MATHEMATICAL ANTHROPOLOGY AND CULTURAL THEORY:
AN INTERNATIONAL JOURNAL
VOLUME 5 NO. 1 MAY 2013

BEYOND FICTIONS OF CLOSURE IN AUSTRALIAN ABORIGINAL KINSHIP

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SUBMITTED: DECEMBER 15, 2012 ACCEPTED: JANUARY 31, 2013

MATHEMATICAL ANTHROPOLOGY AND CULTURAL THEORY:
AN INTERNATIONAL JOURNAL
ISSN 1544-5879

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Abstract: *There is a contradiction between the fact that societal endogamy characterizes most models of Australian Aboriginal systems of descent, marriage and kinship, while societal exogamy, which is freely acknowledged by most observers, widely reported in the ethnographic literature and necessary for Aboriginal survival, is commonly missing from those models. In a field characterized by the modeling of formal relational systems of enormous complexity within societies, surely it is remarkable that representations and analyses of comparable complexity rarely address relations between and among Aboriginal Nations and their constituent societies. The tradition of building endogamous, generationally closed cognitive models of exogamous, behaviorally open societies is valuable for some purposes but is lacking in realism. Drawing on research in demography, genetics, kinship, historical linguistics, ecology and archaeology, I advocate moving beyond cognition and dealing with the facts of life as well.*

I use small-world networks, directed marriage cycles, the geographical distribution of exogamous marriages and additional measures to demonstrate that generational closure and societal closure, which define boundaries around traditional units of analysis in Australian Aboriginal kinship research, are not simplifying assumptions that enhance our understanding, but rather are fictions that distort our understanding. When we impose defective boundaries, perhaps due to over-zealously applying the organic analogy or comparable European folk theories, we cannot clearly discern what happens within each unit of analysis, how the units interact with each other, or how they collectively interact with the world around them.

My central question concerns inbreeding avoidance: How did Australian Aboriginal people and societies achieve a balance between ancestral law that stipulates canonical Kariera/Aranda descent, marriage and kinship patterns, or something similar to them, and biological "law" that demands viable inbreeding coefficients? My tentative answer focuses on reproductive strategies that systematically reduce societal closure while increasing societal complexity, including marriage with tribal (classificatory) kin instead of proper kin, alternate generation-level marriage, Omaha kin term skewing, a broad spectrum of systematic changes in skin terms, circulating connubia, endogamous (perhaps helical) generations and exogamous horizontal and vertical marriage asymmetry.

I suggest that Australian Aboriginal societies responded uniquely when confronted with the food crisis in prehistory. Facing hostile environments throughout most of the continent, and possessing multiple levels of adaptive kin relationships and a worldview that emphasized economic cooperation more than competition, they did not move toward domestication, technological innovation, social stratification and ownership of personal property. Instead, at least two innovations characteristic of Australia occurred; viz., the emergence of section and subsection systems and the adoption of firestick farming, both of which had the benign effect of imparting integration, stability, persistence and abidingness to ever-changing Aboriginal societies. In this context, statistically analyzable marital ties that span multiple generations and interlink diverse section and subsection systems among the Alyawarra; Eastern, Northern and Western Aranda; Wailbri, Kaititja, Warramunga, Anmatjerra and other language groups in Central Australia may be recent legacies of successful attempts to maintain stable regional populations in the face of 19th and 20th century genocide.

Dedication

I dedicate this work to F.G.G. Rose, N.B. Tindale and J.B. Birdsell. They shared an exceptional orientation toward the study of Australian Aboriginal societies in the mid-20th century that yielded large and important bodies of quantitative data whose value increases through time. Without their efforts, we would have much less systematic, continent-wide geographical, demographic, genealogical and genetic data to analyze now. Although I sometimes disagree with their conclusions, I am always deeply indebted to them for their common commitment to examining the foundations rather than the superstructures of Australian Aboriginal societies.

Acknowledgements

My thanks are many. I thank D.R. White for participating in the early development of this paper, a draft of which appears in an online PowerPoint presentation (Denham and White 2007). I greatly appreciate the valuable comments I received from readers including Pat McConvell, Laurent Dousset, Nancy Hubley, Valerie Munt, John Price and Doug White. As a retired independent scholar with no current academic affiliation, I am especially indebted to librarians, interlibrary loan services and online resources at Abbie Greenleaf Library, Franconia, New Hampshire; Lamson Library, Plymouth State University, Plymouth, New Hampshire; Berry-Baker Library, Dartmouth College, Hanover, NH; and UCI Libraries, Irvine, California, where Doug White has facilitated my online guest privileges.

BEYOND FICTIONS OF CLOSURE IN AUSTRALIAN ABORIGINAL KINSHIP

1. The Problem

Boundedness. Peterson (1976a:6) raised a major problem in his critique of the common assumption of closure or boundedness that characterized so much of 20th century ethnographic and theoretical research concerning Australian Aboriginal societies:[1]

> "Boundedness has an aesthetic and analytical appeal. … [B]y creating a finite universe it allows for the total exhaustion of a topic in the course of analysis and makes for ease in comparison. It is this intellectual appeal that transforms what are often really gradients, clines, areas of intergradation or zonation into discontinuous or bounded units … thereby obscuring the degree to which they are continuous variations on a common theme and making it possible to assimilate bounded systems to bounded tribes."

Here I address the general problem of boundedness among the Alyawarra speaking people of Central Australia, and other Aboriginal people throughout Australia, building on F.G.G. Rose's works concerning generational closure (Rose 1960) and societal closure (Jolly and Rose 1943).

Generational closure. On the basis of extensive demographic, genealogical and kinship research among the Wanindiljaugwa of Groote Eylandt in 1939-41, Rose (1960:63) demonstrated conclusively that the mean age difference between wives and husbands was approximately 18 years, a condition that he called "gerontocracy", and that systematic bilateral sibling exchange marriage, which I call generational closure, was impossible under those conditions.

Rose referred specifically to canonical mechanical models of Kariera and Aranda kinship as shown in Figures 1.1 and 1.2 that have their roots in Radcliffe-Brown (1931) and since have been depicted in myriad forms. His conclusions were unambiguous:

> "… the diagrammatic representation of the kinship structures of some Australian societies of so-called "Kariera" and "Aranda" types with bilateral first and second cousin marriage respectively, could have had reality only in a condition where gerontocracy was completely absent" (Rose 1960:8).

> "… under gerontocratic conditions the diagrams representing some of these systems are intrinsically impossible" (Rose1960:129).

[1] Throughout the paper I use reduced font size for quotations, captions, footnotes and discussions of details that you may want to skim quickly.

"… comprehensive diagrammatic structures depicting contemporary Australian kinship organizations striven after by ethnographers of the last generation are largely chimerical" (Rose 1960:179).

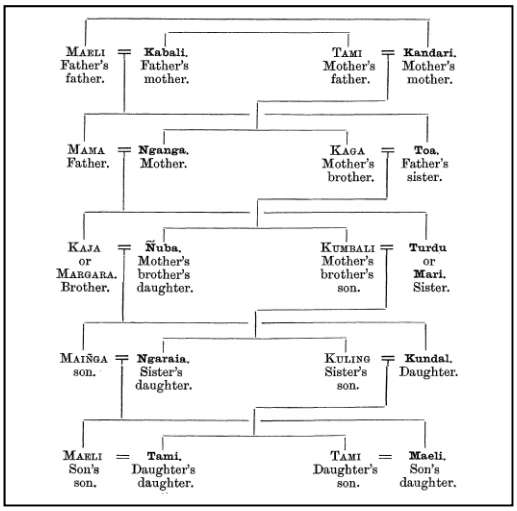

Figure 1.1. Kariera

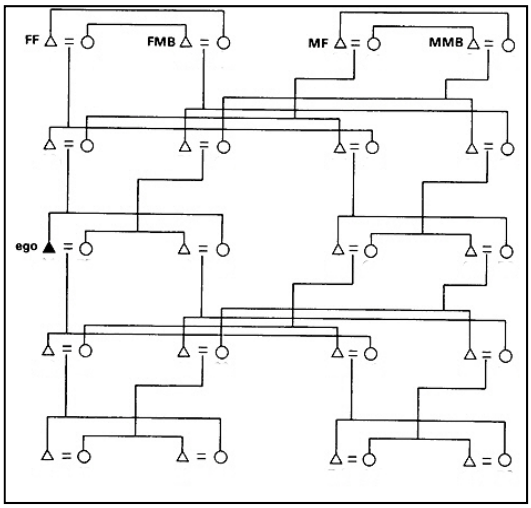

Figure 1.2. Aranda

When Rose presented his mathematically informed findings to A. P. Elkin for publication in 1945, Elkin, formerly a student of Radcliffe-Brown, suppressed them (Rose 1945; Munt 2011:109), apparently for political and/or theoretical reasons. After Rose published his Groote Eylandt book in East Germany in 1960, it was recognized as a classic in Australian Aboriginal research (de Josselin de Jong 1962), but its principal conclusions continue to be ignored systematically.

In his extended critique of generational closure, Rose (1960:168) suggested that in some societies such as the Kariera and Aranda, Malinowski's (1922) disjunction between what people say they do and what they actually do with regard to kinship terminology and marriage rules is facilitated by maintaining a "fiction" of systematic bilateral sibling exchange marriage; i.e., they cannot engage systematically in such marriages when wife-less-than-husband (W<H) age differences are extreme, but being somewhat unreflective as most humans are, they can talk about kinship and marriage "as if" that were not an issue (Hammel 1976:159-60). Comparative data on mean age at first marriage, wife-husband age differences and parent-child generation intervals (Binford 2001, Fenner 2005, Tremblay and Ve´zina 2000, Helgason et al. 2003) support Rose's interpretations. Since it appears that most or all Australian Aboriginal societies were characterized to a greater or lesser degree by a mean W<H age bias of about 14 years, ideal representations of generational closure in Figures 1.1 and 1.2 are lacking in realism (Denham et al. 1980). In other words, from Rose's perspective, cognitive models of Australian Aboriginal kinship that pay insufficient attention to human biology are problematic. I agree with that judgment and pursue it here.

Rose's (1960) analysis of the canonical models pointed out limitations but stopped there. He told us what was wrong with the old models, but did not provide anything with which to replace them. Perhaps that is why his findings have had far less impact than they should have.

Recently I sought an alternative to generational closure (Denham 2012). Focusing on Kariera, Wikmunkan, Wanindiljaugwa, Northern Aranda, and Alyawarra, I dealt with "realities" rather than "fictions", thereby gaining more understanding of what actually happens maritally, demographically and genetically in societies with open generations. A portion of my suggested solution appears in Figure 1.3, where a single pair of open, endless, age biased generations replaces the unlimited number of closed generations in Figures 1.1 and 1.2. Under some conditions they may coil around their vertical axis to form a helix with its slope determined by the W<H age bias. Whether this or derivative structures prove to be the best solution to Rose's problem of generational closure remains to be seen, but at least it was an attempt to deal with realities based on openness rather than with fictions based on closure.

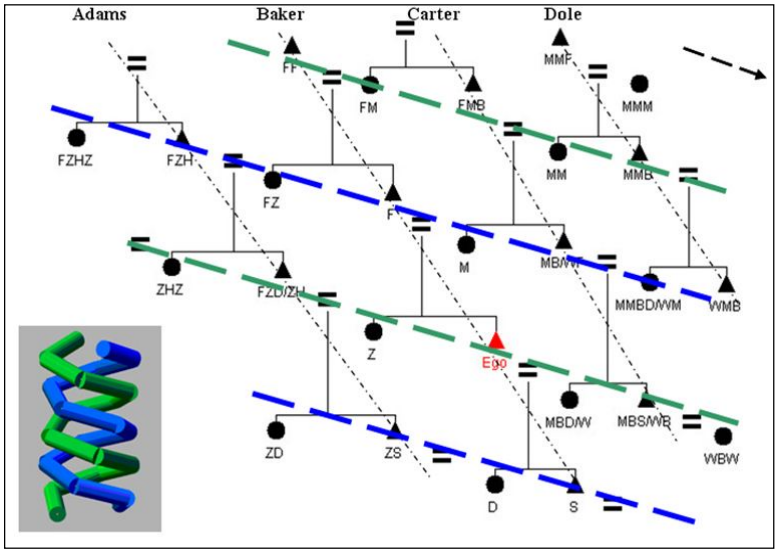

Figure 1.3. Age biased generations forming a double helix in endogamous societies.

Societal closure[2]**.** Throughout this paper, I use *society* in an attempt – sometimes unsuccessful - to avoid the European colonial connotations of boundedness that afflict *tribe*

[2] The usage of *open* and *closed* in the context of hunter-gatherer social organization is problematic. For example, a) Binford (1968:328-331) defines them strictly in terms of mechanisms that maintain steady state populations. He says that a *closed population system* is one "in which a steady state is maintained by internal mechanisms limiting numbers of offspring at the generational replacement level", while an *open population system* is one "in which size and/or density is maintained by either the budding off of new groups or by the emigration of individuals." b) Lourandos (1997:24) defines *open* and *closed* much more loosely in terms of simplicity and complexity. He says that *open social systems* characterize relatively simple egalitarian hunter-

and *language group* as applied to Aboriginal Australians. Figures 1.1 and 1.2 represent societies that are spatially closed within discrete territories; cognitively closed with distinct names; reproductively, genetically and genealogically closed by strictly endogamous marriages; temporally closed with strictly repeating static patterns of descent, marriage and kinship; economically closed with no access to distant resources in case of local shortages; and generationally closed as Rose noted. They agree with a definition by Lévi-Strauss (1969:47) who says that, "True endogamy simply represents the exclusion of marriage outside the culture … defined by certain concrete characteristics such as name, language, race, religion and so on", and with Hammel (1960:15) who says that a basic assumption of each model of marriage-section systems that he discusses is that "the entire model is endogamous." Furthermore, although the diagrams are silent with regard to population size, these societies generally are described as tiny, with mean population sizes of about 500 people (Radcliffe-Brown 1930:696 and many subsequent authors).

If we take these diagrams at face value, naively assuming for the moment that they could or should represent actual relationships among actual people, Figures 1-3 in their most basic, extreme and literal forms would generate extreme inbreeding coefficients[3] and the societies would be increasingly susceptible to extinction. In other words, the canonical models disregard biological inbreeding avoidance and cultural incest avoidance as if neither applied to Aboriginal Australians as they do to people everywhere else, which of course is a fiction.

Birdsell (1993:7) sealed the borders when he argued that, since only 12-14% of marriages involved extratribal unions, the Australian Aboriginal tribe was an essentially endogamous genetic isolate. Being fully aware of the inbreeding problem, he attempted to gloss over it by saying great efforts were made to insure that potential spouses had no known biological

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gatherer societies with fluid group structure, high mobility and immediate return economic strategies, while *closed social systems* characterize more complex hunter-gatherer societies with bounded discrete groups, more formal leadership and delayed return economic strategies. c) In this paper, I define *open* and *closed* strictly in terms of marriage practices. Generational closure refers to systematic bilateral sibling exchange marriage in societies with no or trivial W<H mean age differences, while generational openness refers to horizontally and vertically asymmetric marriages (typically with younger MBD) in societies with large W<H mean age differences. Societal closure refers minimally to systematic societal endogamy while societal openness refers to systematic societal exogamy at low but consistent rates.

[3] Inbreeding may yield higher than expected phenotypic expressions of deleterious recessive genes within a population. As a result, first-generation inbred individuals may be more likely to show physical and health defects including, for example, *increased* genetic disorders and infant mortality and *reduced* fertility, birth rate, growth rate, adult size and immune system function. Parent-child and sibling incest in a single generation yields an inbreeding coefficient of F=0.250. Experimental studies are impossible, but simulations using FSpeed2 (2005) show that, after 10 generations of systematic inbreeding as portrayed in Figures 1-3, people in the bottom rows of those Figures would have the following inbreeding coefficients: Kariera F=0.508, Aranda F=0.245 and Alyawarra F=0.230. These numbers do not take into consideration the long term impacts of physical and health defects mentioned above. Barring intensive culling, all of those coefficients would be expected to increase systematically across additional generations, and none would be expected to yield indefinitely sustainable, small, closed human populations (Bittles 1994, 2001, 2009; Bittles and Black 2010).

relationship to each other and that the impact of inbreeding was negligible (Birdsell 1985:113).

I suggest that Birdsell's argument here is based on a "fiction of endogamy" that dismisses the 12-14% exogamy rate as being irrelevant when in fact it is by no means inconsequential. It is accompanied by a compensatory "fiction of no inbreeding" that is intended to avoid the problem when in fact inbreeding is of major importance, albeit far less intensive than the canonical models suggest, and is balanced by outbreeding.

Thus I see a contradiction between the fact that societal endogamy characterizes most models of Australian Aboriginal systems of descent, marriage and kinship, while societal exogamy, which is necessary for their survival, widely acknowledged and often reported in the ethnographic literature, is commonly missing from those models. In a field characterized by the modeling of formal relational systems of enormous complexity within societies, surely it is remarkable that representations and analyses of comparable complexity do not exist for relations between and among societies. The tradition of building conceptually closed models of behaviorally open societies is seriously lacking in realism.

Although canonical Kariera and Aranda are highly attractive to specialists in cognitive models, they are boxed in by systematic closures that transform simplifying assumptions into unrealistic fictions. They superficially resemble Dravidian kinship systems, common in South India and elsewhere, so long as we ignore both a) the biological impossibility of systematic bilateral sibling exchange marriage and b) the resulting partition of Ego's wife's descent moiety into wife-givers and wife-takers, both of which derive from the age bias and are incompatible with Dravidian kinship (Trautmann 1981 and many others). My objective here is to think outside that box in hopes that something worthwhile will come of the effort.

Using a wide range of sociocultural, biological (demographic, genetic, genealogical, ecological), linguistic, ecological and archaeological evidence, I argue that societal boundaries are permeable rather than impermeable, that Australian Aboriginal societies have survived by engaging in a quantifiable mixture of inbreeding and outbreeding, that genealogical relations encompass the full spectrum from very close inbreeding to remote outbreeding, and that ubiquitous age biased generation moieties facilitate intersocietal marriages when appropriate ecological conditions occur. I acknowledge the social and economic benefits associated with exogamy but deal with them later.

Operational matters. The problem is not simply: How can a tiny society generate and maintain a viable exogamy rate? If Australian Aboriginal societies were like many other human societies, generating that exogamy rate would not be remarkable. People could simply obtain spouses from adjacent or more remote societies at their discretion, by whatever strategies and tactics they chose, and nobody need notice or care.

But Australian Aboriginal societies are different. They generally use two separate, tightly interlocked kinds of kinship systems that apply concurrently and almost universally, and

have precise requirements concerning relationships between marital pairs. Those relationships, reflected in the canonical patterns that have been detected so widely in Aboriginal kinship, seem to be embedded deeply in the ancestral traditions (Spencer and Gillen 1899, 1927; Stanner 1965; Strehlow 1947, 1971). To reject them would be to reject ancestral law, both constitutive and regulative (Searle 1995, 2007:88), an act yielding "wrong marriages" that in especially law abiding societies were incestuous (e.g., Lawrence 1937, ALRC 1986) and were potentially punishable by death. I suggest that ancestral law, based on long term observation of reproductive histories, helped to prevent damage to Aboriginal populations as a natural consequence of parent-child and sibling inbreeding. But the law alone was not sufficient to the task.

Thus the fundamental problem on a day to day basis is that of inbreeding avoidance. If people follow canonical patterns, they generate extreme inbreeding coefficients; if they do not follow them, they violate ancestral law. Thus the question behind all my other questions is: What is the best way to achieve a balance between ancestral law that stipulates canonical Kariera structures or something like them, and biological law that demands a viable inbreeding coefficient?

