffusion Theory

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Abstract This chapter addresses the issue of how different counting systems occurred and in particular the theory of counting systems spreading from a centre. The most comprehensive theory of this kind before 1990 was that of Seidenberg. This theory is expounded and then several queries are raised. In general, the argument is put that the counting systems of Papua New Guinea and Oceania did not spread from the Middle East and the prominence of so-called neo-2 cycles and 10 cycles cannot be supported.

Keywords diffusion of counting systems • Seidenberg's diffusion theory • prehistory of number theories • innovation in counting systems

Introduction

The data presented in Chapters 3 to 8 and which summarise the material given in the appendices of Lean's (1992) thesis indicate the complexity of the counting system situation that exists in the traditional societies of New Guinea and Oceania. The main focus of this chapter is to consider a theory of how this situation may have come about. Do we take the view, for example, that each of the counting systems that are found today is a lineal descendant of a system which was invented by the ancestors of the present inhabitants of the region at some remote time in the past, the essential structural features of each system being retained despite the inevitable changes due to linguistic speciation over time. Such a view implies that once a particular society possessed a given counting system then the integrity of the system would be maintained through succeeding generations despite the possibility that the society may come into contact with another which possessed a different, perhaps more efficient, system.

An alternative view to this is that a society's counting system, far from being a stable and invariant feature of that society, is in fact very susceptible to external influence. If, for example, a society with a 2-cycle system comes into contact with another society which has a 10-cycle system then this view suggests that the most likely outcome of such contact is that the first society will abandon its 2-cycle system in favour of the second society's more efficient 10-cycle one. This transmission of a counting system from one society to another is an example of diffusion which, in a wider context, may also involve the transmission of other cultural institutions as well as artifacts and technologies. Generally speaking, a diffusionist interpretation of how the current counting system situation in New Guinea and Oceania came about would take the following outline. At some time in the past, the

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K. Owens et al., *History of Number*, History of Mathematics Education,
DOI 10.1007/978-3-319-45483-2_9

ancestors of the current inhabitants possessed a particular type of counting system. Subsequently, new and different counting systems were introduced into the region in some sequence and, to use a tidal analogy, as each new system swept in it engulfed and overlaid certain systems already in place while by-passing others leaving them intact. The situation that is now apparent is the end result of a dynamic process of continual flux and change.

Of the two views outlined above, it is the diffusionist interpretation which has prevailed as the dominant explanatory theory of the prehistoric development of counting systems in human societies (see Chapter 1). In this chapter we will first outline the main conjectures of the most influential diffusionist theory of counting systems. Second, we will consider several aspects of the diffusion process itself which have been largely unaddressed in this theory. Third, the data available for this study will be used to elucidate the types of change which have apparently occurred to various counting systems in New Guinea and Oceania. Finally, a detailed evaluation and critique of the major diffusionist theory is provided together with an indication of the degree to which the data available support, or do not support, a diffusionist stance. This will then pave the way to make decisions on whether there is a third possible explanation of the diversity.

The Origin of Diffusion Theories

During the 19th century, as the amount of ethnographic data on the Indigenous cultures of the major continents increased, it became apparent that many societies, located in widely separated parts of the world, shared similar cultural traits, institutions, and artifacts. One view of why this should be the case, that of the independent inventionists, took the stance that each society invented its own cultural institutions and that the similarities which may be perceived in widely separated societies are the outcome of similar and spontaneous reactions of the human mind to the environment. Summarising the main points of this view, Raglan (1939) noted that

> The essence of this doctrine is that every human being is born with tendencies which lead him to make stone axes, bows and arrows, and dug-out canoes; to organise himself into totemic clans; and to believe in witchcraft, animism, and survival after death. These are assumed to be the mental and material equipment with which nature endowed primitive man, and which he proceeded to improve upon wherever local conditions allowed his innate progressiveness to develop. (p. 10)

It was also thought that Indigenous societies underwent separate but parallel development. It was apparent, however, that these societies, despite having similarities, were not identical and that there was considerable variation in the degree to which each society did develop and attain technological sophistication. We therefore find, particularly among 19th century scholars, that the proponents of the parallel development of cultural systems also adhered to a view of cultural evolution in which human societies could, in theory, be placed on a unilinear scale which ranged from the "primitive" to the "civilised". One major and influential representative of this view was Edward Tylor (1871) in his work *Primitive Culture.*

In the early part of the 20th century, at least two different theories were developed to counter that of the parallel and independent evolution of human societies. The first, developed by German and Austrian scholars was the Kulturkreise theory (Lowrie, 1937, pp. 123, 178-179) "that had cultures everywhere developing as a result of overlapping bundles or complexes of traits carried from some heartland in great waves or circles" (Riley, Kelley, Pennington, & Rands, 1971, p. xii). One adherent to this theory and, in particular how it applied to numeral systems, was the German linguist Fr. W. Schmidt (1926, 1929). The second theory was elaborated initially by G. Elliot Smith (1933) during the period 1910 to 1930 and is most clearly stated in his book *The Diffusion of Culture*.

After discussing a wide range of cultural practices, beliefs and myths shared by many societies around the world, Smith (1933) argued that these

> establish beyond question the unity of origin of civilization and the fact of an unbroken diffusion of culture for fifty centuries. When, however it is remembered that for hundreds of thousands of years before then men did none of these strange things nor conceived any of the fantastic ideas just enumerated, the conclusion is established that there is no innate impulse in man to create the material or the spiritual ingredients of civilization. (pp. 186-187)

Smith's view was that there was "one original source" from which

> the civilization of the whole world was derived (p. 232) [and that] the evidence which is now available justifies the inference that civilization originated in Egypt, perhaps as early as 4 000 B.C., but certainly before 3 500 B.C. (pp. 222-223)

A rival theory to that of Smith's was developed in the 1930s by Lord Raglan (1939). Raglan believed, like Smith, that the important inventions of human culture occurred once and once only in a centre of civilisation from which they were diffused all over the world. Unlike Smith, however, Raglan believed that these inventions originated not with the Egyptians but rather with the Sumerians of Mesopotamia.

The dichotomy between the independent inventionists and the diffusionists is apparent in the literature of the history of number. Writing in 19th century on "numerals as evidence of civilisation", Crawfurd (1863) noted that "the general conclusion, then, to which we must necessarily come is that each separate tribe invented its own numerals, as it did every other part of language" (p. 102). One hundred years later, Wilder (1974), in his influential book *Evolution of Mathematical Concepts*, stated that

> whether counting started in a single prehistoric culture and spread thereafter by diffusion or developed independently in various cultures (as seems most likely), is perhaps not too important for our purposes; interesting as it may be to speculate thereon … and since it seems impossible to find out when man developed counting … we may as well get on with what we know from the archaeological and historical records. (p. 35)

Abraham Seidenberg (1960), however, in the first comprehensive statement of the diffusionist view of counting, disagreed with this opinion: "on the contrary, there is a great amount of information scattered through the anthropological literature which can be brought to bear on the question of the origin and development of counting" (p. 215). Seidenberg's influential work was developed as a contribution to Lord Raglan's theory. Seidenberg's achievement has been such that he has effectively established what appears to be the prevailing view of the prehistory of number and one which finds its expression in more recent publications such as those by Flegg (1984, 1989), Barrow (1992), and Van der Waerden and Flegg (1975a, 1975b). It is perhaps no wonder that the diffusion view was strong given the monastic Catholic church's teaching on numbers, like other things, being created by God and unified by patterns (Book of Wisdom 11: 21, "Thou hast ordered all things by number, measure, and weight" that linked science, e.g. calendar histories, with religion (Brown, 2010). Lean investigated the validity of Seidenberg's theory, so it is necessary to provide here a summary of his views which will be the focus of subsequent discussion.

Seidenberg's Theory

The basic tenet of Seidenberg's (1960) theory is that several of the various methods of counting, which can now be discerned in the Indigenous cultures of the world, each had a single centre of origin: "it is known that ideas arose in the ancient civilisations; it is not known that ideas ever arose, anciently, anywhere else" (p. 218). The earliest method of counting to be diffused from its centre of origin (the pure "2-system", identical to the pure 2-cycle system discussed in Chapter 3) "spread out over the whole earth; later, other methods of counting arose and spread over almost all, but not quite all, of the world" (p. 218). The counting systems which we now see are "living documents of archaic civilisation", that is the survivors of counting systems which were diffused early and were not subsequently displaced by counting systems diffused at a later date. Each of these systems is discussed briefly below.

"The Pure 2-System"

Seidenberg (1960) argued that the oldest type of counting system and the first to be diffused throughout the world is the pure 2-cycle system.[1] The geographical distribution of this system among the indigeneous peoples of the world is such that it "appears now only at the edges, and seems ready to be wiped off the face of the globe" (p. 218). It might be argued that "systemless" counting, in which there are three or four cardinals that are not combined to form higher numbers might be considered as a candidate for the oldest type of counting. Seidenberg suggested, however, that systemless counting is only observed in regions which have predominantly 2-cycle systems and that it may be a degenerate form of the 2-cycle type rather than an earlier counting method. It is often observed that the 2-cycle system does not invariably occur in its "pure" form but has instead a secondary 5-cycle and, sometimes, a 20-cycle as well. Seidenberg suggested that the existence of such systems is the result of the hybridisation of two different types: the original pure 2-cycle system and the (5, 20) digit-tally system which was diffused at some time after the 2-cycle system.

In examining the way in which numbers were represented in ancient texts, Seidenberg considers that the arrangement of strokes to represent the numbers from 1 to 10 clearly indicate a paired arrangement indicative of a 2-cycle system. The earliest example of such representations is found in Sumerian pictographs which are dated at 3 500 BC. He thus takes the ancient centre of Sumerian civilisation to be the likely candidate for the origin and centre of dispersion of the 2-cycle system.

"The neo-2-System"

If the 2-system originated in an ancient centre of civilisation in the Middle East and is now only found in the margins of the world, there should nevertheless still be traces of it to be found between the centre of dispersion and its present locations. Traces of the 2-cycle in its pure form between the Middle East and, say, South America, where it is found, are not readily apparent. There is no evidence, for example, of pure 2-cycle systems existing anywhere in North America. Seidenberg argued that while traces of the 2-cycle system in its pure form are not apparent nevertheless there is another counting system which has an affinity with the 2-cycle system or was perhaps developed from it. This system he termed the neo-2-system which he classified into two types:

Type 1: The proto-neo-2-system which is characterised by having

$6 = 2 \times 3$,
$7 = (2 \times 3) + 1$,
$8 = 2 \times 4$, and
$9 = (2 \times 4) + 1$

[1] The terminology used throughout this book will be used to discuss Seidenberg's theory; it was not his terminology.

or, alternatively,

6 = 2 x 3,
7 = (2 x 4) - 1,
8 = 2 x 4, and
9 = 10 - 1.

Type 2: The method of representation of two equal or quasi-equal summands which is characterised by having

6 = 3 + 3,
7 = 4 + 3,
8 = 4 + 4,
9 = 5 + 4.

Seidenberg suggested that the origin of the neo-2 system, in either of its forms, is the 2-cycle system itself. If the latter is represented in tally form, we have (Figure 9.1):

Figure 9.1. 2-cycle systems.

Depending on how such an arrangement is viewed, we can think of the number 6, for example, as being 2 + 2 + 2 or 2x3 or 3 + 3, each representation being, respectively, 2-cycle, neo-2 type 1, and neo-2 type 2.

Seidenberg traced the occurrence of this system in its two manifestations and indicated that they may be found in one form or another in North and South America, Africa, Australia and Papua New Guinea. He also observed that the neo-2 constructions as given above are often associated with 10-cycle systems and which can therefore be characterised as neo-2-10 systems. Seidenberg (1960) indicated that while 2-cycle systems and neo-2-systems have an affinity, they are nevertheless distinct: "the fact that they are distinct suggests to us not only that pure 2-counting came before neo-2-counting but that both of these came before, for example, 5-20-counting" (p. 237).

The 5-and 10-Cycle Systems: The Americas

Seidenberg distinguished two 5-cycle systems, the (5, 20) and the (5, 10). Using data accumulated by Kluge (in particular, 1939) and by reference to a map showing the distribution of counting systems throughout the world compiled by Schmidt (1926), Seidenberg first considered in some detail how the counting system distribution may have come about in the Americas paying particular attention to the 10-cycle system and the two types of 5-cycle system. The picture presented may be summarised as follows. The 2-cycle system was diffused first followed by the neo-2-system. The latter moved down the western side of South America and up the south-eastern side leaving intact the 2-cycle system in the central and north-eastern regions. This was followed by the diffusion of the neo-2-10 system. In South America this resulted in a distribution of neo-2-10 systems as well as a residue of intact neo-2- and 2-cycle systems. The next development was the diffusion of the (5, 20) digit tally system across the Bering Strait and down the western coast into Central America, the Innuit/Eskimos being the only main group in North America affected by this system. The subsequent diffusion of the (5, 20) system from Central America into both North and South America largely had the effect of introducing a 5-cycle into systems which had previously been neo-2-10, thereby producing (5, 10) systems: "the 10-counters took over finger counting from the 5-20 finger-toe counters. The reason they took over finger counting and not toe counting, was that they already had a consolidated 10-system" (p. 247).

There is, then, a fundamental difference between the (5, 20) and the (5, 10) systems: the former, Seidenberg suggested, is one of the primary types of systems, along with the 2-cycle and the neo-2-10 systems, which were diffused each from a single centre. The (5, 10) system, on the other hand, is a hybrid of the (5, 20) and the neo-2-10 system and it came into being in the regions where these two types of system met and interacted. One way in which the difference between these two types of system is reflected is in the construction of their second pentads. While with the (5, 20) system the second pentad numbers 6 to 9 have an explicit quinary construction, Seidenberg noted that the (5, 10) system rarely has an "intact" second pentad in which all the numbers 6 to 9 have an explicit quinary construction: "the non intact character of the 5-10 counting supports the idea that it is a cross" (p. 246).

Seidenberg argued that while the neo-2-10 system is a primary one which arose in a single centre and was diffused, this is not the case with the pure 10-cycle system. He surmised that when the (5, 20) system interacts with the neo-2-10 system, several variants may arise (such as the 2-10-5 system) in which the ideas underlying the way in which numbers are combined to form larger numbers become confused; this, together with linguistic change ("slurring"), results in numerals which appear to be distinct and in which the original components are no longer apparent. This process, Seidenberg suggested, "is enough to yield pure 10-cycle systems (also 10-20 and pure 20-systems)" (p. 247). He also noted that the 10-cycle system, having been "purified" in this way, could itself diffuse.

The 2-, neo-2, and 5-Cycle Systems in Africa

Seidenberg observed that each of the primary counting systems, i.e. the pure 2-cycle, the neo-2-10, and the (5, 20) system, existed in Africa and that these appeared there in the order given: this is inferred from their current geographical distribution in the continent. Furthermore he believed that, of the two types of neo-2 system discussed earlier, Type 1 entered Africa before Type 2. This is inferred because the former does not have a clear spread throughout the continent and that where it does appear it seems peripheral to Type 2. Seidenberg also indicated that his view that Type 1 is chronologically prior to Type 2 is supported by evidence from the Americas in that the former occurs in both North and South America but the latter in North America only.

There is ample evidence of the existence of the (5, 10) system in Africa. Seidenberg distinguished two types of this system: Type A which is such that "the numbers 6, 7, 8, 9 are built in a completely regular manner and use the conjunction 'and'. The word 'seven', for example, is literally 'five and two'" (p. 252). Type B is such that the second pentad numerals have the construction $x+n$ where x is not the word for 5, n takes the values 1 to 4 respectively, and no conjunction is used. We have, incidentally, noted earlier in Chapter 4, that there are three common ways in which the second pentad of 5-cycle systems is constructed: the two types distinguished by Seidenberg together with a third type which has a $5+n$ construction, that is the numerals 6 to 9 are explicitly constructed with 5 but no conjunction is used. Seidenberg's view is that his two types of (5, 10) system were diffused in Africa at different times: Type B, which is "a mixture of neo-2-10 and 5-20-counting" (p. 255), came first while Type A was diffused subsequently.

Digit Tallying and Body-Part Tallying

Seidenberg (1960) observed that body-part tallying, of the kind described in Chapter 4, is found in the Torres Strait islands and among certain groups of Australian Aboriginals. In both locations, 2-cycle numeral systems are also found. This, at first sight, seems paradoxical in that body-part tallying is rather more elaborate than the more common digit tallying and yet it occurs in regions where the simplest type of counting system exists: "the paradox consists in thinking that the simple is older than the complex" (p. 270). Seidenberg's view is that the body-part method is the older of the two and that its genesis had nothing to do with counting but rather with the practice of "parceling out various parts of the body to various gods" (p. 270). The practice of utilising body-parts to represent things evolved into using body-parts to maintain a tally and, in particular, as a calendrical device. The two practices, that of using body-parts and marking them off in a given order, and that of counting, came together and resulted in the use of body-parts for counting purposes. The reason for this fusion of the two practices was, Seidenberg suggested, the counting *tabu*, that is the practice in certain cultures in which the verbal counting of people or objects is expressly forbidden. Verbal counting, however, can be circumvented by the use of gestural, non-verbal counting:

> the gestures themselves had already existed, but became applied, under the circumstances of a *tabu*, to counting. The gestures having become standard symbols for numbers, the verbal descriptions of these gestures (possibly in the same effort to circumvent a *tabu*) began to stand for the numbers. (Seidenberg, 1960, pp. 270-271)

Thus we have the sequence in which:

1. names for numbers existed, but under the circumstances of a *tabu* being imposed on their use,
2. non-verbal body-part or digit tallying was used in which body-parts symbolised numbers; finally,
3. the verbal descriptions of the tallying process or the names of the body-parts themselves came to represent the numbers and displaced the proscribed original number names.

This view contradicted those of many earlier writers on this subject. Tylor (1871), for example, said that with regard to numbers "Word-language not only followed Gesture-language but actually grew out of it" (p. 246). Thus when a child learns to count by using his fingers, this reproduces "a process of the mental history of the human race; that in fact men counted upon their fingers before they found words for the numbers they thus expressed" (p. 246).

The practice of tallying or counting on the fingers is so widespread throughout the Indigenous cultures of the world that many scholars of the nineteenth century, Tylor (1871) and Conant (1896, pp. 7-17) among them, concluded that finger counting was an instinctual rather than a cultural phenomenon. Seidenberg (1960), on the other hand, took the view that the names for numbers and the various primary counting systems existed prior to the practice of using body-parts for counting. In addition, he argued that not only is the association of numbers with the marking off of fingers a cultural rather than an instinctual phenomenon but also that the order in which the fingers are enumerated has a definite significance and a cultural origin. Seidenberg's argument is essentially this: initially, the 2-cycle, neo-2-10, and the (5, 20), counting systems were not associated with body-part gestures. As a result of the operation of the counting *tabu* process outlined above, the (5, 20) counting system became associated with digit tallying and gave rise to two basic types of finger counting: that in which tallying began on the little finger and that in which tallying began on the thumb, the former being chronologically prior to the latter. Two further developments occurred when the (5, 20) system diffused and came into contact with the 2-cycle and the neo-2-10 systems. Seidenberg said that "the pure 2-counters were taught the gestures by the 5-20-counters, and, moreover, by 5-20-counters who began with the left little finger" (p. 263). When, however, the (5, 20) counters came in contact with the neo-2-10 counters, a different type of finger counting arose: "the neo-2-counters did not invent finger counting but were taught this practice by quinary finger counters, but, in acquiring the practice, modified it in accordance with their neo-2 habits" (p. 262). The modification was that counting began not with the little finger or the thumb but with the index finger.