In addition to day to day operations, I am concerned throughout this paper with structures and processes, both ecological and social, that have persisted and changed over many millennia - perhaps 50 millennia - a time scale that makes conjecture inevitable. My argument deemphasizes horizontal societal closure and competition that dominate the economic, demographic and evolutionary legacies of A. Smith, Malthus and Darwin. Instead I follow precedents that favor horizontal societal openness and cooperation including research on endosymbiotic theory, horizontal or lateral gene transfer, coevolution of Australian ecosystems, coevolutionary genetics of ecological communities, evolution of cooperative strategies and multilevel selection theory.

Technical matters. Although this paper relies on data from many societies and sources, I refer frequently to my fieldwork in 1971-72 with the Alyawarra speaking people of Central Australia. In several previous publications, I have described my research setting, field methods, data sets, analytical procedures, and earlier findings. References list my major Alyawarra works including the Alyawarra Ethnographic Archive (Denham 1971/2007) and the KinSources Kinship Data Repository (Denham 2010a, 2010b).

Section 2 focuses on demography, Section 3 on kinship, linguistics, genetics and genealogies and Section 4 on archaeology and ecology that convert static structures to dynamic processes. I am by no means an expert in all of these areas, but I am certain that all of them must be addressed if we are to understand the relationships explored here. If I misinterpret or omit some important points, please share your expertise and help me improve my argument. Clearly my reach exceeds my grasp (Browning 1855, lines 97-98).

Appendix 1 is a glossary, Appendix 2 provides online access to Alyawarra data used in preparing this paper, and Appendix 3 shows preferred and traditional spellings of relevant language group names.

2. Demographic History

Due to the long standing assumption that language group endogamy as depicted in kinship models characterizes Australian Aboriginal societies, my first objective must be to establish that observable properties of language group exogamy warrant further analysis, and to use existing tools to measure some of those properties. I focus here on demographic properties that bear on questions of openness and exogamy continent-wide. I explore topics including: demographic data on exogamy from diverse ethnographic and theoretical perspectives; exogamy rates in small-world networks following Watts and Strogatz (1998); geographical patterns in exogamy; language group population sizes and the so-called "magic number 500" (Binford et al. 1968, Kelly 1994); and population stability using historical data on net reproductive rates.

Since I collected a great deal of demographic data but no genetic data with the Alyawarra, I focus on demographics that have genetic implications but do not directly examine Birdsell's (1993) genetic data. My conclusion, and implicitly that of others (e.g., Ayres et al. 2002, Walsh et al. 2006) who have conducted only a very few DNA studies of Aboriginal populations, is that Birdsell's (1993:7) confidence that "the tribe is an essentially endogamous genetic unit in Australia" may be excessive.

Societal boundaries, nations and drainage basins

Societal boundaries. Traditionally, models of Australian Aboriginal kinship have incorporated exogamy among clans and moieties but have disregarded it among societies, tribes, language groups and dialectal groups. The following quotations concerning boundaries suggest that societal exogamy is just as important as clan and moiety exogamy, at least in some societies. I do not doubt the existence and importance of language groups among Aboriginal people, but I do question the sometimes excessive emphasis that writers have placed on their boundaries.

Concerning Aboriginal people in general, Elkin (1964:61) says:

> "A great deal of ingenuity is displayed when the social organization of the visitor's tribe differs in important particulars from that of the local tribe. The one may have matrilineal moieties and the other eight subsection groups divided between two patrilineal moieties, but the visitor is given a status in the home tribe which can be shown to be theoretically justifiable and is practically workable."

Concerning the Kariera, Radcliffe-Brown says:

> "… it is impossible to say with certainty to which tribe each clan belongs. … there are often near the border a number of local groups that occupy an indeterminate position" (Radcliffe-Brown 1913:160). "When a stranger comes to a camp that he has never visited before, he does not enter the camp, but remains at some distance. A few of the older men … [approach and ask], 'Who is your *maeli*?' (father's father). The discussion proceeds on genealogical lines until all parties are satisfied of the exact relation of the stranger to each of the natives present in the camp", i.e., kinship terminologies and genealogies do not stop at language group boundaries (Radcliffe-Brown 1913:151).

Concerning the Worora, Blundell and Layton (1978:231) carefully avoid references to tribes:

> "Aboriginal societies … are characterized by exogamous patrilineal clans which are totemically linked to spatially discrete and named areas of land referred to here as clan estates [Countries]. Clan members also recognize larger groupings formed by … geographically adjacent clusters of clan estates … generally referred to as "tribes" by anthropologists [but *not* by Aboriginal people] … they include the Worora, Wunambal and Ngarinjin. … Probably of greater importance … are two great … moieties … [that] are patrilineal, exogamous and associated with their own distinct sets of totems and areas of land. [One aspect of exchange in these societies is] … the transfer of women between clans in marriage. … Since the clans … are divided between the two exogamous patrilineal moieties, it is possible to characterize these exchanges at two levels: as taking place between clans and as taking place between moieties [but *not* as taking place between tribes]."

Concerning the Murngin,Warner (1958) says:

> "The eight tribes considered in this book, … , have the same kinship system, the same form of local organization [clans, moieties, phratries, tribes, hordes], largely the same myths and ceremonies, in general the same culture … and a modified subsection system. Clan and moiety are the two most important units. The tribe is of minor importance (Warner 1958:15-16) … [and] when measured by the ordinary definitions of what constitutes a tribe fails almost completely. … Tribal memberships of the clans on the borders of two tribes are uncertain and changing, or the people may sometimes insist that they belong to both tribes. … Even clans well toward the center of a tribe's territory will, under certain circumstances, range themselves with another group" (Warner 1958:35).

Concerning the Eastern Anmatyerr who live adjacent to the 4-section Alyawarra and the 8-subsection Eastern Arrernte, Green (1998:16 fn.17) says:

> Even within the region where people identify as Eastern Anmatyerr, some people are operating within a section system and others a subsection system. The use of either is linked to particular geographical areas of land or "estates" [i.e., different patriclans (Countries) in the same language group use different sets of skin terms, perhaps based on geographical proximity to Alyawarra or Eastern Arrernte Countries].

Thus closed, endogamous models of well documented kinship systems may impute boundaries where they are weak, ambiguous or nonexistent. Even where boundaries are present, their placement may be questionable, they may be important cognitively but not genetically or socially, etc. Individual examples are less important here than the general pattern they reveal.

Drainage basins and nations. Peterson's (1976b) map features 17 proposed culture areas that correlate approximately with the major drainage divisions of Australia. Sutton (1990) extends Peterson's work in two important ways. First he examines the composition of groups intermediate in size between Birdsell and Tindale's small dialectal tribes and Peterson's much larger culture area groupings; second he speculates that the populations of these mid-range groups are dynamically interlinked through migration over periods of unspecified duration. Here I build on his first point and return to his second point later in the paper.

Sutton is especially concerned with groups known in the late 19th century as "nations" by Howitt, Mathews and other early anthropologists (cited and quoted by Blackburn, 2002:137-150), from AW Howitt Papers 1883-1904 and RH Mathews Papers 1894-1906 as listed in the bibliography to Blackburn (2002:156-157).

> "Evangelicals of the early 19th century used the Biblical notion of a nation as a cultural group of common descent, pre-dating 19th century ideas of the nation as a sovereign people. The[y] drew their idea of a nation from that found in the King James Version of the Bible: that God had divided humanity up equally, not into races, but into nations, and that people of all nations were capable of receiving God's grace (Blackburn 2002:137)."

These Australian Aboriginal "nations", whose constituents were "tribes" that generally numbered from 5 or 6 to as many as 20, were defined variously in terms of commonalities in language, initiation ceremonies, kinship organization based on moieties and class systems, a community of descent, and more or less frequent intermarriage (Howitt 1889:35 quoted by Blackburn 2002:141). In other words a "nation" to Howitt and Mathews was a cluster of what Birdsell and Tindale later called "dialectal tribes". In the remainder of this paper, I use "nation" *sensu* Howitt and Mathews for intermarrying clusters of neighboring societies that may resemble Peterson's (1976b) "culture areas" and Lourandos's (1997:25) "alliances".

Exogamy rates

Tindale (1953, 1976) and **Birdsell** (1953, 1976, 1993), on the basis of extensive topographic, demographic and genetic research in Australian Aboriginal societies, argued that those societies were both tiny and isolated. The problem here lies in the co-occurrence of these two constraints. Either tiny *or* isolated need not be problematic, but both tiny *and* isolated point toward extinction. I suggest that their emphasis on *both* needlessly exaggerated the belief in the impermeability of territorial, cognitive, marital and genetic boundaries.

I do not suggest that Birdsell and Tindale were uniquely villainous in implicitly offering support for building closed kinship models of open societies. Rather, I see them as being representative of people who, with the best of intentions, were seduced by the aesthetic and analytical appeal of boundedness (Peterson 1976a:6), with ethnocentric roots deep in the colonial notion of tribe (Fried 1975, Blackburn 2002), and focused on this issue to the exclusion of many others (see Birdsell 1970, 1973, especially the CA Comments following these articles).

Tindale (1953) published his best demographic data, some of which he considered to be problematic, in response to a request from Birdsell. His primary concern was with the "percentage of extratribal marriages". In Table 2.1, I have integrated and edited three sets of data from: Tindale's (1953) Tables 1, 2 and 3; Birdsell's (1993:15) data in Table A-5; and my own Alyawarra data (Denham 1971/2007, 1975, 2010a, 2010b) which I describe in detail below. I omitted societies labeled as having "incomplete data" or showing a total of fewer than 10 cases, and recomputed all subtotals accordingly. The subtotals show that 13.1% of 1244 marriages reported by Tindale and Birdsell were exogamous, and 86.9% were endogamous. Due to intrinsic problems associated with recording boundaries and conducting genealogical censuses, all of these numbers should be treated as estimates that are less precise than the decimal points suggest.

Tribal Blocks (see sources for definitions)	**Endogamous Marriages**	**Exogamous Marriages**	**Total Marriages**	**Percentage Exogamous**	**Fieldwork Sources and Dates**
Southwestern	80	10	90	11.1	NBT 1938-39
Southeastern	59	6	65	9.2	NBT 1938-39
Negritic with adjoining	119	31	150	20.7	NBT 1938-39
Central Negritic without adjoining	81	20	101	19.8	NBT 1938-39
Carpentarian	80	7	87	8.0	NBT 1938-39
Central	124	15	139	10.8	NBT 1930-32
Central (Ngalia 1931)	144	12	156	7.7	NBT 1931+1951
Northwestern+Western	394	62	456	14.1	JBB+NBT 1952-1954
Column subtotals	**1081**	**163**	**1244**	**13.1**	
Central (Alyawarra)	160	47	207	22.7	WWD 1817-1979
Column totals	**1241**	**210**	**1451**	**14.8**	

Table 2.1. Australian Aboriginal language group exogamy
Sources: 8 upper blocks NBT=Tindale 1953, JBB=Birdsell 1993; 1 lower block: WWD=Denham 2010b. Problems with Column 1: "Tribal block" and the row labels appear in the sources but are defined poorly. Consult the sources to identify the societies included in each so-called "tribal block".

With regard to societal boundaries, Tindale (1953:169,186) writes as follows about data collected during several expeditions between 1931 and 1951:

> "…among Australian tribes whose cultures had not been grossly disturbed by the effects of European contacts … about 15% of marriages are intertribal. … In a series of large

> blocks of tribes the percentages of recorded intertribal marriages range from about 7% to 21%."

Tindale simply reports the findings as he sees them. Clearly the numbers are small, but his argument as a whole in his 1953 paper makes it clear that language group exogamy was an ordinary, unremarkable occurrence throughout much of Australia during pre-colonial and early colonial periods.

But Tindale's data seems not to accommodate any ambiguity concerning language group membership. Even though Radcliffe-Brown (1913) says "it is impossible to say with certainty to which tribe each clan belongs", and Blundel and Layton (1978) and Warner (1958) clearly agree with that proposition, Tindale's commitment to the concept and integrity of the "tribe" is unwavering. Radcliffe-Brown's (1913) statement that, "there are often near the border a number of local groups that occupy an indeterminate position"; Warner's (1958) statement that, "Tribal memberships of the clans on the borders of two tribes are uncertain and changing, or the people may sometimes insist that they belong to both tribes"; and my own data from the Alyawarra (Denham and White 2005) showing a small cluster of people with ambiguous language group affiliations (see Figure 3.5 below) together suggest that Tindale's certitude with regard to tribal membership is perhaps excessive, and that he could have erred, randomly or systematically, either for or against endogamy or exogamy. So we must accept Tindale's figures as his best estimates but with unknown biases.

Birdsell, in a series of papers from which I quote only three comments, progressively makes Tindale's argument seem more restrictive than it was in Tindale's paper. First Birdsell (1976:97-99) said that:

> "A genetic isolate is loosely defined as a population unit in which 50% or more matings occur within its boundaries. Tindale (1953) determined that over 85 percent of the marriages occurred within the dialectal tribe in Australia, and less than 15 percent involve women coming from other tribes. The Australian tribe, since it imparted to the whole continent of Aborigines a bounded and cellular structure, is an island type of genetic isolate of a very tight reproductive character".

Near the end of his career, Birdsell reiterated and strengthened his 1976 position in two statements that I paraphrased earlier but now quote in full:

> "The evolutionary importance of the tribe rises from the fact that a great majority of marriages were contracted within the tribe and only … 12-14 percent involved extratribal unions. So the tribe is an essentially endogamous genetic unit in Australia, in fact, a genetic isolate or a deme" (Birdsell 1993:7).

> "Tindale has pointed out that in arranging marriages great efforts are made to assure that the candidates have no known biological relationship to each other. … very few

> individuals in [an Aboriginal Australian] population are affected [by inbreeding] and the impact is negligible" (Birdsell 1985:113).

The actual change in the reported exogamy rate between 1953 (15%) and 1993 (13.1%) is less than 2%, but the systematic increase in the *appearance* of closure and Birdsell's effort to minimize its genetic implications are bothersome.

This matter is complicated by the typically unclear distinction between a) rules or preferences for marriage with classificatory kin that have been reported frequently, and b) statistics on actual practices that have been reported much less frequently. For example, I.M White (1981:21) remarks that:

> "... in much of Lévi-Strauss's writing about Australia, we find him unable to comprehend that compliance with a prescribed marriage rule seldom entails marriage with a close relative. In nearly all Australian societies the rule is for a man to marry a certain type of cross-cousin, but not the actual one."

I do not doubt that Birdsell and White are correct with regard to rules, but I am skeptical of the assumed strong positive correlation between rules and actions; i.e., knowing what the rules say does not necessarily tell us what the people do.

Adams and Kasakoff (1976), in a study of data concerning endogamy from 21 societies of various economic types from around the world, use quantitative (not just "low", "moderate" and "high") endogamy rates to measure genetic isolation in the sense in which Birdsell uses the term. Their work puts Birdsell's and Tindale's figures into a broader ethnographic perspective.

Adams and Kasakoff (1976) said they:

> "… plotted the sizes of endogamous groups reported by ethnographers against the percentage of endogamy they reported for these groups."

They acknowledge that their data and conclusions are imprecise, but they find that as population size increases, endogamy rates change systematically but nonlinearly. In societies with a broad range of medium sized populations ("several hundred to 10,000 individuals"), the endogamy rate remained more-or-less constant at about 80%±10%, thus constituting what the author's called their "80% group". From Adams and Kasakoff's perspective, Australian Aboriginal endogamy rates are near the higher end of the 80%±10% range.

As societies become larger than those in Adams and Kasakoff's 80% group, the endogamy rate gradually approaches 100%, for people have increasing opportunities to find acceptable mates within their own populations. As societies become smaller than the 80% group, the endogamy rate approaches 0%, for people have fewer opportunities to find acceptable mates within their own populations and must marry out or die out.

Certainly exogamy rates appear to be low in Aboriginal Australia, but perhaps the closure is less severe cross-culturally than is suggested by Tindale's data and Birdsell's interpretations of it.

Alyawarra exogamy. Intersocietal exogamy among the Alyawarra with whom I worked in 1971-72 is summarized in the penultimate row of Table 2-1, and appears in greater detail in Table 2-2. It is based on three sources: my own (Denham 1971/2007, 2010a, Appendix 2) Alyawarra field data from 1971-72; Northern Territory Administration (NTA) Aboriginal Census Data for the Alyawarra (Denham 2010b) and adjacent language groups recorded between 1952 and 1973, stored in the National Archives of Australia, and generously provided in raw form to me by Paul Mackett (2005/2012); and Moyle's (1986) Alyawarra field data from 1979-80 (Denham 2010b). These datasets contain demographic, census and densely interconnected genealogical data for 1461 people born between approximately 1817 and 1979, living throughout much of the southeastern quadrant of the Northern Territory. In addition to depicting more recent events, the data reveals pre-contact and very early post-contact marriages between the Alyawarra and their near and distant neighbors.

Considering language group membership for the population as a whole, but disregarding 272 people for whom language group membership data was not available, the dataset shows that about 80% of 1189 people were identified as Alyawarra; about 12% were identified as Aranda but the Northern/Eastern/Western distinction was missing in most cases; Kaiditch and Walbiri constituted nearly 3% each; and the remaining 2% were distributed over 5 other language groups. All non-Alyawarra included here were affines or children of Alyawarra.

AIATSIS Code	One Spouse	Other spouse	Number of Cases	Percentage of Cases
C14	Alyawarra	Alyawarra	160	77.3
C8-E	Alyawarra	Aranda, Eastern	10	9.7
C8-N	Alyawarra	Aranda, Northern	7	
C8-W	Alyawarra	Aranda, Western	3	
C15	Alyawarra	Wailbri	10	4.8
C13	Alyawarra	Kaititja	9	4.3
C18	Alyawarra	Warramunga	5	2.4
C8.1	Alyawarra	Anmatjerra	1	0.5
C16	Alyawarra	Wakaya	1	0.5
N153	Alyawarra	Yanyula	1	0.5
		Total	**207**	**100.0**

Table 2.2. Alyawarra intersocietal exogamy, AU10 Alyawarra 1817-1979 dataset (Denham 2010b).

Table 2-2 summarizes all 207 marriages for which language group affiliations are known. It shows that 160 (77.3%) marriages were endogamous and 47 (22.7%) were exogamous. The

distribution of marriages by language groups closely resembles the distribution of the whole population by language groups.

The Alyawarra data summary that appears in the penultimate row of Table 2-1 reveals that the Alyawarra data are compatible with Birdsell's and Tindale's tabulations in the upper part of the table, being less than 3 percentage points higher than Tindale's values for both of the categories that he called "Negritic". At the same time, however, it raises the "Percentage Exogamous" column total from 13.1% excluding the Alyawarra, to 14.8% including the Alyawarra. Not surprisingly, the mean values reported by Birdsell and Tindale are quite sensitive to the inclusion or exclusion of numbers for one or a few language groups.

The Alyawarra exogamy rate of 22.7% is in the upper third of Birdsell's and Tindale's estimated range, and fits comfortably among Adams and Kasakoff's (1976) "80%

Small-world networks

The 15% exogamy rate that Tindale (1953) and Birdsell (1993) report for Australian Aboriginal societies, the 20% rate that Adams and Kassakoff (1976) report for 21 societies with populations below 10,000 people, and the 22.3% rate among the Alyawarra are interesting albeit approximate figures, but what do they mean? I suggest that they can be interpreted in at least two different ways.