A Genealogy of Counting Systems

The previous sections summarise briefly Seidenberg's views on those counting systems which he regarded as having originated in an ancient centre of civilisation and which were subsequently diffused all over the world. These systems and the order in which they were diffused are: a) the 2-cycle system, b) the neo-2 or neo-2-10 system of which, we have noted earlier, there are two types, and c) the (5, 20) system. The 2-cycle system is thought to have originated with the ancient Sumerians of Mesopotamia by 3 500 BC at the latest. No similar dates were, however, given for the origin of the other two systems. One other system which is commonly found among Indigenous societies is the (5, 10) system. As indicated earlier, this is regarded as a hybrid between the neo-2-10 system and the (5, 20) finger and toe counting in which the quinary nature of the latter was taken over by the former. This system, then, does not have the same primary status as the other three. One further system of considerable significance but which was also not granted primary status in Seidenberg's scheme is the 10-cycle system. It is clear that Seidenberg believed that this system existed prior to the (5, 20) system (p. 261 has a footnote indicating "10-counting preceded finger counting"). He suggested that it may have derived from neo-2-10 systems by a process of linguistic change in which the composite nature of the numerals less than 10 ceased to be apparent. How either type of neo-2 system acquired a 10-cycle in the first place is not explained: it is clear from the data quoted, however, that some, though not all, neo-2 systems do possess a superordinate 10-cycle (p. 271).

Seidenberg provided a diagram (Figure 9.2) which summarised "the genealogy of counting systems" (p. 271)

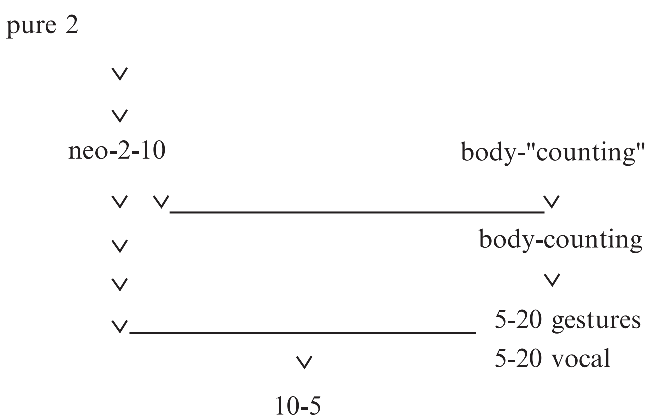

Figure 9.2. Seidenberg's counting system genealogy: A genealogy we dispute.
Source: Seidenberg (1960).

Additional Aspects of Seidenberg's Theory

We are concerned here with evaluating Seidenberg's (1960) views as they relate to the diffusion of various types of counting system and as set out in the previous sections. Several questions raised in Seidenberg's theory are not, however, addressed here largely for the reason that the database provided in Lean's (1992) Appendices will not provide answers to these. One question concerns the relation of numerals to grammatical number and whether the former preceded or followed the latter. Grammatical number, as it occurs in the languages of New Guinea and Oceania, does not merely involve the distinction between singular and plural but includes dual and often trial forms of the personal pronouns as well. Data on the form of personal pronouns have not been collected for this study and questions relating to this are not considered.

A further contribution which Seidenberg (1962) has made to the prehistory of number, although not dealing specifically with diffusion, is an essay on the ritual origin of counting which is an extension of Lord Raglan's (1939) ideas on the ritual origin of civilisation. Seidenberg's view is that "counting was invented in a civilised center, in elaboration of the Creation ritual, as a means of calling participants in ritual onto the ritual scene" (p. 37). In developing this idea, Seidenberg pointed to a belief held in many societies that numbers are sacred and are associated with deities, this belief being apparent in the myths of these societies. Myth and ritual are associated phenomena and the rite in which "deities", that is participants in the rite, are numbered is the Creation ritual or census in which the deities are called forward onto the ritual scene:

> the sacred character of numbers derives … from the numbering of participants in a ritual. I go a step further, however, and see in the words used to call participants onto the ritual scene the very origin of number words and of numbers … Counting is the secularization of the rite which called participants in ritual onto the ritual scene. (Seidenberg, 1962, p. 262)

Except to note these views, the details of this aspect of the theory are not addressed here nor, generally, will we be concerned with speculating about the genesis of numbers. We will, however, scrutinise several aspects of the diffusion theory as it relates to counting systems. We consider, first, whether there are any specific properties of counting systems which may affect their diffusibility and we also consider whether there are special circumstances which have to be met in order for diffusion to occur. Second, we list several types of change that have occurred to counting systems in the New Guinea region and consider whether these changes can be accounted for by diffusion. Finally, we provide a critique of Seidenberg's (1960) theory in the light of this discussion.

Counting Systems and Diffusion

In his book *The Anthropology of Numbers*, Crump (1990) concluded that "If there is one lesson to be learnt from the present study of traditional numeracy, it is that diffusion is the most common explanation of the emergence of numerical institutions in any local culture" (p. 147). In justifying his strong diffusionist stance, Crump pointed to several features which are characteristic of counting systems and which tend to make them easily diffusible relative to other cultural institutions or traits. The first of these characteristics is the abstract basis of counting systems which results in their being able to be diffused without making specific cultural demands: "these demands are in most cases linguistic", however, "once such an institution is understood in terms of the local culture, expressed in local language, it frees itself almost immediately from these cultural ties" (p. 147). The second feature "is that particular ways of using numbers … relate to natural phenomena that know no cultural boundaries" (p. 148). Thirdly, Crump believed that among numerical institutions "there is a sort of 'survival of the fittest' … The expression of numbers, beyond a certain low threshold, in terms of a polynomial with a single base (generally 10) is absolutely better than any alternative" (p. 150). The implication here is that a more efficient counting system will normally displace a less efficient one, a point which will be explored further when discussing the Oceanic AN counting systems below.

For these reasons, Crump maintained that "it is difficult for any society, however traditional, to defend itself against numerical institutions superior to those it already possesses, once they are knocking at the door" (p. 150). While the characteristics enumerated by Crump may well mean that the conditions under which the diffusion of counting systems might occur are favourable, there are nevertheless other factors which may influence the likelihood of diffusion between one group and another. Jett (1971) enumerated several such factors:

> the degree of friendliness, the intensity and length of contact; the degree of similarity of the values and technologies of the group involved; the degree of conservatism of the cultures, both in revealing and accepting ideas; the practical, prestige, luxury, or religious values of the traits, and the ease of learning them. (p. 21)

With particular reference to the diffusion of counting or tallying, whether or not the nature of the contact between two groups had an economic component, that is trade of some sort occurred, would also appear to be an important factor. Finally, it is possible that important changes can occur within a traditional society when it changes its environment by migration. If the migrating group moves into a region largely dominated by another culture, it may be to the advantage of the newcomers to adapt to certain aspects of the prevailing culture and this may include changes to its economy. Under such conditions it seems possible that a migrating group, which might otherwise be seen as the vehicle for diffusing new ideas, could well adapt its economy and numerical institutions to those of the culture already in place.

While the existence of similar cultural traits, including counting systems, among two traditional societies may provide evidence of diffusion, it may also be the case that the groups are related culturally and may share a common ancestor. Thus the situation which we now see among, say, certain traditional societies in Melanesia and Polynesia where there are obvious cultural similarities and clear linguistic affinities, is the result both of the migrations of these related societies and of the differentiation of their languages from a common ancestral proto language. Thus, Seidenberg (1960), in noting that the word for 5 in some Vanuatan languages is *lima*, added that "but it is known that this word is Indonesian" (p. 266) and made a basic error in assuming that somehow Indonesians contributed a word to the Vanuatans. This ignores the common Austronesian ancestry of the languages of Vanuatu and of Indonesian as can be determined by investigating the languages as a whole: isolating a counting system from its linguistic context can easily lead to this type of error. However, with this general caveat in mind, it is possible to find instances where one language possesses in common, in part or in whole, a numerical lexis with another language but in circumstances where the two languages are otherwise unrelated. In such cases the possession of loanwords does provide evidence that diffusion has occurred. The borrowing of numerals, however, is only one type of mechanism by which a counting system may change as a result of diffusion and we will now consider some of these changes as they occur in the languages of New Guinea and Oceania.

Changes Which Occur to Counting Systems

Crump (1990) had the view that

> no part of speech is more susceptible to linguistic borrowing and cultural diffusion than numerals. This in part explains not only why the lexical origins of numerals are so difficult to trace but also why numerals tend, intrinsically, to be so little related to other parts of the vocabulary. (p. 34)

That the counting systems of traditional societies do change is supported by abundant evidence from the data on New Guinea and Oceania. It is a not uncommon view among diffusionists that such changes occur as a result of the influence of one group on another and that the mechanism of change is that one group will borrow the other's numerical lexis, in whole or in part, resulting in an increase in the primary cycle of the borrowing group's counting system. Suppose, for example, that Group A possesses a (5, 20) digit-tally system and that it has some form of contact with Group B which possesses a pure 2-cycle system. The assumptions implicit in Seidenberg's theory is that, normally, influence is unidirectional with Group A affecting Group B so that the latter's 2-cycle system will be displaced or modified in some way, resulting in the adoption of a (5, 20) system. A likely mechanism which brings this change about is that Group B will augment its numerical lexis by borrowing from that of Group A.

In presenting the data that follow we shall investigate the validity of this view. In order to do this we will distinguish the various types of change which have evidently occurred in the counting systems of various traditional societies. We will consider, in passing, whether a system which has a larger primary cycle will always affect a system with a smaller primary cycle, and not vice-versa, and also whether change always results from influence rather than being spontaneously generated.

Borrowing and Displacement

Evidence that borrowing does occur can be seen by the presence of AN loanwords in the numerical lexis of several NAN languages. Three examples are given in Table 9.1 where we give the numerals 1 to 10 for three NAN languages, Yele (PNG), Ekagi (West Papua), and Mbilua (Solomon Islands), together with the corresponding numerals of Proto Oceanic (POC) for comparison.

Table 9.1
Showing the Numerals 1 to 10 for Three NAN Languages and POC

	POC	Yele	Ekagi	Mbilua
1	**kai, *sa, *tai*	*ngeme*	*ena*	*omandeu*
2	**rua*	*mio*	*wisa*	*omungga*
3	**tolu*	*pyile*	*wido*	*zouke*
4	**pat, *pati*	*paadi*	*wi*	*ariku*
5	**lima*	*limi*	*idibi*	*sike*
6	**onom*	*weni*	*benomi*	*varimunja*
7	**pitu*	*pyidu*	*pitiwo*	*sike-ura*
8	**walu*	*waali*	*waruwo*	*sio-tolu*
9	**siwa*	*tyu*	*isi*	*siak-ava*
10	**sangapulu*	*y:a*	*gati*	*Toni*

Note. POC is Proto-Oceanic. Yele (Milne Bay Province, PNG) data are from Henderson (1975) and supported by CSQs. Ekagi (West Papua, Indonesia) data are from de Solla Price and Pospisil (1966). Mbilua (Solomon Islands) from Tryon and Hackman (1983, pp. 123, 127, 131).

Yele appears to have borrowed at least the numerals 4 to 8 from an AN source while Ekagi has borrowed at least the numerals 6 to 8 and possibly 9. Mbilua, however, has borrowed the numerals 2, 3 and possibly 4 which appear in the second pentad and which are part of a 5-cycle construction for the numerals 7 to 9. In each case the AN numerals appear to augment an already existing numerical lexis and the result of this is to extend the original cyclic structure of each system. Lean suggested (see Chapter 5) that this is the means by which these East Papuan Phylum languages have acquired 10-cycle systems. The presence of AN loanwords can also be detected in a number of other NAN languages, for example Moi, Karon-Pantai, and Wodani (Galis, 1960; Lean, 1992, appendix on Oceania), each of which is located in West Papua. Generally speaking, however, it is clear from a survey of the NAN languages that the borrowing of AN numerals is not a common phenomenon even in the case where NAN languages are located in areas which are predominantly AN-speaking, for example Kuot in New Ireland (PNG) (Lean's field notes and Kluge (1941)) and Kovai on Umboi Island in the Morobe Province (PNG) (Lean's field notes and three CSQs).

We also need to consider whether any evidence exists to indicate that AN languages have borrowed NAN numerals. This is a more difficult task than the reverse situation in that whereas AN numerals are usually relatively easy to identify this is not the case with NAN numerals which exhibit enormous diversity. It is possible nevertheless to identify examples of AN counting systems which have a numeral lexis which is no longer recognisably AN in character and which we may infer is possibly due to NAN influence. Several instances of these are apparent: Sissano (and Sera) in Sandaun Province (PNG) and Maisin in the Oro Province (PNG) for example. The first five numerals of these are given in Table 9.2.

Table 9.2
Showing the Numerals 1 to 5 for Sissano, Maisin, and POC for Comparison

	POC	Sissano	Maisin
1	**kai, *sa, *tai*	*pontenen*	*sesei*
2	**rua*	*eltin*	*sandei*
3	**tolu*	*eltin pontenen*	*sinati*
4	**pat, *pati*	*eltin eltin*	*fusese*
5	**lima*	*eltin eltin pontenen*	*faketi tarosi*

Note. POC is Proto-Oceanic AN. Sissano data derive from 4 CSQs but are similar to records of Schmidt (1900) , Ray (1919), and Kluge (1938). Maisin data derive from Strong (1911) and is similar to 9 CSQs.

In neither set of numerals is the original AN character retained. Whereas in the case of the NAN systems we had an augmentation, by the AN loanwords, of an already existing sequence of NAN numerals, in the case of Sissano and Maisin the original numerals have been completely displaced by a new set of numerals quite unlike those we expect to find in AN languages.

We may therefore distinguish two types of change in the examples given above: borrowing and displacement. In the case of the former we have a sequence of several numerals borrowed from some source and grafted onto an already existing sequence. We can also find evidence of just a single numeral being borrowed. In Chapter 7, for example, we cited the case of several NAN languages having borrowed the AN word for domestic fowl used to denote the numeral 1 000. Indeed it often appears to be the case that when a single numeral is borrowed this will be a term for a large number. The second type of change, displacement, does not involve the adoption of a few additional numerals but rather the complete abandonment of the old system in favour of a new one. While it is possible to find isolated instances of displacement of counting systems having occurred in a number of languages in the New Guinea region during the pre-European period, it is now a much more commonly observed phenomenon as the English or Tok Pisin counting systems displace traditional systems. In PNG, in particular, this sort of displacement has occurred frequently among those language groups which possess 2-cycle counting systems. Among those groups that have 10-cycle or (5, 10) systems, it is often possible to observe the use of two parallel systems: the traditional systems which are used in traditional contexts, such as counting shell-money and bride wealth, and the introduced systems of either English or Tok Pisin which are used in non-traditional contexts. It also extends the systems where counting by 10s may occur with two counters with an existing (2, 4, 8) cycle system as in Hagen.

In the pre-European period it is clear that both borrowing and displacement occurred. Either of these types of change is relatively easy to detect when the interaction is between AN and NAN groups: detecting the interaction between two AN groups or two NAN groups, however, is not so easily done and thus it is probably impossible to estimate the degree to which borrowing or displacement may have occurred in such cases. From the data available on AN-NAN interactions, however, it is clear that neither borrowing nor displacement have occurred to any significant extent and that these types of change are probably not the principal means by which the diffusion of counting systems takes place and we need to examine the evidence further in order to establish what other types of change can occur.

Loss of the Numerical Lexis

The effect of borrowing numerals and increasing the basic numerical lexis is to increase the magnitude of the primary cycle of the borrower's counting system. Thus a language group which possesses a 2- or 5-cycle system could, by borrowing a sequence of numerals, acquire a 10-cycle system. The reverse situation is also possible: a language group with a 10-cycle system could, by the loss of part of its numerical lexis, acquire a system with a smaller primary cycle of, say, 5 or even 2. Such a change, however, might seem a retrograde step in terms of the reduction of counting efficiency. The assumptions of diffusionists like Seidenberg and Crump do not generally appear to encompass this type of change, yet, as we will see in the following discussion it is a common occurrence, particularly among the Oceanic AN languages of PNG and Island Melanesia.

A fundamental assumption on which the following analysis is based is that the speakers of POC possessed a 10-cycle numeral system with a basic numerical lexis comprising 10 monomorphemic numerals, as given earlier in Table 9.2: this is a well-established result of the historical linguistics of the Oceanic AN languages. The analysis to be presented below will be discussed in the context of the premise that any AN language which does not possess a "pure" 10-cycle numeral system has undergone a change and that this change has occurred as a post-POC development. In discussing each type of change we will consider whether it is likely that it has occurred as a result of direct or indirect external influence or whether, in the absence of any obvious influence, it has occurred as a "spontaneous" innovation.

(10) → (5, 10). The data presented in Chapter 5 indicate that, of the 420 Oceanic AN languages for which we have data, a total of 113, or 27%, possess counting systems with a (5, 10) cyclic pattern. The change which has occurred in such cases is the loss of numerals 6 to 9 in the second pentad. Three examples of this type, which occur in the languages of Tolai, Mota, and Kaliai, have been previously shown in Tables 5.8 and 5.9. The distribution of the (5, 10) system among the Oceanic AN languages may be seen in Figures 5.2 and 5.3 and this is such that it is found in PNG in 44 languages of the North New Guinea, Papuan Tip, and Meso-Melanesian Clusters, and in only one language, Nauna, of the Admiralties Cluster; it is also found in 68 languages of Vanuatu. Apart from these, the (5, 10) system is not found elsewhere in Island Melanesia, Polynesia, or Micronesia.

Most of the (5, 10) AN systems that are found in PNG occur in regions which are inhabited by NAN groups: along the north and north-east coast, in the New Britain, New Ireland, North Solomons, Central, and Milne Bay Provinces. In these cases it is possible that the AN groups were influenced by neighbouring NAN groups. In the case of Nauna, which is the easternmost language of the Admiralties Cluster, it seems unlikely, given the history of the Admiralties languages, that it was in contact with NAN groups. There is, perhaps, the possibility that the group or groups which left the POC homeland and eventually settled in the Manus region may have taken a route, say through New Ireland, which brought them into contact with NAN groups. Such a contact, though, would have needed to be sufficiently sustained in order to effect a change in the counting system of the migrating AN group. Similarly, with the languages of Vanuatu, there is no immediately obvious explanation of how they acquired a (5, 10) system. Was there, for example, a diffusion of AN groups carrying (5, 10) systems from New Britain, New Ireland, or Bougainville (but not the Solomon Islands where there is no evidence of this type of system)? Or is it possible that Vanuatu (and New Caledonia) sustained, at some time in the past, a NAN population which has since died out but has left, as its legacy, traces of its existence in the counting systems of the AN immigrants? Tryon (1984), in fact, noted with regard to the NAN languages in Melanesia that "there has been some speculation that they may have extended as far as southern Vanuatu and New Caledonia" (p. 152). If we are to assume that a change in the AN counting systems must be brought about by external influence then we need to allow for the mechanism by which this can occur. If we do not concede the possibilities mentioned above, we would have to conclude that the counting systems of Nauna and the Vanuatan languages, at least, have undergone spontaneous change and that their (5, 10) systems were innovations.