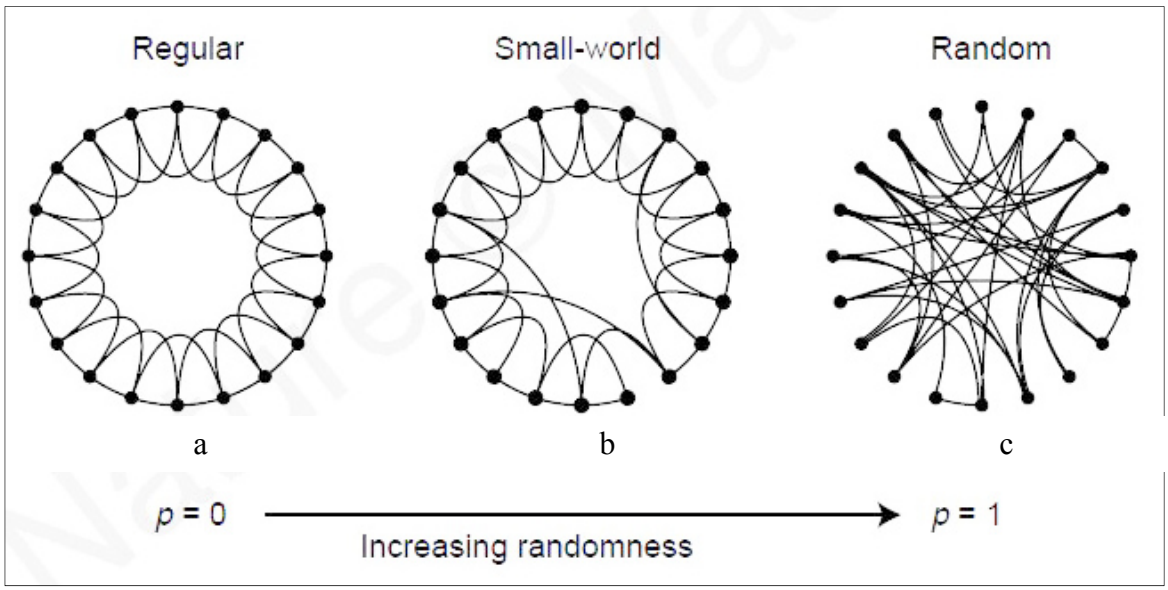


Figure 2.1. Interpolating random rewiring to yield a small-world network.
An illustrative continuum with three panels: a) a regular endogamous ring lattice, b) a transitional exogamous small-world network, and c) a random or panmictic network, all with the same number of points/vertices/Countries (20) and lines/arcs/marriages (4) (Watts and Strogatz 1998:441 Figure 1).

[endogamy] group". In other words, the Alyawarra data do not appear to be at all anomalous, but are consistent with other Australian Aboriginal exogamy rates and with Adams and Kasakoff's cross-cultural data.

Let Figure 2.1 be an abstract representation of marital relations among Australian Aboriginal societies. It is an illustrative continuum that has three panels: a) a regularly structured ring lattice, b) a transitional network with 3 deviations (3/20=15%) from the rigid regularity of the ring lattice, and c) a randomly connected network. All three have 20 points (vertices), each of which is linked to 4 other vertices by lines (edges or arcs), 2 on the ring itself and 2 inside the ring. The Figure is based on Watts and Strogatz's (1998:441 Figure 1) analysis of small-world networks; i.e., mathematical graphs in which most nodes are not neighbors of each other, but most can be reached from every other through a small number of links.

My interpretation of the Figure is that each vertex is an Australian Aboriginal clan, often called Country in Aboriginal English, and that the arcs are marriages that link each Country to 4 other Countries in the network.

In the a) panel, Countries that are adjacent and next-adjacent to each other form clusters that are closely related, socially, linguistically and genetically. These relationships are characteristic of *endogamous* societies; i.e., each group of five centered on one Country is either endogamous or nearly so, with more distant Countries having language group affiliations that are ambiguous or different. On the other hand, Countries on the ring that are diametrically opposed to each other are maximally distant in a structure suggestive of Sewall Wright's (1984) chain species in which mating between any pair of proximate subspecies is frequent, between moderately distant pairs is infrequent, and between remote pairs is rare.

In the b) panel, three of the marriages have been disconnected at random from neighboring nodes and reconnected to more distant nodes. These relationships are characteristic of *exogamous* societies. The exogamous marriages that connect remote Countries to each other are known as "short cuts". The number of marriages disconnected from adjacent nodes and reconnected to more distant ones via short cuts can vary from none as in panel a) to most or all as in panel c) in which case the randomly distributed linkages are unstructured.

Two measurable components of the connectivity of such networks are embedded in these panels (Watts and Strogatz 1998). First, adjacent and next-adjacent vertices linked by arcs form a cluster or neighborhood, and the *clustering coefficient* or cliquishness of a typical neighborhood is a measurable *local* property of the network. Repositioning one or a few arcs has a negligible impact on the clustering coefficient. Second, the number of arcs in the chain that connects each pair of vertices contributes to the typical separation between all vertices in the graph, and the resulting typical *path length* is a measurable *global* property of the network. Since each short cut reduces the characteristic distance not only between the pair of Countries that it connects directly, but also between their neighbors and their neighbors' neighbors that it connects indirectly, one or a few short cuts sharply reduces the typical path length of the network as a whole.

The traditional interpretation of relations depicted in Figure 2.1, used implicitly by Birdsell (1993), conflates clustering coefficients and path lengths by treating the continuum as a single straight line with a unique degree of exogamy or randomness at each point: a) 0% random (endogamous), b) intermediate percentage random (exogamous) and c) 100% random (panmictic). From this perspective, 15% random in panel b) is indeed a small number.

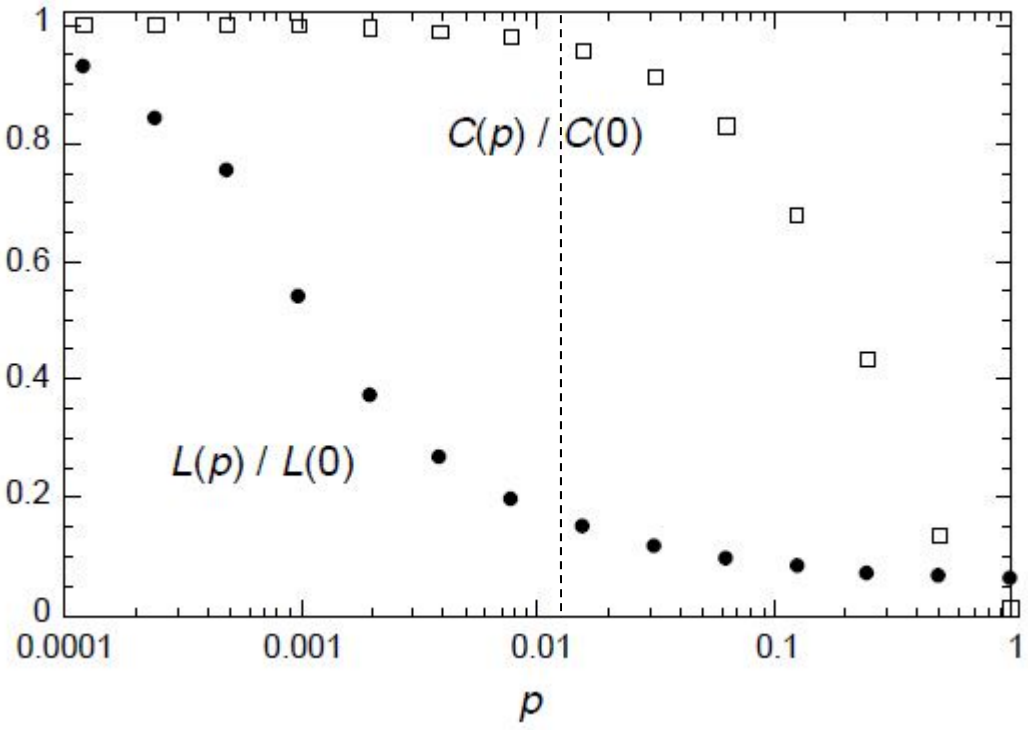


Figure 2.2. Characteristic path lengths L(p) and clustering coefficients C(p) for changing values of p.

L(*p*) is the typical separation between two vertices in the graph, a global property, while *C*(*p*) is the cliquishness of a typical neighborhood, a local property. The small-world network in Figure 2.1b results from the immediate drop in path lengths L(p) caused by the introduction of a few long-range marriages. For small *p*, each short cut has a highly nonlinear effect on L, contracting the characteristic distance not just between the pair of Countries that it connects, but also between their immediate neighborhoods, neighborhoods of neighborhoods, and so on. By contrast a marriage removed from a clustered neighborhood to make a short cut has only a linear effect on clustering coefficients C, hence C(p) remains practically unchanged for small (p) when L(p) drops rapidly (Watts and Strogatz 1998:440-442 Figure 2).

An alternative interpretation proffered by Watts and Strogatz (1998), in a paper published after Birdsell's death in 1993, deals separately with each component, *clustering coefficient* C(p) and *path length* L(p), thereby showing how those two components behave separately and together. Figure 2.2, explained in its caption, shows what happens mathematically as this transition occurs in a network such as the one in Figure 2.1, but with 1,000 vertices

(Countries) and 10 arcs (marriages) each. In making the transition from p=0 to p=1, both C(p) and L(p) decline from maximal (1) to minimal (0) values, but they do so in strikingly different ways (Watts and Strogatz 1998:441, Figure 2).

There are two important implications here. At the *global* level, as reflected by L(p), the transition from *p*=0 to an exogamous small world is immediate: i.e., a very few short cuts yields a precipitous drop in the path length of the network as the connectivity of the Countries rapidly increases. At the *local* level, as reflected by C(p), the transition within clusters is almost undetectable (Watts and Strogatz 1998:440-442): i.e., a few short cuts leaves the clusters almost totally intact and the clusters appear to remain largely unaffected by them. Specifically, where the dashed vertical line marks p=0.01 in Figure 2.2, L(p) has dropped from 1.0 to 0.2 but C(p) remains very near 1.0.

Watts and Strogatz (1998) and related analyses of small-world networks (e.g., Milgram 1967; Strogatz 2001), based on connectivity within social groups, neural nets, power grids, epidemics and the World Wide Web, indicate that the exogamy rates reported above are entirely compatible with the notion that Australian Aboriginal societies have long formed a continent-wide web of social and genetic relations with partially endogamous societies or clusters linked by regionally exogamous marriages.

Birdsell sees about 15% and says it is tiny, while I see the same 15% and, following Watts and Strogatz, say it is highly significant. The problem is not with the number but with its interpretation. Think of 15% exogamy as being analogous to rare but essential micronutrients or trace elements in one's diet; their absence can be fatal, but their presence in small amounts is both necessary and sufficient. My concern here is not with understanding a high percentage of exogamous marriages, but with understanding a low percentage that has a large impact.

Geographical distribution of exogamy

Geographical distribution of exogamy in Central Australia. Absolute numbers and percentages of exogamous marriages are important here, but I am equally interested in how the marriages are distributed geographically.

Figure 2.3 (next page) is a map of three disparate but linked sets of data concerning exogamous marriages among adjacent Central Australian language groups at roughly 20 year intervals; viz, Ngalia, a Warlpiri subgroup (Tindale, fieldwork 1931), Warlpiri (Meggitt, fieldwork 1953-55) and Alyawarra (Denham, fieldwork 1971-72). Comparable maps could be generated for many societies throughout Aboriginal Australia for which numerical (or most often non-numerical) datasets exist.

Tindale's (1931/1953:174-178) Ngalia numerical data for 156 marriages includes 144 that are endogamous and 12 that are exogamous. The exogamous marriages as depicted at the bottom of the Figure are clustered very tightly among groups directly adjacent to the Ngalia.

Meggitt's (1953-55/1962:34-46) report concerning exogamy among the Warlpiri is based on informal interviews, conversations, etc., but not on a census, so numbers are not available.

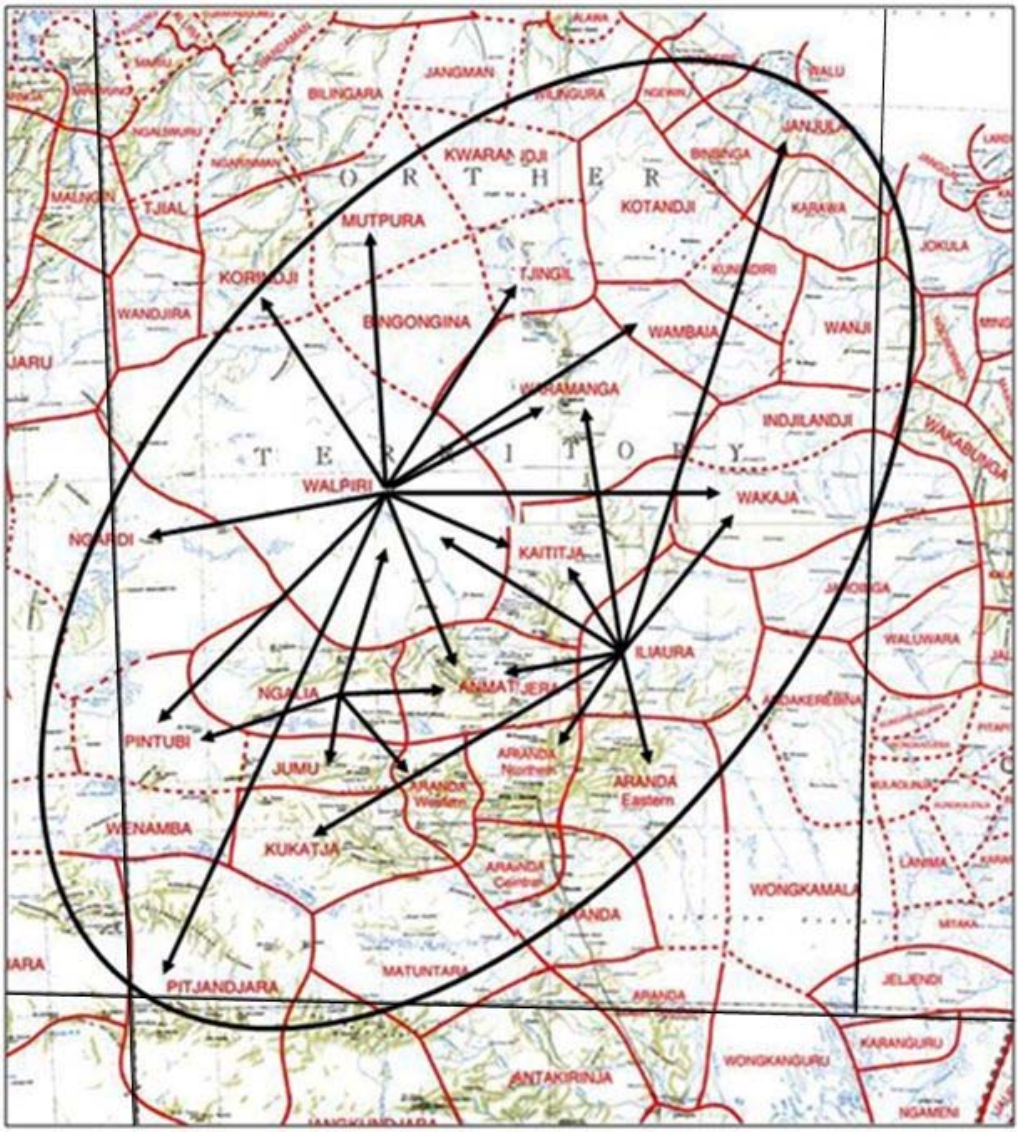


Figure 2.3. Representative distributions of exogamous marriages in Central Australia.
Aboriginal language base map from Tindale (1974). Count code: #exogamous/#endogamous/#total. Ngalia 1931: 12/144/156 (Tindale 1953), Warlpiri 1953-55: no count available (Meggitt 1962); Alyawarra (Iliaura) 1817-1979: 47/160/207 (Denham 2010b). See Table 2.2 for breakdown of Alyawarra exogamy. Light vertical and horizontal black lines near left, right and lower margins are Northern Territory borders.

Warlpiri exogamous marriages as depicted at the upper-left of the Figure are scattered much more broadly, including marriages with 11 other language groups. Among the 5 language

groups that are not directly adjacent to the Warlpiri, the Pintubi and Pitjantjara are especially remote.

My (Denham 2010b) Alyawarra data for 207 marriages, 47 exogamous and 160 endogamous, repeat the star network pattern that appears in Tindale's and Meggitt's data, but in terms of the number and distribution of intermarrying language groups, the Alyawarra more closely resemble the widespread Warlpiri rather than the tightly clustered Ngalia. The Alyawarra data shows exogamous marriages with 9 other language groups, 5 adjacent and 4 remote.

Tight clustering among Ngalia and diffuse scattering among Walpiri and Alyawarra could reflect historical changes between 1931 and 1979, but a more plausible interpretation is that the extent to which exogamous clustering occurred among Australian Aboriginal societies was quite variable, as can be seen by a careful review of Tindale's (1953) tables.

Birdsell (1993) argues that the geometric form of language group territories is basically hexagonal, as are honeycombs (D'Arcy Thompson 1917). Using that as a starting point, in combination with the exogamous marriage patterns in Figure 2.3, I constructed Figure 2.4. The map of exogamous marriages does not suggest a full mesh network topology with all nodes connected directly by marriage to all other nodes. Rather it suggests the topology that appears in Figure 2.4; viz., a concatenation of star topologies based on Birdsell (1958, 1993) and Peterson (1976b:67), but with the nodes understood to be language groups rather than bands.

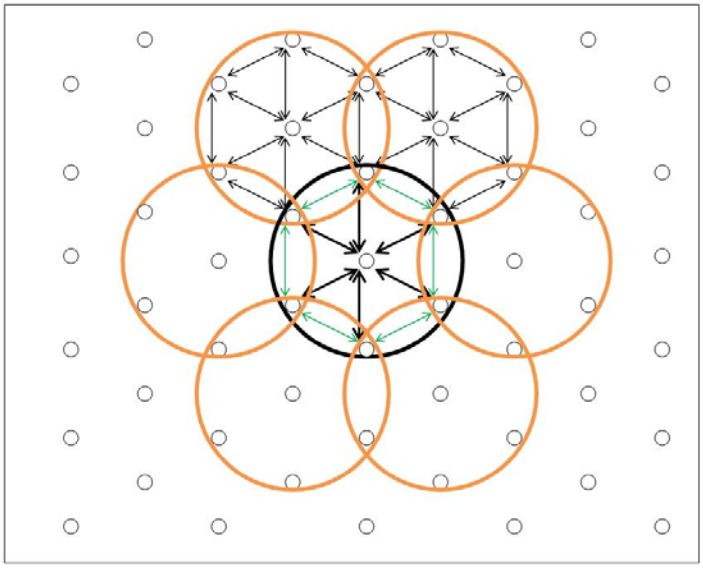


Figure 2.4. Hypothetical nations enclosed by large circles.
The nation within the black circle has a hub (small central circle), spokes (thick arrows) and a peripheral ring (green arrows). The nation and its constituent language groups are 85% endogamous; the nation as a whole is 15% exogamous.

In this diagram, arrows represent marriages. Each nation or neighborhood (in black) has the following components:

- a central language group that functions as a hub
- a tight cluster of about 6 (5 to 10) adjacent language groups attached to the hub by spokes of thick black arrows and to each other by a peripheral ring of green arrows
- a loose affiliation of increasingly remote neighboring societies that form a distant cloud

In this representation, I suggest that both the hub and the nation are 85% endogamous. The hub's 15% exogamy is concentrated within the peripheral ring of 6 neighbors, while the remainder of the nation's exogamy is distributed implicitly among more remote nations and societies. I am not suggesting that a nation is an isolated entity, but rather that societies within a nation are 15% exogamous within the nation, and that the nation as a whole is 15% exogamous with neighboring nations.