(10) → (5, 20). The (5, 20), or digit tally, system is found in 58, or about 14%, of the Oceanic AN languages, and in 5 non-Oceanic AN languages of West Papua. In PNG, the (5, 20) system is largely confined to the North New Guinea and Papuan Tip Clusters where it occurs in 30 languages. It is also found in southern Vanuatu (15 languages) and in New Caledonia (8 languages). The only Polynesian language not to possess a 10-cycle system, Faga-Uvea, is spoken in the Loyalty Islands of New Caledonia and this, too, has a (5, 20) system. The nature of the change which occurs in this system is that while the numerals of the first pentad are retained, the complete second pentad is lost. The original numeral 10 is replaced by an expression meaning 2x5 or "two hands", or something similar, as may be seen in Table 5.3. In some cases, there is reference in the second decade to "feet", as is common in digit tally systems. The original numeral 20 (2x10) is usually replaced by the word for "man", or in some cases, a construction involving the terms "hands" and "feet". (For further details, see Chapter 5, Lean's (1992) appendices or GLEC's (2008) EXCEL summary.)

In seeking to determine whether this type of system was induced in the AN languages by external influence and in particular by NAN languages possessing digit tally systems, the situation is somewhat similar to that discussed above with the (5, 10) systems. Those AN languages which are situated in the East Sepik, Madang, Morobe, New Britain, Oro, and Milne Bay Provinces (PNG), could all, conceivably, have been influenced by NAN neighbours. However, southern Vanuatu and New Caledonia are populated only by AN speakers and we would need to hypothesise either long-distance diffusion from PNG, in the north, or the prior existence of NAN languages in the region which have since become extinct. If neither of these were the case then we would probably have to ascribe the changes to the counting systems of this region to localised and spontaneous innovation.

(10) → (5, 10, 20). Less common than the other two 5-cycle systems, this type occurs in the North New Guinea and Papuan Tip Clusters in a total of 18 languages, and in New Caledonia where it is relatively common and is found in 19 languages. Elsewhere it is found only in West Papua in one Oceanic AN language and 8 non-Oceanic AN languages. The change which commonly occurs to produce this kind of system is the loss of the second pentad numerals 6 to 9: the numeral 10 is normally retained. The original numeral 20 (2x10) is normally replaced by the word for "man" as is common in digit tally systems. Three examples of the (5, 10, 20) system are given in Table 5.13.

In the case of the languages located in PNG, it is possible to attribute these changes in the AN counting systems to the influence of neighbouring NAN languages. In the case of the New Caledonian languages the situation is as set out above, that is we must allow for either long distance diffusion from PNG or for the prior existence of NAN languages which have since become extinct but which, at some time in the past, influenced the immigrant AN languages. If neither of these occurred then the changes most likely may be regarded as a localised innovation.

(10) → "Manus" type. The Manus type of 10-cycle numeral system was discussed in Chapter 6. The use of the term Manus to distinguish this type is because it is found very largely in the languages of the Admiralties Cluster located on or near Manus Island. The deviation from the usual 10-cycle system in this type is such that, normally, the numerals 7 to 9 are lost and are replaced by expressions implying subtraction from 10 or more precisely the number to reach the complete group of 10, although the numeral 10 does not explicitly appear in these. Three examples are given in Table 6.9. One dialect of Levei-Tulu (Manus) has subtractive constructions for the numerals 6 to 9. Elsewhere in New Guinea and Oceania, this type of system is extremely rare and the only instance found among the AN languages occurs in the Mioko dialect of Duke of York and Wuvulu-Aua west of Manus. It also occurs in several NAN languages of Bougainville and one NAN language, Nanggu, in the Solomon Islands. Further comment occurs in Chapter 6 and some details in Table 9.3.

Given the relative isolation of the languages of Manus Island and that the type of change discussed here is almost entirely restricted to them, it seems possible that we have here an example of a localised innovation. However we need to consider whether there is also the possibility that the Manus

Table 9.3 *Examples of 'Manus' Subtractive-Type AN and NAN Outside Manus Region*

	Mioko Dialect of Duke of York	Nanngu	Levei-Tulu
1	*ra*	*tate/šte, šte*	*eri*
2	*rua*	*lali, lšli*	*luweh*
3	*tul*	*latÿ, lštu*	*toloh*
4	*vat*	*lafo, lopo*	*ha-hup*
5	*lima*	*lamaf, lšmšp*	*limeh*
6	*nom*	*lšma, temo*	*choha-hup*
7	*talakatul*	*tumatu, tumtš*	*chotoloh*
8	*talakarua*	*tumali, temli*	*choluweh*
9	*tolotakai*	*tumate, tumšri*	*cho-eri*
10	*ra noina*	*napnu, nopnu*	*ronoh*
20	*rua noina*	*nopnu li*	*lunoh*
30	*tula noina*	*nopnu tu*	*sunuh*
100	*ra mar*	*telau šti*	*ranak*
1 000	*ra rip*		*ropop*

Note. Duke of York (Mioko) data are from Lean's 1986 field notes but reflect Parkinson's (1907, p. 745) and Kluge's (1941, p. 193) data. Nanggu data are from Tryon and Hackman (1983, pp. 123, 127, 131) and Cashmore (1972, p. 55). Levei-Tulu stretches across Manus and has two distinct dialects (if not languages) and the data here are from Lean's (1986) field notes and 2 CSQs but they reflect Smythe's earlier SIL data (prior to 1970) given in Z'graggen (1975).

system may have been induced by some sort of external influence. As was discussed above, in the case of Nauna, if such a change was induced by contact with NAN languages, we would have to assume that such contact occurred early in the history of the Admiralties languages, that is at a time when the speakers of the language(s) ancestral to the present-day languages were still in the POC homeland or during their voyage from the POC homeland to their present location. In the case of the latter, we would most likely have to assume that the voyage included visiting New Ireland where there was sufficiently sustained contact with NAN groups to induce some sort of change in the counting system of the AN travellers. This possibility will be explored further in the general commentary and summary below.

(10) → "Neo-2"-10. This type of change also has a very localised distribution and is found largely in the Central Province (PNG), east and west of Port Moresby. The system in question was discussed in Chapter 6 where it was distinguished by the term Motu type, however Seidenberg (1960) cited the various languages which possess this type of system as being among those which have his neo-2 system (p. 230). In fact the seven languages spoken in the Central Province and which have this system, exhibit Seidenberg's "Type 1 Proto Neo-2" features with 6 = 2x3, 8 = 2x4, and 9 = (2x4) + 1; four languages also have 7 = (2x3) + 1 while one dialect of Keapara appears to have 7 = 8-1 and 9 = 10-1. We thus have the loss of numerals 6, 8, and 9, and in several cases 7. Outside of the Central Province, only one other Oceanic AN language appears to have a counting system showing similar features: this is Wuvulu-Aua, the westernmost language in the Admiralties Cluster. Tables 6.11 and 6.13 show various examples of this type.

Seidenberg's interpretation of how such a system might come about is to hypothesise the existence of a primary type of counting system, the neo-2, which has the same status as the pure 2-system and the (5, 20) system, in that each of these, he believed, was invented and diffused. The data at our disposal, however, throw some doubt on this interpretation. Firstly, the Type 1 neo-2 system is not found at all among the NAN languages which, as was discussed in Chapter 1, were established in the New Guinea region prior to the advent of the AN languages: if the neo-2 system had been diffused some time after the 2-system we would expect to find it distributed among the NAN languages. Since the neo-2 features are found only among the counting systems of a small group of AN languages, all of which derive from an original proto-10 system, and since they could not have acquired them directly from a NAN source, then the likely interpretation is that this variant of the 10-cycle system is an innovation occurring within this group. This does not preclude the possibility that such an innovation was induced by some sort of NAN influence and this will be explored further in the commentary below.

(10) → (4). As was discussed in Chapter 7, only four AN languages have counting systems which exhibit 4-cycle features as can be seen in Tables 7.6 and 7.7. Two of these, Wogeo and Bam, have systems which show pure 4-cycles while the other two, Ormu and Yotafa, have systems which show both 4- and 5-cycle features. In the case of the former two, the only AN numerals to be retained are 1 to 3. It is possible that such systems can be regarded as localised inventions. It was noted in Chapter 7, however, that, along the northern coast of PNG, several 4-cycle systems occur among the NAN languages as well and it does not seem out of the question that there may have been some interaction between the AN and NAN groups. We therefore need to consider the possibility that this system may have occurred originally among some NAN languages and was diffused to the AN groups.

(10) → (2) or (2, 5) or (2″, 5). Perhaps the most surprising of the various transformations which the POC 10-cycle systems has undergone is where the primary 10-cycle has been reduced to a primary 2-cycle as was noted in Chapter 3. There are two examples among the Oceanic AN languages where there has been a loss of the numerals 3 to 10 resulting in pure 2-cycle systems (see Table 3.2). There are, in addition, 18 examples where the AN languages now possess systems with (2, 5) cyclic patterns. For the majority of these what we have is a 2-cycle system augmented by a (5, 20) digit tally system in which the word for 20 contains a “man” morpheme or both “hand” and “foot” morphemes: the full cyclic pattern in such cases is (2, 5, 20). Of the 18 groups which have this type of system, 13 belong to the Markham Family of which Adzera, discussed in Chapter 8, is a member. The remaining five, Sera (Sandaun Province), Roinji (border of Madang and Morobe), Dawawa, and Igora (Milne Bay), and Tomoip (East New Britain), are, like the Markham Family, all located in regions which have NAN languages with similar systems (see Table 3.6 and Appendices).

There are 12 AN languages which possess what Lean (1992) had termed a quasi-2-cycle system as discussed in Chapter 3. This type of system, denoted (2″), has a basic numeral set (1, 2, 3) with the numeral 4 having a 2+2 construction; the word for 5 usually contains a “hand” morpheme as is common with digit tally systems. Of the 12 languages having this system, seven belong to the North New Guinea Cluster and five belong to the Papuan Tip Cluster: all are located in regions which are inhabited predominantly by NAN language groups and it seems likely that these have influenced the AN groups.

Types of Change: Commentary and Summary

The various types of change, outlined above, which the counting systems of New Guinea and Oceania have undergone and which involve either the increase or decrease of their numerical lexis, do not provide an exhaustive list of the changes which have occurred. In particular, those changes which have obviously resulted from the introduction of the numerical institutions of the colonial languages (German, English, Dutch, Indonesian, and French) or of the Melanesian pidgins, have largely been ignored. These institutions now hold a predominant place in day-to-day commerce and in schools and are having an overwhelming impact on the numerical institutions of the traditional societies in the region (see, e.g., Saxe (2012)). These changes provide the most obvious and decisive evidence of the effects of the diffusion of counting systems which are an integral part of an introduced culture which has achieved political and economic dominance. The changes that we are concerned with here, however, are those which have occurred to the counting systems of the traditional cultures prior to the introduction of the colonial cultures.

In the cases where the borrowing of numerals has taken place we have clear evidence of language groups interacting in such a way as to bring about changes in the borrowers' counting systems. Such borrowing is most easily identifiable when it takes place between NAN and AN groups but is difficult to detect when it takes place between like groups. The degree to which borrowing appears to have occurred between unlike groups, however, is not particularly marked and this suggests that the borrowing of numerals cannot be regarded as the primary mechanism by which diffusion occurred in the pre-colonial, traditional context.

We have suggested that a substantial proportion of the Oceanic AN languages have had their counting systems changed by losing part of their numerical lexis. In some cases this has resulted in a change to the cyclic structure of the counting system; in others, the cyclic structure has remained essentially unchanged but there has been a change to the way in which the numerals of the second pentad have been constructed. For each of the changes to the AN counting systems discussed above, we have briefly indicated whether it seems possible that such changes may have come about as a result of influence by, say, NAN language groups, or, alternatively, whether they appear to be localised innovations. Unlike the case of borrowing where the presence of, for example, AN loanwords in an otherwise NAN numeral lexis provides direct evidence of influence, the evidence in the case where there is a loss of the numeral lexis must necessarily be circumstantial. Thus, when we observe that the Markham Family languages no longer have 10-cycle systems and have instead (2, 5) systems, we may inquire whether there appear to be any special circumstances which may have induced such a change. As was discussed in Chapter 8 with respect to the Adzera, in particular, and the Markham Family generally, it appears that the language groups ancestral to the present day groups left their predominantly maritime environment and eventually moved inland up the Markham Valley in the Morobe Province (PNG). In so doing, they moved into a region inhabited by NAN speakers and with whom they engaged in trade. The AN groups adapted themselves to the dominant NAN culture and modified aspects of their own cultural institutions, including their economy and their counting system, the latter becoming, like that of their NAN neighbours, a (2, 5) system.

Such an interpretation seems reasonably plausible and, indeed, a similar interpretation could be made in all cases where AN groups have acquired a (2, 5) system (or (2) or (2″, 5) systems as well). For many of the types of change discussed above it is possible to invoke similar mechanisms by which AN groups came into sustained contact with NAN groups and thereby acquired certain of their characteristics. This is particularly the case with those AN language groups belonging to the North New Guinea and Papuan Tip Clusters which moved onto the PNG mainland. There are a number of instances where change has occurred to the counting systems of AN languages which is less easily attributed to NAN influence. For example, the Admiralties Cluster languages, which now have the Manus type of counting system, would appear to have had little or no contact with NAN languages at all, at least according to their current distribution. In Chapter 1 we discussed Ross's reconstruction of the history of the Admiralties Cluster in which he envisaged the speakers of their ancestral language(s) leaving the POC homeland at a relatively early date and travelling to the previously uninhabited Manus Island. Whether these travellers had contact with NAN groups prior to their leaving their homeland, or on their way to Manus, perhaps in New Ireland, is unknown. The point is that we need to hypothesise that some sort of contact did take place if we assume that changes to counting systems are always induced and do not occur spontaneously. If we dismiss the possibility that such contact did take place then it seems difficult not to conclude that the Manus type of system is an example of an independently invented innovation.

We have suggested that the Motu type of system, which displays Seidenberg's neo-2 (Type 1) features in the second pentad, does not seem to have been acquired as a result of the diffusion of this system: where it does occur, it appears to be an innovation which has occurred among a small number of AN languages. As indicated earlier, nowhere in the New Guinea region does this type of system occur among the NAN languages: if the neo-2 system had been introduced into the region from outside, we would expect to find some trace of it among these. Since the AN languages did not acquire this system directly from NAN groups then it seems likely that we have here an example of a localised innovation. If this conclusion is valid, the implications for Seidenberg's theory, as far as the hypothesised neo-2 system is concerned, are considerable. We need, however, to consider, as we mentioned above with regard to the Manus type of system, whether such an innovation occurred spontaneously or whether it was induced by NAN influence.

The remaining systems that we need to consider are those in which a primary 10-cycle has been replaced by a primary 5-cycle and of which there are three different types. With regard to the (5, 10) system, Seidenberg's view was that this is a hybrid of a 10-cycle (perhaps a neo-2-10) system with a digit tally (5, 20) system. It also seems possible, although Seidenberg did not deal with these specifically, that the (5, 10, 20) and the (5, 20) systems are outcomes of interactions between AN 10-cycle systems and NAN digit tally systems. As indicated earlier, the AN 5-cycle systems found in the PNG region could have resulted from interactions with NAN groups in that the AN groups having these systems are all located in regions inhabited by NAN groups. This is not the case in Vanuatu and New Caledonia which are now inhabited only by speakers of AN languages but where we find, nevertheless, all three types of 5-cycle system. In order to account for this, we have suggested three possibilities: (1) long distance diffusion by other AN groups carrying 5-cycle systems with them from PNG, to the north, and incidentally by-passing the Solomon Islands and parts of central Vanuatu, (2) the prior existence of now extinct NAN groups in southern Vanuatu and New Caledonia which interacted with the immigrant AN groups, at some time in the past, to the extent of affecting their counting systems, or (3) that the AN groups in this region spontaneously changed their counting systems from 10-cycle to 5-cycle systems without external influence.

We have, then, a number of instances in which changes to the AN 10-cycle counting system could be accounted for by the direct influence of NAN language groups on AN language groups. In the cases, however, of (a) the Manus type, (b) the Motu type, together with (c) the 5-cycle systems of Vanuatu and New Caledonia, the reason why such systems occur requires a more complex explanation. First, with regard to (a) and (c), if these were outcomes of NAN influence, we have to allow for the languages having these systems to have come in contact with NAN groups at some time in the past because they exist in regions now uninhabited by such groups. Second, with regard to (a) and (b), neither of these systems is found to any extent in the NAN languages and therefore we cannot attribute their existence in the AN languages to direct diffusion from NAN groups. This, however, is not to discount the possibility that such changes to the AN systems were indirectly induced by contact with NAN groups and indeed Lean (1992) proposed a mechanism by which this may have occurred. Finally, we cannot discount the possibility that certain of these AN systems may have resulted from spontaneous change and were not induced, directly or indirectly, by NAN influence. In Chapter 10, we suggest a mechanism by which such spontaneous change may occur in certain special circumstances.

In considering the case of indirect NAN influence on AN counting systems, suppose that speakers of an AN language who possess an intact 10-cycle counting system come into a period of sustained contact with speakers of NAN languages who possess a digit tally system or, possibly, a 2-cycle numeral system augmented by a digit tally system. It is possible that a variety of outcomes could result from such a contact, the most likely being that the AN 10-cycle system is modified so as to acquire the 5-cycle feature characteristic of the digit tally system which, as we have seen, primarily affects the second pentad numerals 6 to 9 or 10. Thus we might expect the AN group to acquire any of the systems with (5, 10), (5, 10, 20), or (5, 20) cyclic patterns. However, we suggest that the effect on the AN system could be more generalised in that, while the construction of the second pentad numerals is affected, this does not necessarily involve the adoption of the additive 5-cycle construction of the form, say, $5+n$ but may involve instead other alternative constructions including the subtractive Manus type or the doubling Motu type. If we allow these possibilities we might expect to find in any related group of AN languages which had come in contact with NAN digit talliers, not only one resultant type of system but rather several different types, each with variant second pentads. Thus in the case of the Admiralties languages, for example, if the language(s) ancestral to these did come into contact at some time in the past with NAN groups possessing digit tally systems and this induced instability in the second pentad of the original AN 10-cycle system, then we might expect several different systems to be apparent in the daughter languages today. What we do find, in fact, is that in addition to the common Manus type of system, Nauna has a (5, 10) system, Seimat has a (5, 20) system, and Wuvulu-Aua has a system similar to the Motu type. Similarly, with the AN languages of the Central Province (PNG), which all belong to the (Peripheral) Papuan Tip Cluster, six possess the common Motu type of system, however both Kuni and Mekeo have (5, 10) systems while the Keapara system exhibits some subtractive constructions in its second pentad. We thus appear to have, within related groups of languages, a range of systems with variant second pentads which could be attributed to the interaction between the 10-cycle system and the (5, 20) digit tally. One such system includes Seidenberg's (1960) neo-2, or Motu, type which we suggest occurs as a result of such an interaction and cannot, as Seidenberg asserts, be regarded as a primary counting system in its own right.