Patterns of intermarriage in Figure 2.3 suggest that boundaries were porous between Peterson's (1976b) culture areas and drainage basins. Figure 2.3 (Tindale 1974), Figure 2.5 (Strehlow 1947), and Figure 2.6 (Duguid, et al. 2005) could be treated as stacked overlays on the Google Earth base map, but since that yields serious problems with legibility, I have left them unstacked. Properly positioned, the southern edges of all three align with the South Australian border, but their eastern and western borders do not align properly. The text that accompanies Peterson's (1976b:66) culture area map says:

> "… the influence of the direction of flow of rivers and their coincidence with cultural boundaries is well shown in the linguistic boundary that divides the Arandic speaking people from the Walpiri and Kukatja, drawing them (the Arandic speaking people) into the Lake Eyre drainage system".

The scale of Peterson's map makes it impossible to see these features clearly, but Figures 2.3, 2.5 and 2.6 are clearer. In Strehlow's map in Figure 2.5, most of the Northern and Western Aranda regions plus those of the Walpiri and Kukatja correspond in Figure 2.6 to the Mackay and Burt Basins of the Western Plateau Drainage Division, while the Southern and Eastern Aranda and the Alyawarra are in the Lake Eyre Drainage Division. Figure 2.3 attests to marriages between the Western Plateau and Lake Eyre Drainage Divisions, showing that the Arandic-speaking Alyawarra from the Lake Eyre drainage regularly married Walpiri, Kukatja, Anmatjerra, and Northern and Western Aranda of the Western Plateau drainage in the 19th and 20th centuries. Furthermore, Strehlow (1947) attests to travels (with or without intermarriages) among residents of the various Arandic speaking groups in both drainage divisions.

In other words, societal exogamy across these drainage basin and drainage division boundaries seems to have been more frequent in Central Australia than Peterson suggested. Perhaps that pattern was exacerbated for the Alyawarra by earlier depopulation of areas to their northeast, east and southeast, but I have no data for those regions.

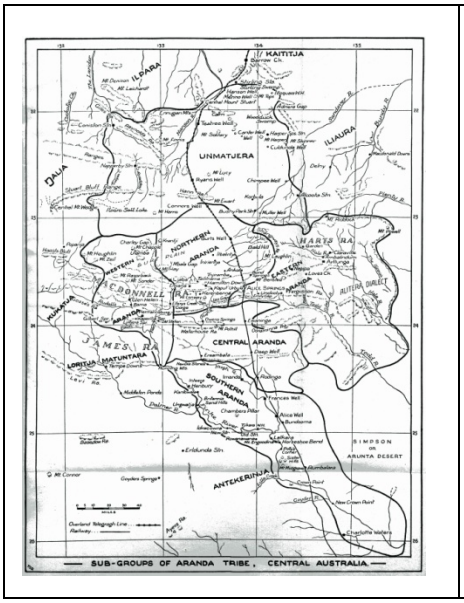


Figure 2.5. Arandic language groups. From Strehlow 1947 and Guhr 1963.

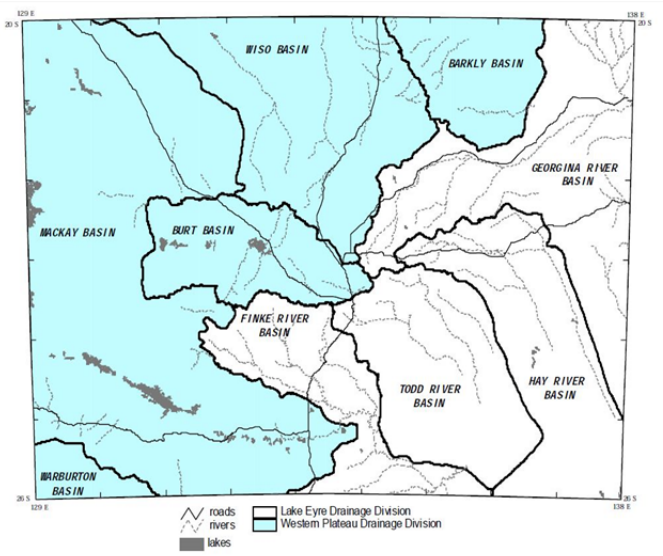


Figure 2.6. Drainage divisions and basins, with major rivers. Southern half of the Northern Territory, from Duguid, et al. 2005:36.

Spatial distribution of exogamy among the Alyawarra. Figure 2.7 provides a detailed view of the spatial distribution of Alyawarra marriages. It is a 2-dimensional close-up vertical view of the AU01 Alyawarra marriage network containing 114 cases. By dealing with marriage relations between Countries rather than between language groups, it is possible to distinguish between an individual person's language group affiliation that can be highly ambiguous and situational, and the language group affiliation of a Country itself, which still may be ambiguous but less so than among individual people. The map has four layers. The topographic base map of Australia comes from Google Earth. The first overlay is a map of 27 Countries (green diamonds) that had known representatives in my Alyawarra research population, showing the alphanumeric codes that I assigned to them and their physical locations "on the ground" in and near Alyawarra territory. The second overlay is a map of marital linkages between all known pairs of intermarrying Countries. The final overlay has two ellipses labeled A and B. Marriages entirely within the inner A ring (the core) are exclusively between Alyawarra, while marriages in which one spouse belongs to a Country outside the A ring but within the B ring (the periphery) represent language group exogamy within what we might call the "Alyawarra Nation".

Figures 2.3 and 2.7, as well as Figure 3.5 clearly show that the Alyawarra and their neighbors were not among Birdsell's (1993) "essentially endogamous genetic unit[s]", either in 1971 or at earlier periods in the 20th century.

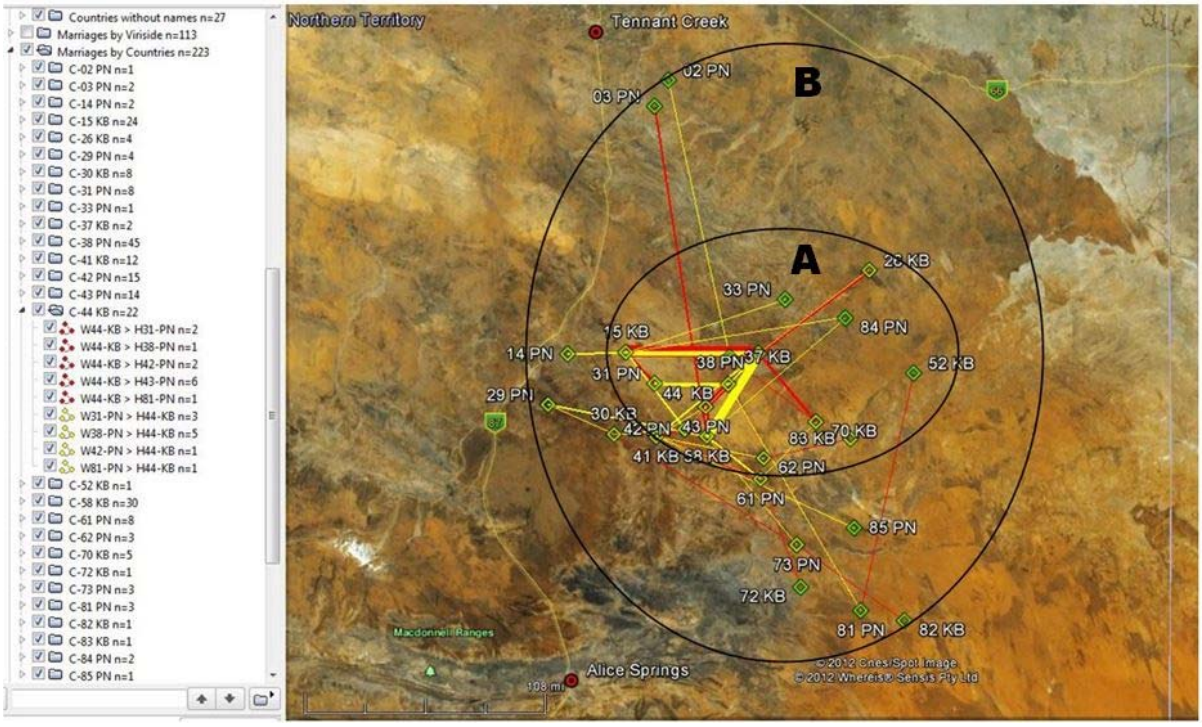


Figure 2.7. Marriages between Countries, AU01 Dataset.
114 marriages; green diamonds = Countries; AA ## = alphanumeric Country+patrimoiety code (KB, PN); Linkage color codes: red=men, yellow=women. Inside Ring A = endogamous core; between Rings A and B = exogamous periphery.

Exogamy in the Western Desert cultural block. Dousset (2005) presents a very strong case for openness and exogamy among Elkin's (1938-40) "Aluridja group", also known as Berndt's (1959) "Western Desert cultural block". This block covers most of the interior of Western Australia, the southwestern corner of the Northern Territory and the western third of South Australia. The societies and populations in this vast region form "distinct dialectal groups" characterized by a pan-regional network of interrelations between families and groups of families (Dousset 2005:30).

The Western Desert cultural block is culturally and linguistically homogeneous, with many people speaking Wati and related languages of the Pama-Nyungan language family. But there is considerable diversity within that homogeneity. Most groups have sections, usually with 4 terms but sometimes with 6; one group has 8 subsections, and 2 do not use the section system at all. None have named matrimoieties, some have named patrimoieties, but "the main social category classification used by all Western Desert groups is generational moieties" (Dousset 2005:31; I.M. White 1981; Allen 1989). Throughout the block, marriage occurs between consanguineal or classificatory cross-cousins, be they close, distant or remote, and dialect group exogamy is a "strong characteristic" (Dousset 2005:85). He notes that, "A phenomenal number of [Dreaming tracks and trade routes] crisscross the most remote areas of the desert and beyond" (Dousset 2005:86), and argues (*passim*) that the

primary function of the section system in any of its forms is to facilitate intergroup relations throughout the block, perhaps most importantly with regard to arranging exogamous marriages. Dreaming tracks and trade routes in the Western Desert and elsewhere in Australia seem to have served a vital function as ecological habitat corridors following permanent or semi-permanent waterholes, their resources systematically maintained and enhanced by anthropogenic fire (Pyne 1991:92), thereby enhancing gene exchange between and among populations and buffering ecological and demographic stochasticity.

Although Dousset does not provide census data on exogamous marriages, he presents a great deal of quantitative data concerning the structure and nomenclature of section systems in 24 to 27 named social groups within the Western Desert block, and about 13 others adjacent to it along Australia's northwest coast and in Central Australia (Dousset 2005:8-9,97-100). Together the core groups use 42 different section names which, when variations in spelling and pronunciation have been removed, reduce to about 8 basic section terms. Each social group uses 4 of those terms in a distinctive logical structure (Dousset 2005:31,35,37). In this huge, desolate and sparsely populated region, everybody seems to navigate effectively through the maze of section terms and logics when arranging exogamous marriages that characterize the region.

Population sizes

Radcliffe-Brown's (1930) reconstructed census of Australian Aboriginal societies has served as a basis for estimating language group populations. It has been argued (Birdsell 1968, 1993; and many others) that Australian Aboriginal language groups had average sizes of 500 or fewer people in pre-colonial times. Although we cannot know whether that number is right or wrong, we can safely assume that many populations, however defined, often had less than 500 people while some had more, and that all of them were subjected to severe ecological, demographic and genetic stochasticity over many millennia. Under such extreme conditions, tiny populations would have faced extinction had they been truly isolated. But if we suspend our belief in isolation, we see that clusters of 6 to 20 intermarrying groups, such as the ones of which the Ngalia, Walpiri, Alyawarra and Western Desert people were members, probably had mean populations of 3000 or more. That number exceeds most Minimum Viable Population size estimates and probably would have precluded the extinction of any of them even if the clusters or nations were isolated, which they were not (Bocquet-Appel and Masset 1982:331-32; Fix 1979, 2008 p.c.[4]; Primack 1993:291ff; Reed 2005; Soule 1987; Traill et al. 2007).

Population stability

In addition to my concerns about population boundaries, linkages and sizes, I am equally concerned about long term population stability. Although Birdsell, Stanner, Strehlow and others commented on the stability of Aboriginal populations in the 19th and early 20th

[4] p.c. = personal communication

centuries, it is not intuitively obvious how population stability might have been maintained among small, isolated language groups at a time when the total Aboriginal population was in serious decline. Historical demographic data from the AU10 Alyawarra 1817-1979 dataset may help to solve the conundrum.

Here I use Net Reproductive Rate (NRR) as a demographic estimator, and watch its performance through time. The NRR is the average number of daughters born to a woman (or group of women) who passes through her lifetime conforming to the age-specific fertility and mortality rates of a given year. This rate is similar to the Gross Reproductive Rate but takes into account that some women will die before completing their childbearing years. NRR =1.0 means that a generation of mothers has exactly enough daughters to replace itself in the population and the population size is stable; <1 means the population is contracting, while >1 means that it is expanding.

Since I finished collecting my Alyawarra field data in 1972, I used that year as the ending date for computations of population stability. Members of the 10-year cohort of women whose 35-year reproductive careers (ages 15-50 years) ended in 1972 were born between 1918 and 1927. The preceding 10-year cohort spanned the period 1908-1917 and the oldest cohort for whom I collected sufficient data spanned the period 1898-1907. Within each of the three 10-year cohorts defined here, I computed the mean number (NRR) of living daughters those women had produced by the end of their reproductive careers. By comparing those numbers across the period of three decades, historical trends should be detectable. Extracting the data and performing the computations were simple but interpreting the results was not.

The decades between 1898 and 1927 were among the most difficult periods of genocide in the Aboriginal history of Central Australia. It included the years during which homesteaders established pastoral properties, including MacDonald Downs Station, in the Sandover-Bundey River drainage basin, and the Alyawarra began the transition toward a sedentary lifestyle. In addition to open hostilities between White Australians and Aboriginal adults, the period included the "stolen generations" in which many thousands of children of Australian Aboriginal descent were removed from their families by Federal and State government agencies and church missions, perhaps in part to protect them from observed catastrophic population decline and the predicted extinction of Aboriginal people following European contact.

Cohort	# Mothers	# Daughters	NRR	Mo/Total Proportion
1898-1907	22	25	1.136	22/47 = 0.468
1908-1917	35	35	1.0	35/70 = 0.5
1918-1927	29	31	1.068	29/60 = 0.483
Total	86	91	1.058	86/177 = 0.486

Table 2.3. Net Reproduction Rate for Alyawarra women 1898-1927.
10-year cohorts of women in the early 20th century with NRR very close to 1.0.
I thank Bocquet-Appel (p.c.) for preparing and interpreting this table.

Table 2.3 reveals a remarkable pattern. Under these traumatic conditions, the Alyawarra data depict a population that is essentially stationary but increasing slightly. Working from the proportion of mothers in each cohort, the test of the null hypothesis at p=0.5 for the three groups is not rejected ($k^2 = 0.258$ at 2 df; Bocquet-Appel p.c.). People accustomed to dealing with populations of thousands or millions may be uncomfortable with such small numbers, but in fact hunter-gatherer societies are small.

Under such severe stress, how did the Alyawarra population remain essentially stable? One possible answer is that they escaped the stress. However, I know of no historical data that show the Alyawarra to have been effectively insulated from the world surrounding them. Although the Chalmers family at MacDonald Downs Station were highly supportive of the Alyawarra, it would be foolish to think that they alone could have shielded them from the pervasive effects of colonialism and genocide in Central Australia (Bell 1993).

I speculate, more plausibly I believe, that open boundaries and exogamous marriages such as those described here enabled the Alyawarra to maintain their stable population. In Figures 2.3 and 2.6, ties to Aranda and other language groups spanning several generations may be legacies of those successful attempts to maintain a stable population under difficult circumstances.

I do not argue that the Alyawarra were anomalous in this regard, for Birdsell (1993), using data from a huge sample of Aboriginal societies from the 1930s to the 1950s, as well as Strehlow (1947) and Stanner (1965) all report comparable resilience for pre-contact (and early-contact) Aboriginal societies in general.

A great many Aboriginal societies were driven to extinction by European colonization. Thus, although the societies appear to have been highly resilient and able to fight back even when pressed to the wall, they nevertheless could be destroyed when enough deliberate genocidal pressures were applied to them for long enough.

I argue that the evidence introduced here fits together as pieces of the same indigenous puzzle based in part on the openness of marriage systems as documented by Birdsell and others, that Dousset's argument for the presence of reproductively open systems in Western Desert societies applies to a large percentage of Aboriginal Australia, and that his arguments concerning the Western Desert and mine concerning the Alyawarra most likely apply not just to recent times but to a period measured in millennia.

Finally, I suggest that Birdsell's confidence that Australian Aboriginal societies were tiny, closed and isolated is excessive, and that his half-century of support for building endogamous kinship models was unfortunate. I have no doubt about the quality and integrity of the computations Birdsell used in preparing his extremely valuable summation in 1993. But I have serious doubts about unintended biases that may have contaminated his data and their interpretations.

Implications of demographic patterns

In summary, societal exogamy in Aboriginal Australia occurs at a frequency and in spatial patterns that warrant further analysis.

Traditional marriages seem to have been, on average, about 85% endogamous and 15% exogamous, but that ratio could vary in either direction. It would vary systematically with population size at either end of Adams and Kasakoff's (1976) "80% endogamy group", with endogamy rates expected to approach 100% in very large populations and 0% in tiny populations or in societies where boundedness was minimal. Tindale (1953:186) said that the percentage of recorded intertribal marriages that he studied ranged from about 7% to 21%, pertaining to many societies at one time or to one society at various times. Birdsell (1993) argued for about 13% among the Aboriginal people with whom he worked. I take about 15%, with a range of about 7-21%, to be the most robust estimate.

In a society with a hypothetical population of 120 marriages contracted over a period of 40 years, the mean overall marriage rate would be about 3 per year. If 15% of those 120 marriages were exogamous, the mean exogamy rate would be just over 1 out of 6, or about 1 every 2 years. This number is a plausible estimate of the magnitude of the task at hand: small, but important and too large to ignore.

These data suggest that pre-contact Australia was not occupied by several hundred tiny, endogamous "genetic isolate[s] of a very tight reproductive character". At the very least it seems to have been occupied by something approaching Howitt and Mathews' "nations", but more likely by a continent-wide small world network - a metapopulation (Soule 1987), or population of populations, including most or all of the 600+ named groups on Tindale's (1974) map of the Aboriginal tribes of Australia, and the entire Aboriginal population often estimated at perhaps 300,000 or more at the time of initial European contact (Radcliffe-Brown 1930). The dynamics of survival in the metapopulation would have been fundamentally different from the dynamics of extinction in population isolates.

While a group's concepts and activities remained in conformity with the law of the Dreamtime, the group could remain fully engaged with others who shared the same values and could intermarry with them. The resulting gene flow would have made all of those linked societies resistant to extinction from environmental, demographic and genetic stochasticity. Societal isolation was not the norm, but rather was a major problem.

3. Inbreeding avoidance

Here I shift my focus from demography to kinship, genetics and historical linguistics to consider implications of inbreeding avoidance and societal exogamy for Aboriginal social organization.

On the advice of several readers, I have placed my glossary in Appendix 1. It contains my sometimes idiosyncratic definitions or usages of concepts pertaining to kinship and inbreeding that underlie Sections 3-6. I understand that placing the glossary at the beginning of Section 3 interferes with the readability of my argument, and that it is easier to find the terms for later reference if they are in the glossary than if they are buried in the text. However, understanding the concepts in the glossary is necessary for understanding my argument in Section 3. Please examine the glossary before continuing with Section 3.

Diagrammatic conventions

Diagrammatic conventions that I use to represent Australian Aboriginal kinship and genealogical relations have their roots in the ancestral traditions as well as in well known works by 19th century anthropologists.

For example, Elkin (1964:103) says:

> " … the principal of descent is always based on the mother-child relationship. Not only do they speak of it that way … but in any case of alternate or irregular marriage, the father is "thrown away"; that is, he is not considered. The child's section is the one related to its mother's section."

On the other hand, Strehlow (1947:128-143) says:

> "The unbreakable bond that exists between a father and his own son, not a class son, is unhesitatingly emphasized in all Aranda groups. … No account is taken in this matter of the official doctrine of conception which … disregards the physical relation between father and son, and affects to treat the child as the offspring of its mother alone. … The bond of a common *pmara kutata* [everlasting home] links all of the individual members together in a firm totemic clan [father-son *njinanga*]."

Disagreements such as these can generate controversy, but in this case the alternatives are logically equivalent, so it is acceptable to do it either way. I use a patrilineal orientation for the Alyawarra, but publications concerning other societies use a matrilineal orientation. Beware!

Measuring Alyawarra endogamy

My emphasis on the extent of exogamy serves as a counterbalance to the fiction of the absence of exogamy in the writings of Birdsell and so many others. However, the corresponding fictions of the presence of generational closure and the absence of inbreeding are equally important since all of them work together.

Data used in Section 2 for 207 marriages in the AU10 Alyawarra 1817-1979 dataset are more comprehensive but less detailed than the data for 114 marriages in the AU01 Alyawarra 1971 subset. Here in Section 3, I shift my focus to the more refined AU01 subset.

Among the 114 marriages in AU01, 58 (50.9%) show no immediate genealogical ties between husband and wife; i.e., they are tribal kin but are not proper kin. Within that 50.9% of marriages, 28.2% are between pairs of Alyawarra and are the people to whom Birdsell (1985:113) referred when he said, "… very few individuals in [an Aboriginal Australian] population are affected [by inbreeding] and the impact is negligible"; i.e., these are acceptable marriages according to Birdsell and Tindale. The remaining 22.7% are between Alyawarra and non-Alyawarra and are reported above as exogamous. According to the fiction of endogamy, these marriages are at best marginal, suboptimal or anomalous.

Among the 114 marriages, the remaining 56 (49.1%) are characterized by directed marriage cycles (Harary and White 2001:40); i.e., in addition to the H-W affinal link that joins the spouses, the pairs are connected by other kinds of consanguineal and affinal linkages in violation of Tindale's assertion as reported by Birdsell above. Among them, 17 have consanguineal links only, 18 have multiple consanguineal links plus one close classificatory link, and 21 have consanguineal links plus 2 affinal links. The 17+18=35 that have only 1 affinal link plus consanguineal and close classificatory links may be thought of as the structural core of this Alyawarra population. According to the fiction of inbreeding avoidance, these marriages should not have existed.

In sum, among the 114 marriages considered here, 49% are among proper kin, 28% are among close or distant classificatory kin and 23% are among remote classificatory kin. Thus 72% of these marriages fail to comply with Birdsell's and Tindale's commonly accepted theory of societal endogamy without inbreeding.

With regard to skin terms, of the 114 marriages only one is a "wrong marriage". No marriages within the 35-marriage core group violate skin rules.

Male egos' genealogical relationships to spouses among the 35-member core show MBD=18, MMBDD=7, FZD=7, FZDDD=2 and MBDDD=1; i.e., 20% comply with the stated preference for MMBDD but the kin types of the other women are poor predictors of marriage partners. Matrilateral 1st and 2nd cross cousins far outnumber all others; i.e., while there is a significant lack of precision in complying with the stated genealogical preference of MMBDD, it is not great enough to yield violations of skin rules.

Because of the W<H 14+ year mean age difference that precludes generational closure, a suitable wife among the Alyawarra has a 76% chance of being a matrilateral cousin (MBD/MMBDD/ MBDDD) and a 24% chance of being a patrilateral cousin (FZD/FZDDD) (Denham 2012). In the Alyawarra genealogies there are no cases of brother-sister exchange, but 11 cases of two brothers marrying two sisters, which is compatible with systematic age differences between spouses.

With regard to kin terms, H refers in every case to W as "*anowadya"*. This Alyawarra term for MMBDD, 2nd cross-cousin and preferred wife, is cognate of "*anua"* or "*unawa"*, the Aranda term for MMBDD (Spencer and Gillen 1899:76; Denham, McDaniel and Atkins 1979:7). Thus in practice the term "*anowadya"* encompasses wives in the preferred MMBDD group, wives who are other proper kin most often 1st rather than 2nd cross cousins, and still other wives who are close, distant and remote tribal kin of the correct skin and generation level. The kin terms that ♂Egos would have applied to their non-preferred wives before marriage are unknown.

It is clear that Alyawarra marriages in 1971, many predating the European invasion of Alyawarra territory, did not comply with the fiction of generational closure, the fiction of strict endogamy, or the fiction of no inbreeding. Rather, uncomplicated and unsophisticated statistics such as the ones used here demonstrate that these empirical questions reveal a quantifiable biological world that is distinctly different from that depicted in the canonical models.

Statistics from Alyawarra and other datasets suggest that criteria for arranging Australian Aboriginal marriages that required 100% compliance included rules favoring marriage between a man and a woman, between correct skins (opposite patrimoiety, opposite matrimoiety, same generation moiety) and between correct kin types (MBD/FZD or other designated cross cousins as coded into the skins). Egocentric kin terms may have been of limited importance for arranging endogamous marriages since terms could be adjusted after marriage, and almost certainly were irrelevant for arranging exogamous marriages. Additional statistics suggest that criteria requiring less than 100% conformity included compliance with *tualcha mura* or similar customs yielding a normal distribution of W<H age differences with a mean of about 14 years; marriage within one's own language group (85%); with proper kin (50%); in a polygynous union (perhaps 90% in coastal Arnhem Land but 50% or fewer elsewhere); as an infant bestowal or a widow remarriage (perhaps 30% in coastal Arnhem Land but fewer elsewhere); etc.[5]

My primary objective in the remainder of this section is to better understand how the realistic statistical patterns seen in Alyawarra demographic, kinship and marriage data, and related datasets, might emerge in societies that have been characterized by unrealistic canonical Kariera and Aranda models.

[5] Statistical estimates used here are based on suitable albeit incomplete quantitative data from: Birdsell and Tindale, cited above; Binford 2001; Wanindiljaugwa, Groote Eylandt 1941, Rose 1960; Tiwi, Melville and Bathurst Islands 1954, Hart, Pilling and Goodale 1988, Goodale 1971; Alyawarra, Central Australia 1971, Denham 1975, 2007, 2010a, 2010b; Denham, McDaniel and Atkins 1979; Denham and White 2005.

Primary inbreeding avoidance in canonical Kariera

I interpret the basic components of Figure 1.1 as three pairs of moieties: patridescent, matridescent and generation. The first two are exogamous and the third is endogamous. I label patridescent moieties as A-A and B-B (vertical), generation moieties as 1-1 and 2-2 (horizontal), and matridescent moieties as A1-B2 and B1-A2 (diagonal).

Figure 3.1 is a simplified schematic representation of named section relations (skin terms) among the Alyawarra. The society's 4 named skins are represented by a square containing 4 quadrants. This diagram displays the same relationships that appear in Figure 1.1**,** but in a different format. I place Ego in quadrant A2 and take that as my focal point.

- Quadrants A2+A1 correspond to one exogamous patrimoiety (Burla + Kamara) and B2+B1 correspond to the other (Ngwariya and Pityara). These are F-S alternating generations.
- Quadrants A2+B1 correspond to one exogamous matrimoiety (Burla + Pityara) and B2+A1 correspond to the other (Ngwariya + Kamara). These are M-D alternating generations.
- Quadrants A2+B2 correspond to one endogamous generation moiety (Burla + Ngwariya) and A1+B1 correspond to the other (Kamara + Pityara). These put H and W in the same generation moiety and implicitly in the same generation level.

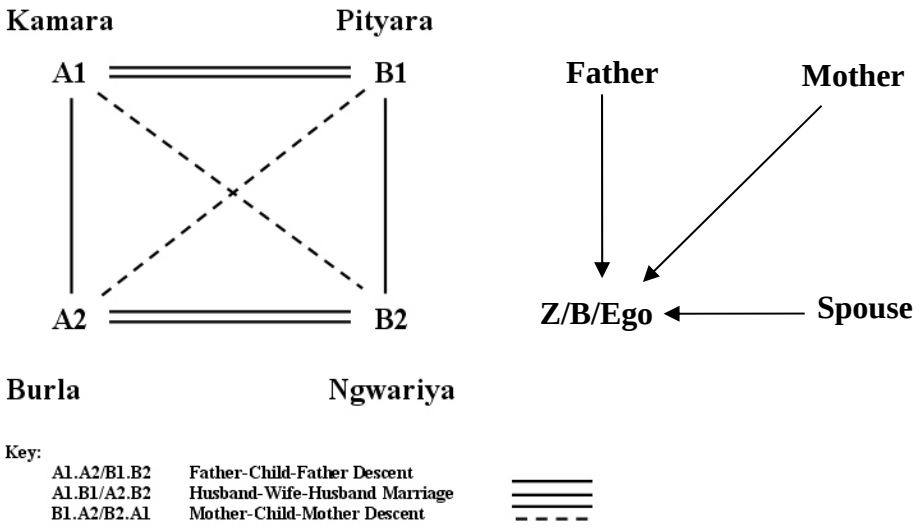


Figure 3.1. Descent and marriage within the four named Alyawarra sections.
These relationships embody and display descent and marriage rules governing relations among skins.

The minimal rules sketched above, possibly subject to rare exceptions, mean that an A man cannot marry an A woman who is in his own patrimoiety, so he marries a B woman, and vice versa. A man who is a 2 cannot marry a woman who is a 1 in the wrong generation moiety, so he marries a woman who is a 2, and vice versa. Thus the only marriageable women of a

man in A2 are women in B2, preferably of his own (even-numbered) generation level, who by definition are 1st and 2nd female cross-cousins, simultaneously his MBD/MMBDD and FZD/FFZDD. A preferred or prescribed canonical bilateral sibling exchange marriage would occur if, for example, an A2 man married a B2 woman and his proper A2 sister married his wife's proper B2 brother.

Each patrimoiety encompasses multiple patrilineal descent lines (Countries or clans), each matrimoiety encompasses multiple matrilineal descent lines, and each generation moiety encompasses multiple sibling-in-law chains. Generational closure occurs when the sibling-in-law chains necessarily wrap around the vertical axis of the diagram as finite horizontal loops with H and W assumed to be approximately the same age. Societal closure occurs when sibling-in-law chains fold back upon themselves at the left and right patridescent lines which constitute the outer limits of the endogamous society.

Thus for some purposes it is useful to view generational and societal closure as two separate issues, but it is equally reasonable to see it as two facets of the same phenomenon which occur simultaneously. In studies of moieties, sections and subsections, it has been common practice to emphasize the two pairs of descent moieties and deemphasize the single pair of generation moieties, sometimes treating them as qualitatively different from descent moieties. In the remainder of this paper I generally emphasize all three equally, and sometimes place greatest emphasis on generation moieties because of their key role in societal exogamy.

Despite the fact that the canonical Kariera-type arrangement successfully precludes parent/child or sibling/parallel-cousin mating, its closed boundaries, small population size, bilateral sibling exchange marriages and timeless replication of the same patterns swamp the benefits of the canonical model. Hence, if followed literally, it promptly generates extreme inbreeding coefficients (twice that of parent-child or sibling incest) and the society may be vulnerable to extinction in only a few generations. Additional means of avoiding inbreeding by enhancing the canonical Kariera structure are called for.

Enhanced inbreeding avoidance in canonical Kariera

Enhancing the minimal inbreeding avoidance structure built into canonical models can reduce inbreeding within fully endogamous societies and is equally applicable to exogamous societies. Perhaps it is common for these enhancements to be adopted as a package that leaves intact the appearance of the 4-section Kariera system (or its 8-subsection Aranda counterpart), including whatever fictions may be present, but significantly changes its operation to reduce inbreeding. Only one of the following enhancements is exogamous, but all of them "partake of its spirit" by pushing individual endogamous marriages outward and away from the intense closeness of the canonical Kariera pattern.

Incremental Changes

The first three adjustments considered here are incremental, gradualistic and conservative, and can be instituted, separately or collectively, at the discretion of individual members of a society. All of them assume that husband and wife are approximately the same age, but are applicable to age biased generations as well.

Marriage with tribal kin instead of proper kin. Perhaps the easiest and most obvious way to approach the problem is to marry tribal kin instead of proper kin. In a sense, marrying close or distant tribal kin is a kind of "internal exogamy" in that it yields marriages between relatives who are members of the same society but are more distantly related than those depicted in canonical Kariera. Tindale and Birdsell, being aware of extreme inbreeding fostered by the canonical Kariera model, argued that this procedure was *de rigueur* throughout Aboriginal Australia. But the detailed statistical data introduced above for Alyawarra marriages in 1971 contradicts their position.

In other words, arguing that canonical Kariera represents "nothing but" classificatory kinship is false, just as it is false that these societies are isolated endogamous islands. Rather this is a quantitative question: How much marriage occurs with proper, close, distant or remote kin, and to what extent do societies differ in that regard? For example, among the Alyawarra in 1971 societal exogamy was far too common to ignore or explain away, while among the Pitjantjatjara, rules prohibiting marriage between close kin may have yielded "dispersed affinal alliances" (McKinley 1971:411), "semi-complex systems" (Héritier 2000:29) or "shifting webs" with affinal and close kin networks shifting at each generation, perhaps cycling back every few generations (Keen 2002:153; Dousset 2011). Thus marriage with tribal kin may make a valuable contribution to inbreeding avoidance, but it is not the whole story. Rather, learning how a 49/28/23% apportionment of marriages among proper/close-distant/remote kin is managed among the Alyawarra may be a better way to approach the problem at hand.

Alternate generation-level marriage. The default spouse for an A2 man of generation level G^0 is a B2 woman also of G^0, but other options are available. Adjacent generation marriages (e.g., between a man of G^0 and a woman of $G^{\pm1}$) generally are prohibited, but alternate generation marriages (e.g., between a man of G^0 and a woman of $G^{\pm2}$) are commonly accepted since both are in the same generation moiety and both are in the same generation level, either even or odd. Such a woman is likely to be more distantly related to her potential spouse than the preferred or prescribed cousins of G^0 in the canonical Kariera model. Evidence of such marriages is widely available (e.g., Denham 2012).

Here I do not consider oblique marriages such as those found in Cape York Peninsula. They are not well enough understood and are under investigation now (McConvell p.c.).

Omaha kin term skew. A man who is a member of a society that ordinarily uses Dravidian or Kariera kin terms may, under some conditions, apply Omaha kin terms as an optional

overlay (Kronenfeld 2001:179) that transforms his proper (and perhaps tribal) MBD into a terminological M. When that happens, the Omaha skew pushes the normally marriageable woman into an unmarriageable category, thereby reducing the availability of proper kin and increasing the likelihood that the man will marry a woman to whom he is more distantly related. This is one aspect of the larger problem of matching skin terms and kin types within and between societies.

C1	C2	C3	C4	C5	C6	C7	C8	C9
Sect	Subsect.Gen.Kintype. Mini-Gloss	KT # TERM	RELATIVE SECTION OWN	PATRI	SPOUSE	MATRI	ROW TOTAL	PERCENT ACCURATE
A2	A2a (G0) eB= ♂Ego	10 awaadya	816	5	1	1	823	99.1
	A2a (G0) eZ= ♀Ego	11 angurlya	953	15	2	0	970	98.2
	A2a (G0) yB/Z	12 adladya	1,750	0	6	8	1,764	99.2
	A2a (G±2) FF/SS/SD+	1 arengiya	542	5	0	1	548	98.9
	A2b (G+2) MM/MMB	2 anyainya	883	4	6	9	902	97.9
	A2b (G0) MMBSS/MMBSD	3 aidmeniya	559	0	7	2	568	98.4
A1	A1a (G+1) F	6 agngiya	2	794	1	1	798	99.5
	A1a (G+1) FZ	7 aweniya	3	692	1	4	700	98.9
	A1a (G-1) own S/D	16 aleriya	12	2,657	10	8	2,687	98.9
	A1b (G+1) WM/WMB/MMBS	19 muriya	3	1,130	6	7	1,146	98.6
	A1b (G±1) BWM/DHZ	23 aneriya	1	447	3	1	452	98.9
B2	B2b (G0) FZS/MBS	13 angeliya	6	0	623	0	629	99.0
	B2b (G0) MBS	15 adniadya	1	0	112	0	113	99.1
	B2b (G0) FZD/MBD	14 algyeliya	0	7	886	0	883	99.2
	B2b (G±2) MF/MFZ/DS/DD	5 adardiya	5	5	1,156	10	1,176	98.3
	B2a (G0) W/MMBDD+ H/MFZDS*	18 anowadya	0	0	740	0	740	100.0
	B2a (G0) WB/HZ	21 amburniya	0	4	499	1	504	99.0
	B2a (G0) ZH/BW	22 andungiya	0	5	270	1	276	97.8
	B2a (G±2) FM/FMB/SS/SD	4 aburliya	2	6	837	1	846	98.9
B1	B1b (G±1) M/SW+	8 amaidya	5	0	235	1,342	1,582	84.8
	B1b (G±1) MB/SWB+	9 abmarliya	6	7	258	1,344	1,615	83.2
	B1a (G-1) S/D*/ZS/ZD+	17 umbaidya	15	7	27	3,060	3,109	98.4
		COLUMN TOTAL	5,564	5,790	5,676	5,801	22,831	96.8

Table 3.1. Distribution of Alyawarra kinship term applications by section and subsection membership.
In C1 sections (A1,A2,B1,B2) are explicit In C2 subsections (a,b) are implicit. Table based on Denham, McDaniel and Atkins (1979:11 Table 4). See Appendix 2 to access recent Artificial Intelligence research with these data.

Evidence demonstrating that optional Omaha skewing has been used frequently in this way in Aboriginal Australia is available now (Denham et al. 1979; Denham 2011; Hiatt 1996:55-

56; Green 1998:61-62; McConvell and Alpher 2002; McConvell 2012, etc.). The statistics in Table 3.1 show one example of statistical relations among Omaha skewing, skin terms, kin types and kin terms among the Alyawarra. Not surprisingly, Rose (1960) reports the same phenomenon among the Wanindiljaugwa of Groote Eylandt.

Construction of Figure 3.1 began with 2 patrimoieties, 2 matrimoieties and 2 generation moieties, with each pair defined only as "mine" and "not mine", and with ♂Ego's F seeded in the upper left quadrant (Kamara). In that context, the distribution of kin types follows logically, automatically, inexorably in the pattern shown below in Table 3.1 which shows the frequency of linkages between kin and skin among the Alyawarra. Skin terms (Col.1) and kin terms (Col.3) vary considerably among societies, dialects and languages, but skin rules and clusters of kin types at each generation level (Col.2) associated with each section or subsection generally remain constant.