The situation, then, in New Guinea and Oceania, regarding the way in which traditional cultures have interacted so as to produce changes in their counting systems is rather more complex and less predictable than that which we would expect from the views of diffusionists such as Seidenberg (1960) and Crump (1990). It is clear, for example, that the more efficient 10-cycle system of the AN speakers has not swept in and overwhelmed the less efficient systems of the NAN speakers and indeed in many cases the reverse situation has occurred. It is also clear, however, that diffusion of counting systems has occurred even if the way in which it has occurred is somewhat unexpected. There are few instances in the various types of change which were delineated above which cannot be attributed to direct or indirect influence of one language group on another. Even in the case of AN languages which are now located in regions which are uninhabited by NAN groups, we cannot rule out the possibility of past contact and hence NAN influence on the counting systems of the AN groups. We therefore have not yet found unequivocal evidence to support the idea that counting systems can be spontaneously and independently invented: the Manus and Motu type systems, together with the 5-cycle systems of Island Melanesia, may be examples which provide evidence that localised innovations do occur but it is also possible that these have not occurred spontaneously and may have been indirectly induced according to the mechanism described above. As will be discussed in the next section and in the next chapter with the views of recent research by Spriggs (2006, 2011), the only candidates which do appear to be genuine innovations are the 6-cycle systems and certain of the 4-cycle systems which occur among the NAN languages.

A Critique of Seidenberg's Theory

Seidenberg's theory is open to criticism on at least two levels. First, there are several shortcomings with regard to his methodology which consists largely in providing a big picture interpretation, at once historical and diffusionist, of the current geographical distribution of the various counting system types throughout the major continents. Second, it is possible to take issue with his interpretation of how this distribution came about with regard to the both the nature and the chronology of his various counting system types.

The Nature of Diffusion

Seidenberg (1960) did not consider in any detail the nature of the diffusion process. The two principles on which his theory was based are that 1) knowledge always arises in the centres of ancient civilisations and not anywhere else, and 2) "knowledge always passes from those who know to those who do not know, not the other way" (p. 218). No model was suggested in order to explain either the *vehicle* of diffusion, i.e the means by which a counting system is transmitted from one location to another, or the *mechanism* of diffusion by which features of a counting system are transmitted from one group to another. In both cases, there are certain necessary conditions that need to be met in order for diffusion to occur. If, for example, diffusion is thought to occur by a migration, or a sequence of migrations, from one location to another, then there must be a plausible geographical route which the migration could follow. Thus in considering how the 2-cycle system might have been diffused from its supposed origin in the Middle East to, say, the Australian continent, we need to take into account that the latter has been largely isolated since the last Ice Age, that is from 8 000 to 10 000 BP, and that there has probably been little human movement into the continent after that time. Furthermore, as we have noted above, when an immigrant group carries a counting system into new and inhabited territory, it is not necessarily the case that the introduced system will overwhelm and displace existing systems: the outcome may be quite the opposite, with the immigrant group accommodating itself to the existing culture and circumstances. Generally speaking, Seidenberg was not concerned with considering whether or not his theory is plausible in the light of the constraints placed upon it by the nature of the diffusion process itself.

Sources and the Lack of Collateral Evidence

The scholarly sources on which Seidenberg relied in order to develop his theory were drawn from anthropological, linguistics, and historical literatures, the data on Indigenous counting systems being derived from the first two. Much of this material was gathered in the nineteenth century and Seidenberg did not avail himself of the advances in either field in the period from 1930 to 1960. With regard to New Guinea and Oceania, Seidenberg's sources comprise about a dozen publications which deal with only a small proportion of the 400-odd AN languages and hardly any of the 700-odd NAN languages spoken in the region. Seidenberg's main source for the linguistic situation generally, and for the counting system situation in particular, both for this region and other parts of the world, was Schmidt's work published in 1926 but based on data gathered in a somewhat earlier period prior to 1910. Hence Seidenberg did not take into account, for example, the advances made by Dempwolff and others in the field of historical linguistics which established the Oceanic Hypothesis, mentioned in Chapter 1, and the essential unity of the Oceanic AN languages. While Seidenberg's failure to consult such material as this does not necessarily invalidate the main thrust of his arguments, it needs to be recognised that a wider review of pertinent literature would have provided a more secure basis for his theory.

A more serious omission concerns the lack of use of collateral evidence from fields outside the immediate purview of Seidenberg's sources: for example, the evidence from archaeology and prehistory places some important constraints on Seidenberg's speculations regarding the time scale that he allowed for the diffusion of his primary counting systems. As we have noted, Seidenberg located the origin of these in the ancient centres of civilisation of the Middle East - as though other equally ancient centres, such as those in India and China, need not be considered - and dates the genesis of the 2-cycle system at, or somewhat before, 5 500 BP. Archaeological data for the Americas, however, suggest that the major migrations from Asia occurred in the period 30 000 to 15 000 BP and that the ancestral Eskimo (Inuit) population was established by 4 000 BP (Zegura, 1985, p. 13). Similarly, the dates at which the main migrations into the New Guinea region, Australia, and Oceania occurred range from 50 000 or 60 000 BP to about 5 000 BP, as indicated in Chapter 1. These data suggest that the migrations which might have carried primary counting systems into these regions may have been largely completed before the time that Seidenberg suggested for the beginning of their diffusion. There is of course the possibility that such diffusion was not necessarily effected by the major migrations mentioned above but were rather brought about by a combination of the incursion of smaller groups and the subsequent transmission of systems by group-to-group interaction. This possibility seems less likely to bring about widespread diffusion in that the introduction of a new and relatively small group into an established culture which has political and economic dominance would probably result in the new group adapting to the existing culture rather than vice-versa.

Seidenberg's Theory: Data from Australia, New Guinea, and Oceania

Seidenberg's genealogy of counting systems was established very largely on data from the Americas and Africa and, to a lesser extent, on data from Australia and Asia. We consider here how his theory fits the data from New Guinea and Oceania by focusing on two main aspects of the theory: (1) the counting and tally sustems that are accorded primary status and those accorded secondary or hybrid status, and (2) the chronological order of the genealogical development. Two other aspects will also be addressed: Seidenberg's dating of the historical development of counting systems and the degree to which innovation and independent invention may have occurred.

With regard to the 2-cycle system, Seidenberg's view was that this would have been the first of his primary counting systems to have been introduced into the region and, generally speaking, the data from Australia, New Guinea, and Oceania do not controvert this view. As indicated in Chapter 3, various 2-cycle systems, including the pure 2-system, are commonly found throughout Australia and the Torres Strait islands. We also find, in the same locations, instances of pure 2-cycle counters also possessing body-part tallies. To a lesser extent, we also have evidence of the existence of (5, 20) digit tally systems in their pure form but also, in a larger number of cases, systems with (2, 5) or (2, 5, 20) cyclic patterns which could be interpreted as being hybrids of pure 2-cycle systems with digit tally systems. There is no firm evidence of other major types of counting systems being found in the Australian continent. While this situation does not controvert Seidenberg's views, there is no definite evidence to suggest that, of the three main types of counting system or tally that are present, one may have been introduced into the continent earlier than another. All we can infer is that it seems likely that they were introduced either with the early migrations into Australia or with the subsequent NAN migrations into the New Guinea region followed by diffusion southwards into Australia.

Wurm (1982) said of these migrations that

> the first wave of immigrants are believed to have been Australoids coming from the west who occupied first the northern part of what was then the single New Guinea-Australian continent, and gradually spread south through the entire continent. New Guinea and Australia became separated and isolated from each other by rising sea levels about 10 000 to 8 000 years ago … The first ancient Papuans entered New Guinea … and overlaid the Australoid population still present in New Guinea. Kirk … suggests that the immigration of the first ancient Papuans into New Guinea took place a short time after, or not too long before the isolation of New Guinea from Australia (through Torres Strait coming into being) and points out in support of this view that Papuans have not entered the Australian continent, at least not in significant numbers. (p. 226)

If we assume that counting systems were carried with the migrations into Australia then it seems likely, given Wurm's statement, that this diffusion was largely complete by 8 000 BP and that the systems were either carried by the original Australoid populations or were diffused from the early NAN immigrants into New Guinea. If this is the case, then the 2-cycle system, the (5, 20) system, and the body-part tally were not only present in Australia by 8 000 BP but were present in the New Guinea region as well. We have noted previously that Seidenberg's two types of neo-2 system are not found in the NAN languages nor are they found anywhere in Australia. There are several implications of this interpretation for Seidenberg's theory. First, that in agreement with Seidenberg, we regard the 2-cycle system and the (5, 20) system as having primary status. Second, that, contrary to Seidenberg, we do not regard the neo-2 system, in either of its forms, as having primary status and that where it does occur, in its Type 1 form, among a few AN languages, this is possibly the result of an interaction of a 10-cycle system with a (5, 20) digit tally system. Third, Seidenberg's dating of the genesis of the 2-cycle system as being contemporaneous with the Sumerian civilisation, that is at about 6 000 BP, seems unlikely in that the system was probably present in Australia at least 2 000 years prior to that time but most likely tens of thousands of years earlier.

Chapter 1 provided an outline of the currently accepted picture of the various language migrations into New Guinea and Oceania. The relative chronological order of these is:

1. the Australoid migrations into Australia and New Guinea,
2. a sequence of two or three NAN migrations, and finally,
3. the introduction of AN-speaking groups carrying pre-POC.

Keeping this in mind, the current counting system situation for this region may be interpreted as follows. The 2-cycle system and its variants, the body-part tallies, and the (5, 20) digit tally system, are primarily associated with the NAN languages: these types were established in New Guinea prior to the advent of the AN languages. The AN-speakers brought with them a pure 10-cycle system and, after the breakup of POC, this system was carried throughout Island Melanesia, Polynesia, and Micronesia. Interactions between AN and NAN groups brought about changes to the counting systems of some members of both groups: certain NAN groups acquired systems with (5, 10), (5, 10, 20), (10), and (10, 20) cyclic patterns, while AN groups, as we have seen above, acquired systems with primary 2-cycles, 5-cycles, and even 4-cycles. We have also suggested that several variant 10-cycle systems, such as the Manus and Motu types, may have been induced as a result of an AN-NAN interaction. According to this interpretation, then, those counting systems which appear to be candidates for primary status are the pure 2-cycle system (and, associated with some 2-counters, the body-part tally), the (5, 20) system, and the 10-cycle system: the first two were introduced into New Guinea (and Australia) first, the 10-cycle system being introduced subsequently.