In Table 3.1, the Alyawarra explicitly use the four sections from Figure 3.1, and their alphanumeric codes (A2, A1, B2, B1) appear as row labels in Col.1. At the same time, they implicitly or behaviorally use eight subsections as shown in Col.2, but do not name them. Lawrence (1937:338) uses the term "anonym" to designate unnamed subsections embedded in section systems and cites the Southern Aranda as an example.

Among the relationships available for exploration in Table 3.1, consider the following example. The A-A descent moiety holds two classificatory patridescent lines in implicit subsections A2a-A1a and A2b-A1b. For example, A2a and A1a in alternation contain Ego's FF's patridescent line (FF, F, Ego, S, SS), and Ego's MMB's patridescent line (MMB, MMBS, MMBSS, MMBSSS), etc. Note that A2a holds Ego and his siblings in generation 0, and his FF and SS and their siblings in generation ±2. One of the major differences between sections and subsections is that section B2 groups together all 1st and 2nd cross-cousins, but the subsections differentiate between them; i.e., 1st cross cousins MBD/FZD are in subsection B2b, while 2nd cross cousins MMBDD are in B2a.

The numerical values in the cells of the table represent 22,831 cases in which applications of kin reference terms can be checked against section memberships. For example, in subsection A2a, Egos apply kin terms to (823+970+1764=) 3557 siblings in their own subsection and their accuracy rate is 98.93%. Only 38 errors occur when Ego mistakenly applies a sibling term to a person who is not a member of his own section. The error rate of 1.07% suggests unsystematic noise due to random errors in recognition of Alters' photographs, speaker's word choice, ethnographer's recording or legibility errors, etc.

Twenty of the 22 kin terms used in this Table show accuracy rates of 97.8 or higher, including 8 with accuracy rates of 99.0 or higher. In other words, there is nearly perfect correlation between 20 of the 22 kin terms that Ego applies to Alter, the kin type to which Alter belongs, and the relative section and subsection memberships of Ego and Alter. Since details concerning kin terms *per se* are essentially local issues, they are important for endogamous marriages but are less important than kin types for exogamous marriages; i.e.,

since kin types can be recognized commonly across multiple societies by virtue of their positions in skin sets, they seem to take precedence over kin terms in arranging exogamous marriages.

Notice however that the terms "*amaidya*" and "*abmarliya*" (spellings from Denham, McDaniel and Atkins 1979), near the bottom of the Table, are used in accordance with canonical models in less than 85 percent of 3,200 cases. But this 15% "error rate", small though it may be, is highly systematic and in fact is not an error at all. According to canonical models, Ego should apply both terms to members of his mother's section, with one term typically referring to real or classificatory mothers and the other to real or classificatory mothers' brothers. But in fact Ego also frequently uses both terms to refer to people who belong to the section from which he receives spouses; i.e., he uses the terms for M and MB to refer to members of both sections of the opposite patrimoiety. A detailed examination of genealogies shows that the Alyawarra optionally employ an Omaha cousin terminology that sets MBSS = MBS = MB and MBSD = MBD = M. These statistics show that the Alyawarra optionally change the kin term for MBD to the kin term for M, which has the effect of converting a marriageable cross cousin into an unmarriageable terminological Mother. Hiatt (1996:55-56) succinctly illustrates the use of this optional terminological change in an example from the Gidjingali of northern Arnhem Land.

So the Table shows that twenty of the twenty-two terms in the Alyawarra kinship vocabulary correspond almost perfectly with relative section membership as predicted by the canonical models, and that two of them conform in about 85% of cases while deviating systematically and significantly in 15%. The deviations reflect the optional use of Omaha cousin terms as a distancing mechanism that contributes to inbreeding avoidance among the Alyawarra.

Although the canonical models are poor predictors of Alyawarra behavior associated with generational closure, they are good but imperfect predictors of behavior patterns at the global level associated with kin types, kin terms and skin terms. More detailed analyses of these patterns, revealing significant discrepancies, appear in Denham, McDaniel and Atkins (1979).

I cannot argue that the patterns in Table 3.1, based solely on Alyawarra data, represent all Australian Aboriginal societies, for I have never seen comparable data from other Australian societies. However, the logical relations built into the three sets of moieties appear to be constant across Australian societies, as do the distributions of kin types in the implicit or explicit sections and subsections. The blooming buzzing confusion often associated with historically changeable kin terms and skin terms generally masks the long term global stability of these foundational structures.

Therefore I suggest that the hypothetical infrastructure proposed in Figure 3.1 and Table 3.1 provides continuity and stability in both time and space. Temporally it underlies and sustains the invention and diffusion, the mobility and transience, of ephemeral kin terms and skin terms as revealed by recent research in historical linguistics (McConvell and Evans 1997).

Spatially it serves as a common network of predictable relations in the deep structure, shared at the very least within nations and probably much more widely, that facilitate horizontal linkages between neighboring societies at any point in time.

Phase Transitions

All of the adjustments proposed above retain the basic structure of canonical Kariera, while those proposed below are much more radical in that they alter that basic structure. They are not based on the behavior of individuals, but reflect systematic changes in the structure and operation of a society as a whole. I refer to such societal transformations or state changes as "phase transitions". By analogy, they are not gradualistic as would be true of lowering or raising the temperature of liquid water by one degree, but rather are stepwise changes in form such as those that occur when water becomes ice at 0^{o} C or steam 100^{o} C. The first converts a society with 2, 4 or 8 skins into a society with a different number of skins. The second introduces horizontally asymmetric marriages, the third adds vertical asymmetry to the horizontal asymmetry, and the fourth transforms an intrinsically endogamous structure into an exogamous structure.

Skin term transformations. Here I review four hypotheses concerning skin term transformations in Australian Aboriginal societies. The first two, by Jolly and Rose (1943) and McConvell (1985a), use strikingly different approaches to depicting a reconstructed past. The third does "not depict a reconstructed past, but discuss[es] the historical mechanisms behind the diffusion of section systems" (Dousset 2005:10). My own efforts are not historical but make more sense in the historical context provided by the first three,

Jolly and Rose (1943) seek a general theory of the origin and evolution of skins. They attempt to solve the problem of societal closure by hypothesizing a complex 10-step evolutionary sequence based on lineage exogamy. Beginning their argument with general promiscuity, they incrementally add a series of incest taboos and sequential exogamous fusions of 1-, 2- and 4-lineage societies, ultimately deriving 8-lineage societies that make the paternity of each child the responsibility of one man. Their scheme is compatible with both the Great Chain of Being (Lovejoy 1936) and the Idea of Progress (Bury 1920, Nisbet 1980), and is reminiscent in content and method of well known 19^{th} century works on unilinear cultural evolution.

McConvell (1985a) directly addresses the problem of societal closure by explaining the derivation of subsections from a pair of exogamous section systems in societies that intermarry by means of a circulating connubium. By focusing narrowly on subsections, his objective is more modest than that of Jolly and Rose (1943) who focused broadly on all skins. His approach is based on recent data from historical linguistics and in my opinion is much superior to Jolly and Rose's, but in fact both papers account for 8-subsection systems as end products of unidirectional evolutionary or historical sequences that entail societal exogamy.

> McConvell's account says that marriage ideally and nearly always takes place between clans of opposite patrimoieties belonging to a single endogamous language group or to two or more exogamous language groups. Likewise the exchange of women may be bilateral and reciprocal, or it may be unilateral and occur within a circulating connubium. Circulating connubia established between moieties of different language groups are consciously articulated by groups of clans in north-eastern Arnhem Land, not far from Rose's (1960) research on Groote Eylandt and Keen's (1982:640) research with the mainland Yolngu, both of whom use age biased generations.
>
> McConvell argues that such an arrangement was established between two language groups or societies (call them East and West), each with two patrimoieties (call them Eagle and Heron) and each with a unique set of section terms (call them E1-E4 and W1-W4). The essential feature of the model is that Eagle clans in both patrimoieties gave women exclusively or predominantly to Heron clans within their *own* language groups, whereas Heron clans in both patrimoieties gave women exclusively or predominantly to Eagle clans in the *opposite* language groups in keeping with the circulating connubium. When Heron men married Eagle women of their own group, their children received section names from their own group. But when Eagle men married Heron women of the opposite group, their children received section names from their mother's group, disregarding the father's section name as is a common practice when wrong (irregular?) marriages occur. Multigenerational recursion yielded a pair of groups each with a total of eight marriage class names; i.e., the two separate section systems merged to form subsection systems incorporating terms for both E1-E4 and W1-W4.

McConvell's proposed transformation is convincing with regard to social change in the Katherine area of the Northern Territory at a single time probably within recent centuries, followed by diffusion south, west and east from there, and it yields a significant reduction in societal closure. But his explanation is specific rather than general, and the proposed transformation is unilinear when there is at least a logical possibility that such events are reversible. I address these issues below.

Dousset (2005 *passim*) examines terminological and logical changes in 4-section systems of about 25 Western Desert societies. Careful linguistic and logical analysis of those changes yield an extended series of discussions and maps showing where various section names probably originated and the probable directional sequences in which changes in them occurred. The patterns suggest that section systems emerged twice in coastal Western Australia. They seem to have diffused in part along the coast toward each other and eastward into the interior of the Western Desert leaving a mixture of the two along their imprecise interface. The sequences or paths of changes generally correspond to major long range Dreaming tracks that interconnect societies throughout the region. Whether the changes reflect diffusion of concepts, migration of people, chains of societal exogamy, or some combination, generally is unknown, and intellectual, social and ecological factors that motivated the changes are unknown. At least with regard to these data, societal closure seems not to have characterized Western Desert societies.

My own proposal is a speculative[6] step toward a general explanation (*sensu* Jolly and Rose) that subsumes McConvell's and Dousset's specific schemes and builds on them.

I suggest that a society with skin terms may use indigenous mathematical methods to multiply or divide by 2, thereby transforming the terms and logic of 2 moieties into 4 sections in a single step, or those of 4 sections into 8 subsections, or *vice versa*. In principle, the computational method may entail conceptual changes within an endogamous society, or social adjustments based on fusion (perhaps fission as well?) of exogamous societies as Jolly and Rose (1943) and McConvell (1985a) suggested. An upward step in the number of skin terms increases the mean genetic distance between all husbands and wives who conform to the change, e.g., from 1st cousin to 2nd cousin, while a downward shift has the opposite effect. In addition, a shift upward among proper kin increases the possible number and genetic diversity of one's potential spouses. Furthermore, when a society makes a shift that increases or decreases the genetic distance between spouses, it tracks similar changes in neighboring societies thereby facilitating intersocietal marriages if they occur.

Evidence that is compatible with this hypothesis is available from Dousset (2005), McConvell (1985a, 1985b), von Brandenstein (1982), Koch (1997) and others. It shows systematic, non-random transformations of terms and logics of contemporary and obsolete section and subsection systems, all of which appear to have been associated with migrations of people and diffusion of languages throughout Australia in recent centuries.

Consider Figure 3.2 below as an example from Central Australia. Strehlow's (1947) map of Arandic speaking people and their near neighbors serves as a base for systematized tables showing skin terms in 3 section systems and 5 subsection systems used by the Alyawarra and 7 of their neighbors. It is based directly and indirectly on earlier reports by Spencer and Gillen (1899:90) and many others, as reported by McConvell (1985b:26-30), Koch (1997) and others. Following McConvell (1985a:3,14), my concern here is with linguistic or cognate equivalence (i.e., the match between skin terms used in compared sets) and pragmatic equivalence (i.e., the match between the logic of descent and marriage rules in compared sets). Pragmatic equivalence is standardized here in accordance with Elkin's (1964:103) matrilineal orientation: Ego (lower-left), M (upper-left), F (upper-right), W (lower-right),

[6] It is unfortunate that conjectures and speculations such as those in this and subsequent sections of the paper have poor reputations in Australian Aboriginal cultural or social anthropology for they are basic to creative research (Evnine 1993). Alan Turing (1950:442), in a paper that laid the foundations of computer science and Artificial Intelligence research, noted that "The popular view that scientists proceed inexorably from established fact to established fact, never being influenced by any unproved conjecture, is quite mistaken. … Conjectures are of great importance since they suggest useful lines of research". Karl Popper (1963) built his study of the growth of scientific knowledge around the twin notions of conjectures and refutations. And Doyle (1902/2006:436) says that, "[Speculation] is the scientific use of the imagination, but we [must] have always some material basis on which to start". Here and throughout this paper, I have followed Sapir (1916), McConvell (1985b) and Sutton (1990) in offering conjectures and speculations with a solid material basis in hopes of seeing beyond current horizons.

which differ from the patrilineal descent orientation used in Figure 3.1 and the order used by McConvell (1985b:26-30 Tables 1-6).

Dimensions within which similarities and differences may occur include: number of skin terms in each set; selection of terms used; relative positions of terms in the grids; pronunciation (i.e., spelling) of terms taking into consideration dialectal variations of speakers and first language interference in hearing, speaking, reading and writing among recorders and analysts; and random errors.

I follow Koch's (1997) spellings. Among the 3 societies with sections, the Eastern and Southern Aranda use the same set of 4 terms (*kemarre, peltharre, perrurle, penangke***)**. The Alyawarra use a slightly different set (*akemarre, apetyarre, pwerle, kngwarreye***)**, the 1st a trivial difference in pronunciation, the 2nd and 3rd more significant dialectal differences, the 4th a significant difference in vocabulary that McConvell (1985:12) suggests may be a term from an obsolete section system. In sum, the languages of these three societies are closely related and their skin terms (excepting *kngwarreye***)** and rules closely match.

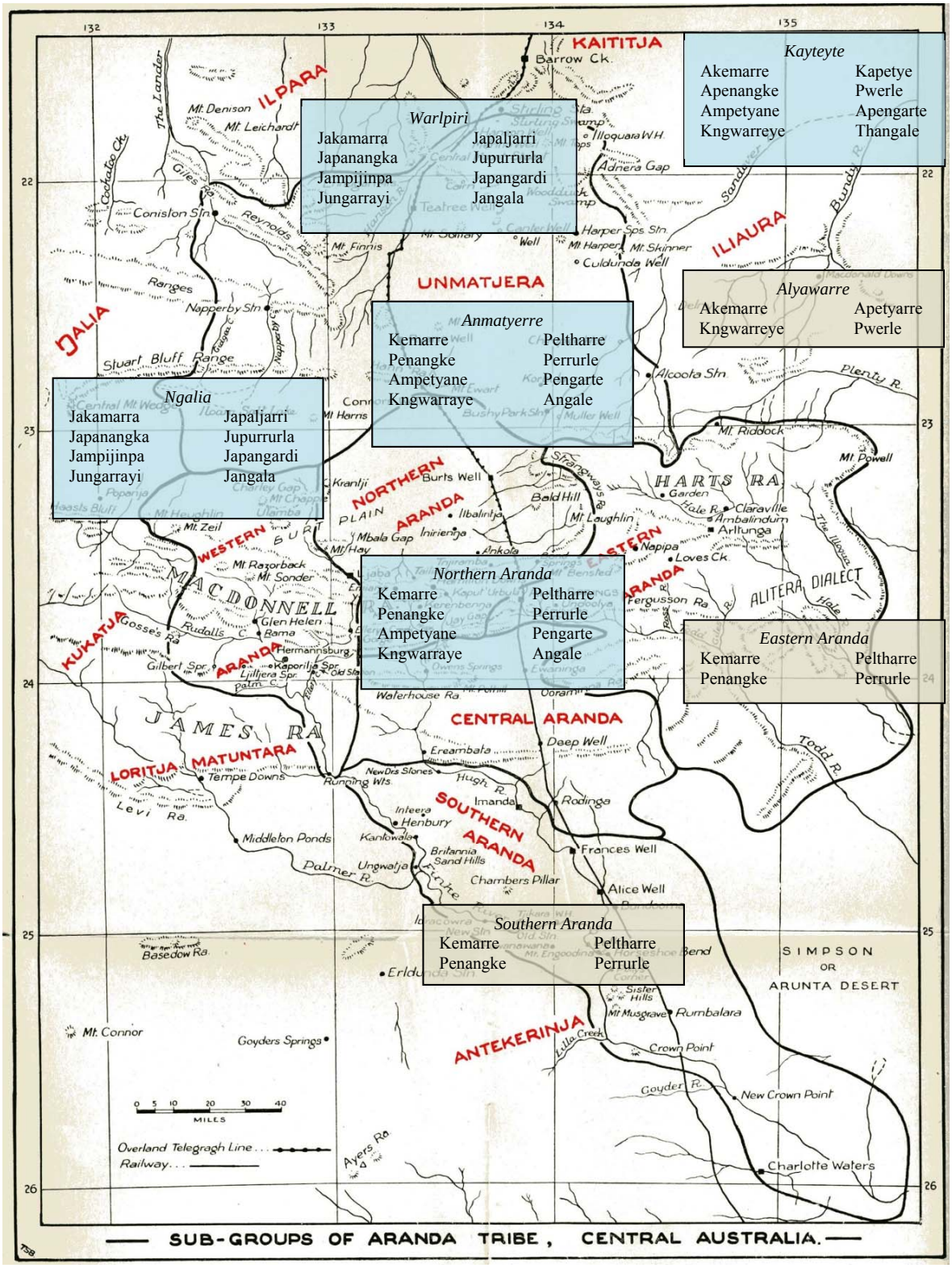
The 5 subsection systems are more difficult to summarize. Four of them use *ja/na* gender prefixes (e.g., Warlpri: *jakamarra* = masculine; *nakamarra* = feminine) but the Northern Aranda do not. Excepting the Kayteyte, all of them use the same terms in the upper 4 positions, and those terms are the same as the ones used by the Eastern and Southern Aranda. All of them use the same terms in the lower 4 positions. And all 5 of them use *kngwarreye* or a close cognate in the lower left position, which is the same term that is used in the lower left position by the 4-skin Alyawarra. All of these societies use *kemarre* or a close cognate in the top left position.

In sum, the small tables superimposed on the map in Figure 3.2 are remarkably similar to each other even though some have 4 terms and some have 8.

In Central Australia, intermarriage within the cluster of section societies and within the other cluster of subsection societies presumably was not problematic since skin terms and rules of those respective sets of societies were closely related to each other, but intermarriage across the divide between section societies and subsection societies could have presented more problems. In general the proposed complexity continuum could have served as a mechanism for adjusting mismatches; specifically, anonyms as incipient, unlabeled subsections within section societies would have facilitated exogamous marriages.

ON FOLLOWING PAGE:

Figure 3.2. Central Australian section (gray) and subsection (blue) terms and their relative locations.
Map from Strehlow (1947). Data from Koch (1997) and his sources.
Random errors removed, dialectal variations retained, spellings standardized.
Matrifiliation: left column bottom to top; right column top to bottom.


Warlpiri
Jakamarra
Japanangka
Jampijinpa
Jungarrayi
Japaljarri
Jupurrurla
Japangardi
Jangala
Kayteyte
Akemarre
Apenangke
Ampetyane
Kngwarreye
Kapetye
Pwerle
Apengarte
Thangale
Alyawarre
Akemarre
Kngwarreye
Apetyarre
Pwerle
Anmatyerre
Kemarre
Penangke
Ampetyane
Kngwarraye
Peltharre
Perrurle
Pengarte
Angale
Ngalia
Jakamarra
Japanangka
Jampijinpa
Jungarrayi
Japaljarri
Jupurrurla
Japangardi
Jangala
Northern Aranda
Kemarre
Penangke
Ampetyane
Kngwarraye
Peltharre
Perrurle
Pengarte
Angale
Eastern Aranda
Kemarre
Penangke
Peltharre
Perrurle
Southern Aranda
Kemarre
Penangke
Peltharre
Perrurle
KAITITJA
ILPARA
UNMATJERA
ILIAURA
JALIA
KUKATJA
LORITJA
MATUNTARA
ANTEKERINJA
NORTHERN ARANDA PLAIN
WESTERN ARANDA
EASTERN ARANDA
CENTRAL ARANDA
SOUTHERN ARANDA
ALITERA DIALECT
MACDONNELL RA.
JAMES RA.
HARTS RA.
SIMPSON OR ARUNTA DESERT
Barrow Ck.
Mt. Denison
Mt. Leichardt
Conisten Stn.
Napperby Stn.
Stuart Bluff Range
Mt. Finnis
Harper Spg. Stn.
Mt. Harper
Mt. Skinner
Culdunda Well
Alcoota Stn.
Mt. Riddock
Mt. Powell
Burts Well
Bald Hill
Mt. Laughlin
Claraville
Arltunga
Napipa
Loves Ck.
Mt. Razorback
Mt. Sonder
Glen Helen
Hermannsburg
Gilbert Spr.
Waterhouse Ra.
Erearnbata
Deep Well
Tempe Downs
Running Wtr.
Imanda
Rodinga
Henbury
Middleton Ponds
Frances Well
Chambers Pillar
Alice Well
Basedow Ra.
Mt. Connor
Goyders Springs
Mt. Musgrave
Rumbalara
Crown Point
New Crown Point
Charlotte Waters
Todd R.
Plenty R.
Overland Telegraph Line
Railway
SUB-GROUPS OF ARANDA TRIBE, CENTRAL AUSTRALIA.

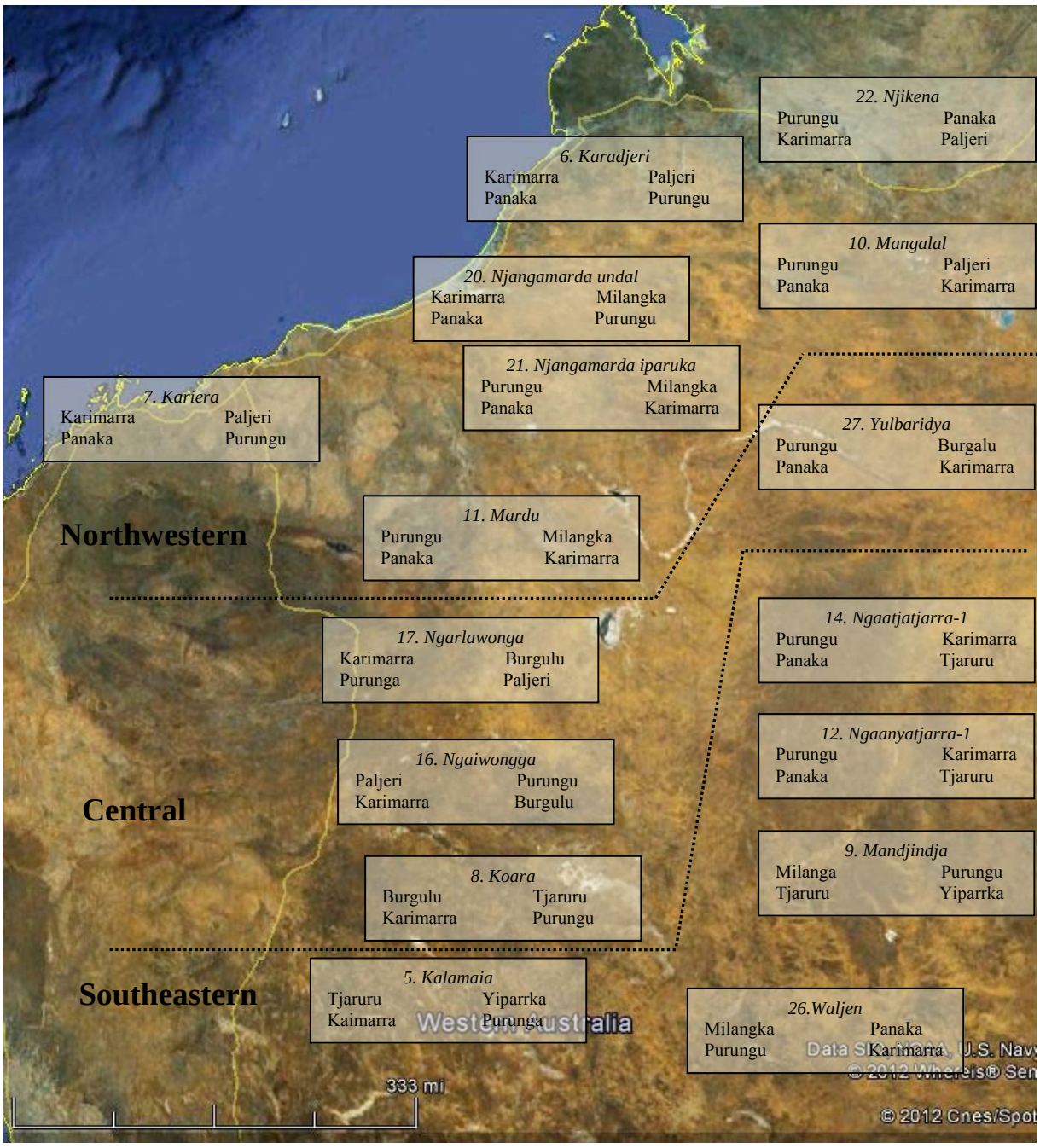


Figure 3.3. Western Desert section terms and their relative positions
Map from Google Earth. Data from Dousset (2005:16, 38, 42, 97-100) and his sources.
Sample of 16 datasets selected to enhance spacing and legibility; locations are approximate.
Random errors and dialectal variations removed; spellings standardized by Dousset.
Matrifiliation: left column bottom to top; right column top to bottom:
Ego (lower-left), M (upper-left), F (upper-right), W (lower-right).

Now consider Figure 3.3 as an example from the Western Desert cultural block. Arranging matches between these increasingly divergent societies could have been more difficult. The Figure shows 16 sets of skin terms from intermarrying societies in that region (Dousset 2005). Dousset removed random errors and dialectal variations, but necessarily incorporated his own first language interference in hearing, speaking, reading and writing. Data from a larger sample appears in his book, but the smaller sample is sufficient for illustrative purposes here.

These 16 Western Desert societies with 4 skins each reveal both unity and diversity in their terms as do the Central Australia societies, but the kinds of patterns are conspicuously different. Minimally, all of the Western Desert sets use only 4 skin terms, which on the surface seems to reduce the complexity, but that is not necessarily so. Nevertheless, the ubiquitous generation moieties and the myriads of sibing-in-law chains that they embody effectively integrate the apparent jumble of skin terms and rules that characterize the region (Dousset 2005, I.M. White 1981).

Dousset (2005:50-51) proposes 8 geographical subclusters among these Western Desert societies. I have taken the liberty of collapsing them further into 3, which I have labeled as Northwestern, Central and Southeastern. Table 3.2 shows that a total of 4x16=64 skins are labeled in Figure 3.3, and 8 different terms occupy those 64 positions. Three of them (*purungu*, *karimarra* and *panaka*) account for 65.6% of the 64 usages region-wide, are present in all three of the regional subclusters, and in a general sense characterize the entire cluster. The next 3 (*paljeri*, *milangka* and *tjaruru*) account for 26.6% of the total usage and each is present in 2 of the regional subclusters. The last 2 account for only 7.8% and are present in only 1 subcluster each. It is at least plausible that the numerous major differences among terms and among rules (not tabulated here) in the Western Desert might pose more significant interface problems than would the minor dialectal variations in Central Australia.

Western Desert Skin Terms	**Geographical Subclusters**			**Row Totals**	
	North Western	**Central**	**South Eastern**	**Number**	**%**
Purungu	7	4	5	16	
Karimarra	7	4	4	15	65.6
Panaka	7	1	3	11	
Paljeri	4	3	0	7	
Milangka	3	0	2	5	26.6
Tjaruru	0	1	4	5	
Burgulu	0	3	0	3	7.8
Yiparrka	0	0	2	2	
Column Totals	**28**	**16**	**20**	**64**	**100**

Table 3.2. Summary of the geographical distribution of skin terms in the Western Desert cluster.

Despite the heterogeneity in terms and rules in Figure 3.3, Table 3.3 reveals great homogeneity across both Central Australia and the Western Desert (McConvell 1985a). This table is based on a carefully selected sample of terms and rules from Figures 3.2 and 3.3; viz., a) the 4 skin terms used by the Central Australian Southern Aranda, b) the top 4 terms in the Central Australian Warlpiri 8-skin set, and c) the 4 terms in the Western Desert Kariera set. Notice that all of these terms and rules (standardized relative positions) are the same with minor dialectal variations.

a) Central Australia: Southern Aranda (4-skins)	
Kemarre	Peltharre
Penangke	Perrurle
b) Central Australia: Warlpiri (top 4 in 8-skins)	
Jakamarra	Japaljarri
Japanangka	Jupurrurla
c) Western Desert: Kariera (4-skins)	
Karimarra	Paljeri
Panaka	Purungu

Table 3.3. Comparison of terms and their positions in Central Australia and the Western Desert.

Figures 3.2 and 3.3 immediately raise questions about covert patrilineal, matrilineal and generation moieties that serve as the primordial foundation *underlying* sections and subsections; exogamous marriages *between* societies that might generate transformations of moieties, sections and subsections; possible cognitive transformations *within* individual societies; and diffusion *among* societies of changes in section and subsection terms and rules as overlays on the foundational structure.

These Figures seem not to depict an evolutionary sequence (*sensu* Jolly and Rose 1943), but probably do depict fragments of multiple recent diffusion sequences (Dousset 2005) that partially obscure a logical complexity continuum, a sequence of increasingly complex logical variations on the theme of sections and subsections, with increases in genetic separation between spouses occurring at some but not all points.

Of special interest are transitions in Figure 3.2 between the following discernible points on the proposed complexity continuum: a) simple 4-skin societies probably located to the east of the Alyawarra in Queensland; b) complex 4-skin societies such as the Alyawarra and Southern Aranda with implicit 8-skin anonyms; c) simple 8-skin societies such as the Northern Aranda; d) complex 8-skin societies such as the Warlpiri and Ngalia (e subdivision of the Warlpiri) with gender prefixes (ja- and na-) yielding a total of 16 skins, half of them masculine, the other half feminine; f) hyper-complex 8-skin societies such as gender prefixing Kayteyte in which additional skin terms (perhaps 24-32 terms *in toto*) are used to mark social maturity distinctions between pre-pubescent girls and uninitiated boys on the one hand, and marriageable women and initiated men on the other. g) Furthermore, among the

Eastern Anmatyerre near the center of Figure 3.2, Green (1998:16 fn.17) reports that some Countries use a section system while others use a subsection system, but precisely how that extra bit of complexity fits into the larger scheme is not clear. h) Also it is important to go beyond the scheme outlined here to consider even more esoteric possibilities including possible "hypercubes" among the Warlpiri (Meggitt 1962, Glowczewski et Pradelles De Latour 1987, Glowczewski 1991, Héran 1996).

How might these transitions and their related intermarriages work? As shown above, McConvell (1985a) deals specifically and very effectively with circulating connubia, societal exogamy and the origin of subsections at one point in time and space, but the questions are more general than that.

Lawrence eloquently describes an Aboriginal understanding of skins right across Australia but says nothing about how they share that understanding across such vast distances.

> "In association with far-flung intertribal contacts … there has developed a recognition of the equivalence of classes the length of the continent. … though the number of classes increase, though the names of classes be unlike, though like names be arranged in unlike affiliations, the native nevertheless recognizes the corresponding divisions in different tribes" (Lawrence 1937:321-322).

Bell's (1993:261-263) tabular display of relationships between Alyawarra skin terms and skin terms used in neighboring societies is based on data collected by her during fieldwork with the Alyawarra at Warrabri Settlement in the 1970s. Green (1998:15-16,79-94) takes a similar approach in her analysis of skin and kin among 5 Arandic language groups including the Alyawarra. While Koch (1997) and Dousset (2005) demonstrate how terms relate to each other within individual societies, Bell and Green follow Spencer and Gillen (1899:90) in demonstrating how terms relate to each other in multiple societies. In his even more detailed meta-analysis of Aranda data, Guhr (1963: Diagrams 8-11) takes a diagrammatic approach to examining interrelations between 4 sections among the Southern and Eastern Aranda and 8 subsections among the Northern Aranda.

The articulation of skin terms with kin terms in the co-occurrence of descent and generation moieties and Dravidian/Kariera kinship terminologies is not just a coincidence. They seem to occur as a "package" whose constituents are "made for each other" (Dousset 2005:23). But the fact that they are made for each other in a generic sense means that a society that uses 4 skin terms and Dravidian kin terms might make a seamless transition to a different set of 4 skin terms or can reconfigure its 4 skin terms and rules to match similar changes in neighboring societies. Likewise, it might transform 4 sections to 8 subsections and incorporate their more complex logic. During periods of adjustment, transitional mismatches between skin terms and kin types should be expected, as Barnes (1968) noted for the Murngin. Intensive linguistic research on historical sequences and processes linking these and other skin sets is in progress as part of the AustKinII project (McConvell and Dousset 2012).

I suggest that constant change among kin and skin probably is and always has been a major symptom of societal openness. Under these conditions, interfaces between alternative forms seem not to have been shatter zones in the infrastructure characterized by contamination, competition, breakdown and wrong marriages. Rather, they seem to have been growth points in the superstructure characterized by cooperation among systems that intermingled, coevolved, coadapted and ultimately merged. The terms and rules behave as *Wanderwoerter* (McConvell 2012), wandering words, reflective of great mobility, that have scattered across multiple languages, with complex etymologies, changing here and there but retaining much of their identity over vast stretches of space and time.

I agree with McConvell (1985a:17) when he says, "There is little doubt that the invention of subsections took place once, in one area, not several times independently in different areas." But I suspect that his statement applies only to the current array of subsection systems in northern Australia, not to all categories of skin terms spanning much of Australian Aboriginal history. Consider his scattered references to pre-existing or obsolete skin terms including *kngwarreye* among the Alyawarra, Dousset's discussion of two sets of section terms in Western Australia, the separate emergence of Eastern section terms perhaps in Queensland (Berndt and Berndt 1964:55, McConvell p.c.), the adoption of subsection terms to replace section terms among the Aranda (Spencer and Gillen 1899), the emergence of a 6-section system in Ambrym Island (Lane and Lane 1958) and other similar phenomena. Together they suggest that we do not know how many onion-like layers of moieties, semi-moieties, sections and subsections – or something like them - underlie the current array continent-wide, most or all of them based on the intersection of ubiquitous covert generation and descent moieties as depicted in Figure 3.8 below.

My general hypothesis leads directly to a question that McConvell's specific hypothesis did not ask; viz., what events or conditions might motivate the onset of shifts along the logical complexity continuum? In Section 4, I attempt to answer this question in part from the perspective of the deep ecological history of firestick farming. Although today's active sets of terms and rules may be recent – even ephemeral on a geological time scale – I speculate that they overlie a deep and complex history that encompasses continuity and change, unity and diversity, across much of the continent spanning untold millennia (Flannery 2012).

Circulating connubia. A society that practices bilateral sibling exchange marriage between cross cousins can replace it with unilateral cross cousin marriage, with wife and husband still presumed to be the same age. Changing a canonical Kariera model to a circulating connubium is a major phase transition that requires the discontinuation of one direction of spousal flow, typically FZD marriages, with the retention of spousal flow from the other direction, generally with men marrying their MBD (Denham 2012:13). As a striking example, McConvell (p.c.) notes:

> "… the phase transition between symmetrical and matrilateral marriage in Cape York Peninsula and North-East Arnhem Land in which Omaha skewing played a catalytic role" (McConvell and Alpher 2002, McConvell and Keen 2011, McConvell 2012).

Unless Rose's fiction of bilaterality is maintained, the behavioral distinction between wife-givers and wife-takers can induce major changes in kin terms and rules such that defining features of Dravidian kinship may be distorted or lost in the process (Trautmann 1981). The resulting circulation in which spouses flow horizontally in one direction only (Blundell and Layton 1978, Warner 1958) yields spouses that are less closely related to each other than they are in a canonical Kariera society in which spouses flow in both directions. Of course 100% compliance with the unilateral adjustment may not occur, so its effect is best described in statistical terms. McConvell's (1985a) hypothesis concerning the origin of subsection systems demonstrates the critical role that circulating connubia can play in enhancing societal openness, and Tjon Sie Fat's (1983a, 1983b) papers document their importance in Indonesia, Aboriginal Australia and elsewhere.

Endogamous helical generations.[7] The phase transition from horizontal asymmetry alone to a combination of horizontal and vertical asymmetry builds directly on the circulating connubium and Rose's oft repeated argument that generational closure is impossible in the presence of a significant W<H age bias. I described the rationale, emergence, construction, operation and geographical distribution of hypothetical or real endogamous helical structures in Denham (2011, 2012). Here I summarize and expand upon that argument. The kinds of changes introduced here may occur independently of or in conjunction with those introduced above, hence the statistics may be complex.

If the mean age difference between wives and husbands is not approximately equal to zero in a canonical Kariera or Aranda society, generational closure fails. Individual marital pairs might still be approximately the same age so they could participate in bilateral sibling exchanges, but the greater the *mean* W<H age difference, the less likely that is to happen. Since W>H age differences are exceedingly rare worldwide, I am not concerned with them here.

On average in Australian Aboriginal societies, the mean W<H age difference is approximately 14 years, by far the highest of any continent-wide population (Binford 2001, Denham 2012). Under these conditions a man marries a woman who is on average 14 years his junior, while his sister marries a man who is 14 years her senior. Since the mean age difference between brothers and sisters is zero, the mean age difference between their two spouses is 28 years. It is patently impossible to maintain systematic bilateral sibling exchange marriages under these conditions.

[7] Since publishing my recent paper (Denham 2012) on age biased or helical generations, the following additional references have come to my attention. I cite them here to expand the bibliography for this body of kinship research: Meggitt (1962), Guignard (1975, 1984), Jorion and Leach (1981 MS), Allen (1986, 1989), Glowczewski et Pradelles De Latour (1987), Glowczewski (1991), Tjon Sie Fat (1990), Héran (1995).

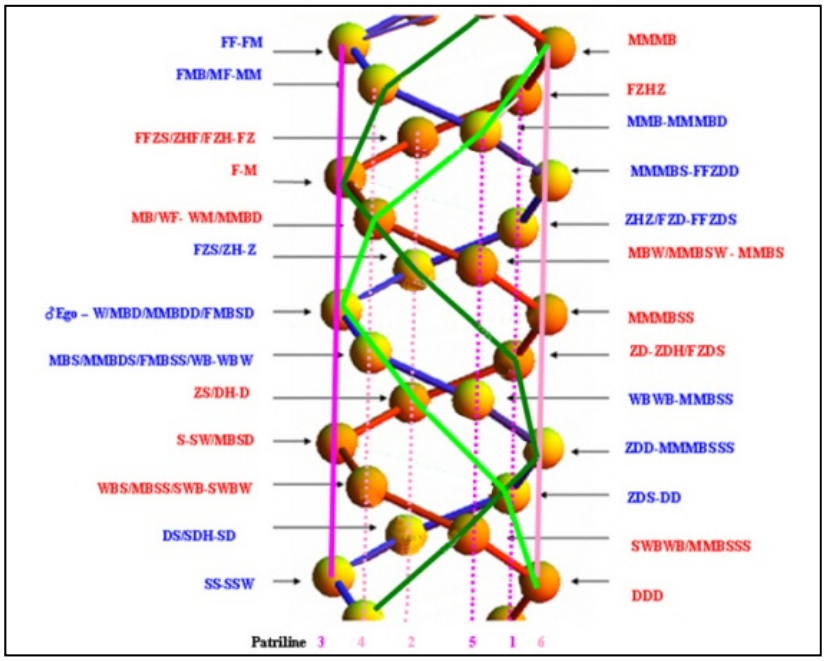


Figure 3.4. Closed helical generations in an endogamous society.
3-dimensional representation.