This interpretation of the counting system situation in New Guinea and Oceania has both points of agreement and disagreement with Seidenberg's theory. First, as we found in the case of Australia, the evidence suggests that the 2-cycle system and the (5, 20) cycle system both have primary status as suggested by Seidenberg. The only other counting system to which primary status can be accorded is the pure 10-cycle system, introduced by the AN immigrants. As we have discussed earlier, Seidenberg did not regard the 10-cycle system in its pure form as having primary status: he suggested that it was probably diffused initially as a neo-2-10 system, was introduced into the Americas prior to the (5, 20) system, and subsequently became a pure 10-cycle system by linguistic change. Our interpretation disagrees with this view in at least two respects. First, we do not regard the 10-cycle system as having been introduced into the New Guinea region as part of a neo-2 system but that it came in its pure form. Second, the 10-cycle system was introduced after both the 2-cycle and the (5, 20) cycle systems. There is a feature of the AN 10-cycle system which suggests that, at some earlier time, it may have evolved from a digit tally system: the POC word for 5, **lima*, is identical to the word for "hand". However that may be, the 10-cycle nature of the system was already established prior to its introduction into New Guinea as the reconstruction of the Proto Austronesian numerals shows.

We have suggested above that, wherever the (5, 10) system occurs, this had largely arisen as a hybrid of the 10-cycle system and the (5, 20) digit tally. Seidenberg, who has a similar interpretation of how the (5, 10) system came about and that this has a hybrid, secondary status rather than primary status. With regard to such systems, Seidenberg ascribed some significance to the way in which their second pentads are constructed and, in discussing the counting system situation in Africa, he distinguished two types of second pentad construction and suggested that these actually constitute two different types of counting system, each type being diffused into Africa at different times. The data available do not unequivocally confirm or deny such a view. It is true that the second pentad constructions of 5-cycle systems can be classified into a relatively small number of types, the most common being of the form $5+n$, $5+c+n$, and $x+n$, as described in Chapter 5. Summarising the data from Chapter 5 in a single table (Table 9.4).

Table 9.4
Showing the Numbers of NAN and AN Languages Having Particular Second Pentad Constructions for 3 Types of 5-Cycle System

	$5+n$	$5+c+n$	$x+n$	Type
NAN	14	17	26	(5, 20)
	2	5	6	(5, 10)
	4	2	6	(5, 10, 20)
AN	18	21	10	(5, 20)
	10	19	74	(5, 10)
	12	22	7	(5, 10, 20)

In PNG, an analysis of how these various types of second pentad construction are distributed geographically indicates that the distribution appears to be random. In the New Ireland Province, for example, the neighbouring and related languages Tigak, Tiang, and Nalik, each has a (5, 10) system with one of the three different second pentad constructions (Lean, 1992, appendix on New Ireland). In Vanuatu, however, the situation is far more uniform with some 60-odd AN languages having 5-cycle systems with the $x+n$ second pentad type (and thus accounting for most of the 74 languages in the table above).

In the foregoing discussion of the various types of counting system which are found in New Guinea, Australia, and Oceania, we have focused on those types which are given prominence in Seidenberg's theory. This does not include either of the two types of system discussed in Chapter 7, the 4-cycle and 6-cycle. The reason that these are given scant attention is, perhaps, that neither system is adequately encompassed by the diffusionist view. Unlike the 2-, 5-, and 10-cycle systems, they do not have a wide geographical distribution over most continents: outside of New Guinea they are found only in Africa and North America. In each of these locations their occurrence is sporadic and in the case of the 6-cycle system it is rarely found in its completely intact form and is usually such that only some of its 6-cycle features are displayed. The 4-cycle system, however, is found in its fully intact form in both New Guinea and North America but in both locations it is restricted to a relatively small number of groups.

The inference which we might draw from the pattern of distribution of the 4- and 6-cycle systems is that neither was diffused and dispersed over a wide region but rather that each is instead a localised development. We have suggested earlier that the 4-cycle system had its genesis in digit tallying and that, whenever this type of system is found, tallying is done by treating the hand as comprising the four fingers but not the thumb. It may also be the case that the 6-cycle system had a similar origin in that the fingers, including the thumb, of the hand were augmented by the thumb joint, although the evidence for this is less robust.

An interpretation which we may therefore put on this is that the (5, 20) digit tally system was diffused but that the 4- and 6-cycle systems were not: these arose from varying the way in which digit tallying is carried out. While the large majority of digit talliers retained the conventional method, a relatively small number of groups varied the tallying procedure according to their own needs giving rise to localised innovations. We thus have a situation, not encompassed by Seidenberg's theory, in which the occurrence of counting systems is plausibly accounted for by a combination of both diffusion and independent invention rather than by diffusion alone.

In conclusion, then, the main focus of this chapter has been to test whether the current distribution of counting system types among the NAN and AN languages and, to a lesser extent, the Australian languages, may be accounted for by a diffusionist interpretation of events, generally, and by Seidenberg's theory in particular. In the discussion above three categories of counting systems or tallies were distinguished. First, there are the primary systems which we may regard as the original or proto systems introduced into the region as part of the cultural baggage of the immigrants. The prehistory of these systems and their subsequent fate will be elaborated in Chapter 10. Lean (1992) suggested that the three candidates for primary status are the 2-cycle, the (5, 20) digit tally, and the 10-cycle systems: the body-part tally may also be included in this category and this will be pursued further in the next chapter. That the first two systems are accorded primary status is in agreement with Seidenberg's theory; according the pure 10-cycle system primary status is not. He also argued that the evidence does not support Seidenberg's idea of the primacy of the neo-2 system.

The second category comprises the secondary or hybrid systems which have their origin in the interaction of the primary systems and are thus the products of diffusion which has occurred within the region. Thus the (5, 10) and (5, 10, 20) systems may be regarded as outcomes of the interaction of the (5, 20) and 10-cycle systems. The hybridisation of systems is allowed for in Seidenberg's theory. The other possible outcome of the interaction of primary systems is the displacement of one system by another: we have argued that the evidence indicates that displacement does not appear to have occurred to any great extent although there is evidence to suggest that the borrowing of part of a numeral lexis to increase the primary cycle of a counting system has occurred in a number of instances.

The third category of counting systems encompasses the 4-cycle and 6-cycle systems, discussed above, which appear to be innovations that have occurred in the region and therefore cannot be regarded as the outcomes of diffusion. It may be that the Motu and Manus types of 10-cycle system may also belong to this category. With these exceptions, the contemporary counting system situation may be interpreted as having resulted from a degree of diffusion between language groups already in place rather than diffusion introduced from some external source. There are certain aspects of Seidenberg's theory that appear to be supported by the available evidence. There are, however, a number of details of Seidenberg's theory, for example the ritual genesis of counting, the origin of tally methods, and the status of the variant second pentad constructions of 5-cycle systems, which have not been addressed here in any detail. These matters are largely speculative and probably will not be resolved one way or another by the evidence available.

Finally, we have suggested that the evidence casts doubt on the validity of Seidenberg's conjectures regarding the place of origin of the 2-cycle system and the chronology for the diffusion of his primary counting systems: it seems likely that both the 2-cycle system and the (5, 20) digit tally system were present in Australia and New Guinea by at least 8 000 BP, that is 2 000 years before the time suggested by Seidenberg for the genesis of the 2-cycle system in Sumeria. The choice of Sumeria, or indeed any one of the ancient centres of culture in the Middle East, as the source of counting seems, in any case, a decidedly Eurocentric view which ignores the existence of equally ancient centres in, for example, India or China. As Barrow (1992) pointed out, however, "the most ancient evidence of human counting is to be found in the remains of smaller groups of hunters and gatherers who existed long before any of these great centres of civilisation" (p. 31). These remains comprise engraved bones found in Africa which are clearly tallying devices. One of these dates from 35 000 B.C.; another, the "Ishango" bone, dates from about 9 000 BC and an analysis of the groupings of notches on the bone suggest that it may have been used as a calendrical device (Barrow, 1992; Bogoshi, Naidoo, & Webb, 1987; Joseph, 1987). The main implication of such evidence is that the locus of the genesis of counting, one of the most momentous inventions in the intellectual history of the world, may be found not among any of the known centres of "civilisation" but rather in humbler "primitive" societies whose existence predates these by, perhaps, many thousands of years. However, Barrow (1992) disputed whether civilisations invented counting over and over to meet their living demands, resulting in all people counting. He claimed that even the few 2-cycle systems occurring in vestiges in Australia, Africa and South America originated from Sumeria around 5 000 BP. The Persians around 2 500 BP used a decimal system. The Babylonian adaption of two marks in different positional relationships to record all 59 numbers for the 60 base system was regarded as too complex while base 5 was too small. However, the digit tally systems with base 20 were less easily discounted except to say they were too concrete. Similarly he noted body part tallies and classifier systems as too concrete. From his evidence in map form, he continued to explain the replacement by "civilisations" whom he noted interacted in one way or another to eventually reach what he claimed as the most efficient counting system using a zero and place value columns for recording and calculating. Barrow's (1992) argument, however, lacked the close grained analysis of Indigenous counting systems that Lean (1992) provided by a closer and more comprehensive analysis of the counting systems in one of the regions where multiple different kinds existed along with 2-cycle systems. Thus Barrow's analysis also needs scrutinising.

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