Figure 3.4 shows a hypothetical 3-dimensional view of the resulting kin type diagram in an endogamous society. The left-most (purple) descent line is centered on a male Ego and his wife. His immediately adjacent primary kin include his parents and children plus his siblings and their spouses. In this diagram the generational closure of canonical Kariera transforms itself into generational openness in which the 14 year W<H age bias yields a pair of endless diagonal generation moieties (blue and red) comprised of sibling-in-law chains. The diagonal generation moieties wrap around their vertical axis to form a helix. Its number of coils and its inclination depend upon detailed numerical relationships within the structure as described in Tjon Sie Fat (1983a) and Denham (2012). In this helical configuration, the wraparound enables men near the left margin of the Figure to marry women near the right margin. The increased genetic separation between husbands and wives contributes further to the reduction in inbreeding coefficients. But societal closure remains unaffected.

Exogamous horizontal and vertical asymmetry. Although the adjustments described to this point can contribute significantly to inbreeding avoidance, all of them occur within the confines of individual endogamous societies as epitomized by the closed structure of canonical Kariera. As they stand, they cannot make any direct contribution to the 15% exogamy rate that seems to characterize Australian Aboriginal societies. This of course does not mean that exogamy cannot occur under the conditions discussed above, but it does mean that mechanical models of kinship in such societies focus exclusively on ideology in the narrow context of endogamy while systematically ignoring nonverbal behavior (actual

marriages) in the broader context of exogamy. They thereby fail to depict realities that are essential to keeping such societies viable.

Figure 3.5 below shows what happens when a society represented by the helix in Figure 3.4 opts for exogamy: the structure undergoes another phase transition. In this Figure, alternating generation moieties and the sibling-in-law chains that they embody are represented by blue dotted lines. The phase transition occurs when they uncoil to yield an open network stretching diagonally from upper left to lower right that by default can interconnect precisely and automatically with other similarly open networks in neighboring societies. The resulting intersocietal connectivity can facilitate the small but vital 15% exogamy rate between neighboring societies in one's own nation and more remotely. The age biased helical generation moieties in Figure 3.4 are optimally suited to transforming a society with canonical Kariera kinship or a circulating connubium into the open or unbounded exogamous society depicted in Figure 3.5.

Figure 3.5 is a horizontal network visualization of the 114 marriages viewed vertically in Figure 2.7. Procedures used to generate it have been described in detail (Denham and White 2005, Denham 2012), and are not repeated here. While some aspects of this diagram are problematic as discussed elsewhere (Denham 2012), its interpretation here is straightforward. The large group of white symbols at the right of the figure corresponds to the core group of Alyawarra inside ring A of Figure 2.7. The green cluster in the ellipse to their left represents children of marriages between Alyawarra and Aranda. The black cluster in the ellipse on the far left depicts Aranda who were included in the research population and were linked to the Alyawarra through exogamous marriages; e.g., Aranda who were married to Alyawarra, etc. In addition to these three larger clusters, there are smaller clusters or singletons scattered across the diagram whose societal affiliations are unclear (blue symbols) or whose positions in the network are isolated from others of their own society.

To focus my field research on a manageable population of Alyawarra speaking people centered at MacDonald Downs Station, I included Aranda at MacDonald Downs and Utopia Downs Stations who had intermarried with the Alyawarra, but systematically excluded more than 100 at Utopia who were two or more steps removed from the Alyawarra. Had I collected a complete dataset for those excluded Aranda and included them in Figure 3.5, they would greatly enlarge the cluster of black symbols at and beyond the left margin of the Figure. Then the function of the encircled green cluster as a "bridge" between Alyawarra and Aranda would be even clearer.

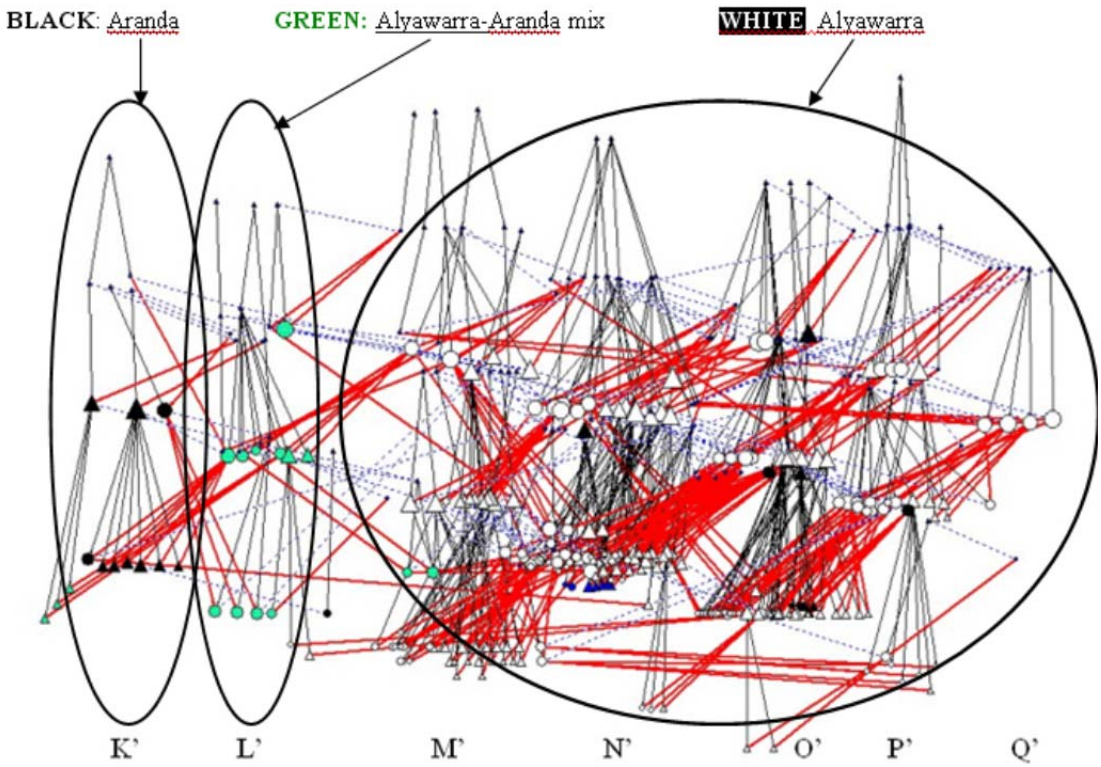


Figure 3.5. Network patterns in Alyawarra marriage data.
People: Δ = male, O = female; *Language group membership of each person:* white = Alyawarra, green = Alyawarra-Aranda mix, black = Aranda, blue = informants disagreed on language group affiliation; *Linkages*: solid black lines = father-child links (patridescent), solid red lines = mother-child links (matridescent), dotted blue lines = husband-wife links (generation moieties); *Vertical descent groups:* K' = Aranda, L' = part-Alyawarra, M' through Q' = full-Alyawarra (alternate descent group codes 1-6, 0 explained in text). *Network* based on data from Denham (1971/2007, 2010a), prepared by D.R. White (Denham and White 2005), featuring sibling sets generated with Pajek network analysis software (Batagelj & Mrvar 1998; de Nooy, Mrvar & Batagelj 2005).

Figure 3.6 is a schematic representation of the Alyawarra portion of Figure 3.5, with descent and marriage relations among kin types displayed in an open 2-dimensional lattice format. As in Figure 3.4, it is centered on a male Ego and his wife, siblings, spouses, parents and children.

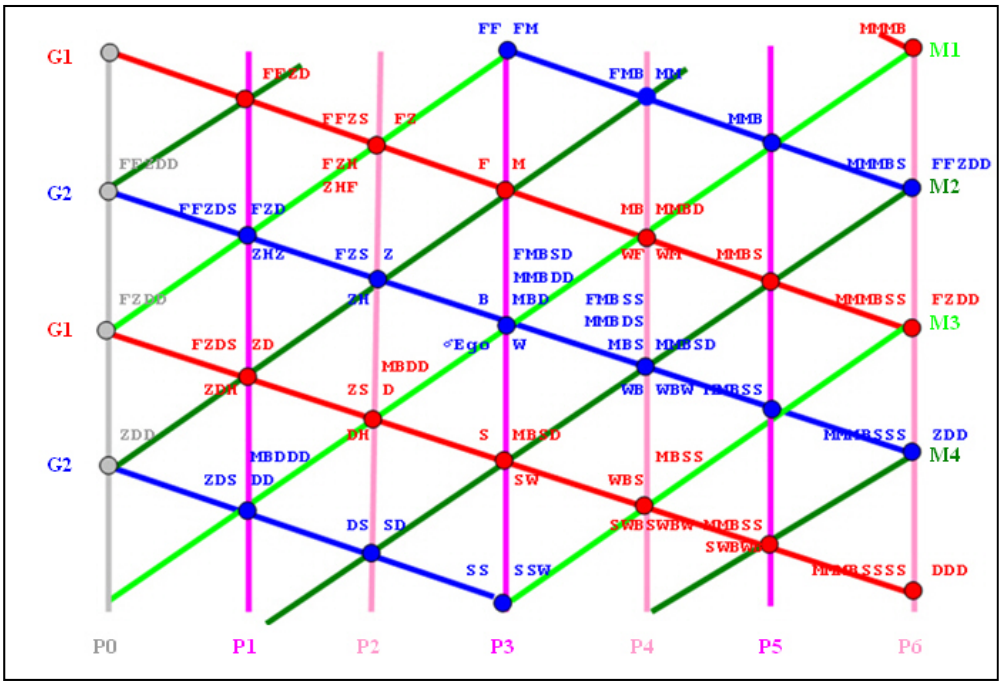


Figure 3.6. Open helical generations in an exogamous society.
2-dimensional representation.

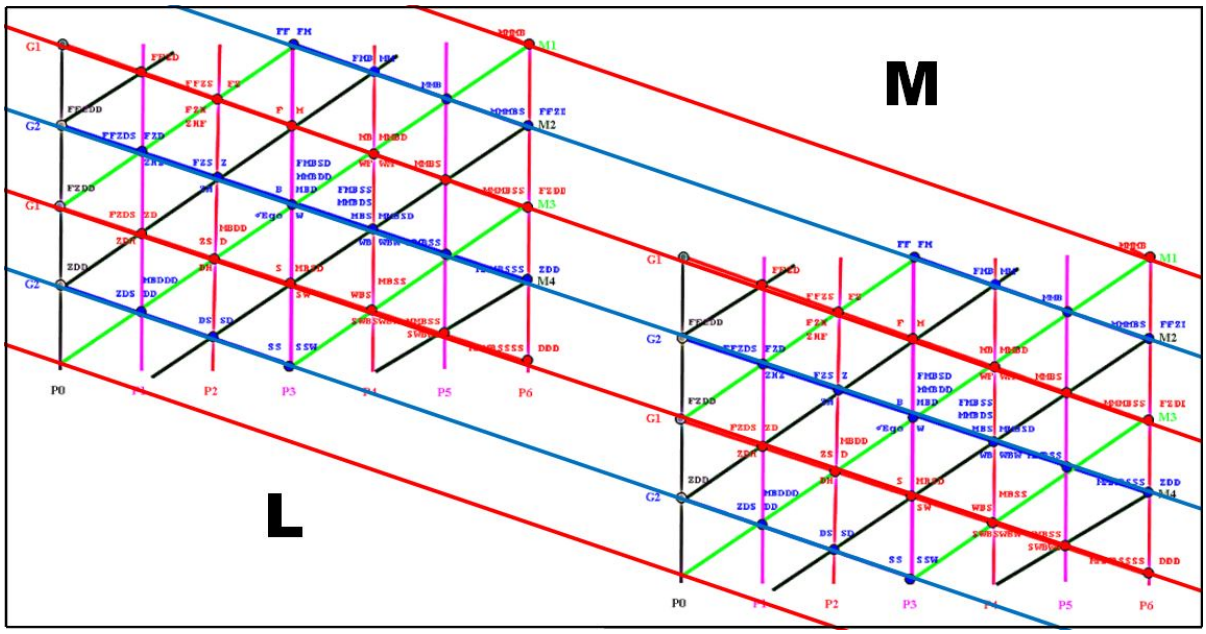
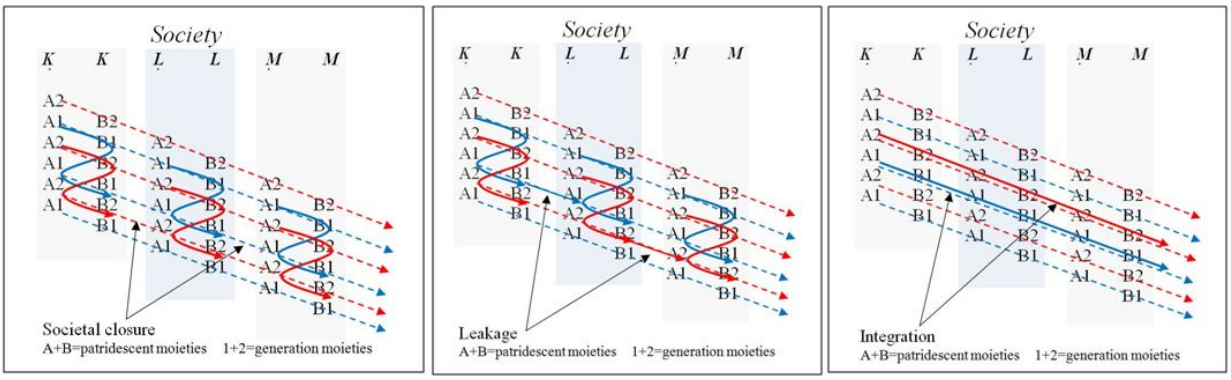


Figure 3.7. Preliminary schematic diagram of intersocietal linkages via generation moieties.

Figure 3.7 is a partial schematic representation of both the Alyawarra and the Aranda portions of Figure 3.5. Each society has a genealogical and terminological core with internal

patri- and matri-descent moieties and its own set of kin terms and rules. Both societies share a common pair of blue and red generation moieties that embody multiple levels of alternating generations that constitute a metaphorical "connective tissue" between societies. An exogamous marriage between a man in Society L and a woman in Society M must comply with the same requirements that would prevail if both were members of the same society; e.g., they must be in opposite descent moieties and the same generation moiety, and the woman in M, who stands in the relationship of MBD to the man in L, is approximately 14 years younger than he is. So long as kin type distributions within skins remain constant across neighboring societies, individual kin terms and structures of systems of kin classification (Scheffler 1981) of which they are parts may be of lesser importance in that context; i.e., kin terms may regulate relations within societies, but skins and kin types seem to do so between societies. In principle a comparable network showing all of the intersocietal marriages in Figure 2.3 could be constructed, but with insufficient data concerning marriages within non-Aranda societies, such a network would not be informative.



A. Endogamous societies B. Transitional societies C. 7-21% Exogamous societies

Figure 3.8. Refined schematic diagram of Figure 3.7.
Endogamous, transitional and exogamous stages in the development
of a nation characterized by 15% exogamy among neighboring societies**.**

However, Figure 3.8 is a schematic diagram of the approach suggested here for depicting exogamous marriages between adjacent pairs of societies. The diagram depicts three neighboring exogamous societies such as those suggested in Figures 3.7. Figure 3.7 shows purple-pink classificatory patridescent lines and green classificatory matridescent lines that are essentially local within each society, while Figure 3.8 emphasizes the fact that the red and blue generation moieties encompass regional or global sibling-in-law chains.

Thus Figure 3.8 suggests a sequence that might transform Panel A, a collection of free-standing endogamous societies with helical generations, into Panel C, an integrated neighborhood or nation of exogamous societies. Each society (K, L, M) has two exogamous patridescent moieties (A and B) and two endogamous generation moieties (1 and 2). Matridescent moieties are omitted here to enhance legibility. In Panel A, the descent and generation moieties are in place but no marriages link the societies. In Panel B, sporadic

marriages occur in one or the other generation moiety but helices continue to define the structure of the societies. In Panel C, a variable but persistent rate of exogamy signifies the phase transition that converts closed helices in Figure 3.4 to open, linked lattices in Figure 3.8.

In this Figure, a marriage between a B2 man in Society L and an A2 woman in Society M is logically equivalent to a marriage between a pair of people of the same sections within one's own society. If no prior marriages exist between the societies, even a single exogamous marriage between them can establish a precedent for future marriages to follow. That linkage and all of the concomitant linkages that it entails across the generations can act like an endless zipper that holds together the full length of the A and B moieties, either within a single endogamous society or between a pair of exogamous societies. The helices themselves and their ability to attach to adjacent helices by means of kin and skin suggest possible analogies between helical structures in Australian Aboriginal kinship and DNA.

4. Ecological history

In Section 4, I transform static models into dynamic models by building on phase transitions and the skin term complexity continuum introduced in Section 3.

After briefly reviewing habitat features with which Aboriginal people interacted to develop basic and enduring kinship patterns, I explore stochastic changes in genetics, demography and climate that have long recurrence intervals, and suggest that they may have controlled the timing and direction of changes in kinship behavior among individuals and societies. Then I expand on Sutton's (1990) notion of demographic pulsations in response to environmental changes, his pulsations being related to societal migrations, mine being related to societal openness with "hard times" increasing openness and "rich times" increasing closure.

Using the concepts developed to this point, I explore some kinship implications of firestick farming and the food crisis in prehistory, and conclude with an overview of long term ecological and social cycles that may shape the dynamics of Aboriginal kinship. My objective, then, is to better understand kinship dynamics in the highly stressful habitats of Aboriginal Australia.

Habitat features and stochasticity

Major themes of this section come from Lourandos (1997) and Flannery (1993, 2012) because their works are complementary, comprehensive and integrative for Australia as a whole. I focus primarily but not exclusively on the semi-arid and arid interior of Australia, partly because that is the region I know best, but more importantly because it currently occupies two-thirds of the continent and occupied much more than that during the last glacial maximum (LGM) *circa* 30 to 19 thousand years ago (kya) by which time it was already

inhabited by Aboriginal people (Burrows and Christensen 1990:297, Lourandos 1997:170-194).

I suggest that ever changing marital linkages among societies depend at least in part on ever changing ecological linkages between societies and their habitats. Australia as a habitat is characterized predominantly by its nearly flat topography, its aridity and its progressive nutrient impoverishment due to prolonged leaching and the absence of volcanoes and glaciers that might enhance their availability. Nutritionally Australia is the poorest continent on Earth (Flannery 1993; Pyne 1991; Orians and Milewski 2007).

It is a truism that long term climate changes on a global or continental scale exercise significant control as limiting factors on the behavior of all organisms. For example, recurring large scale temperature and rainfall cycles spanning multiple millennia during Pleistocene and Holocene epochs are reflected in most if not all aspects of Aboriginal prehistory and history (Lourandos 1997:passim).

In this intrinsically stressful context, I am concerned as well with environmental stochasticity that falls into at least three major categories. *Long term changes in habitats* include changes in global climate, sea level reduction by 120-130 meters at LGM (Lambeck et al 2002:343), regional and continent-wide fire regimes defined in terms of fire size, intensity, frequency and seasonality (Gill 1975; Burrows and Christensen 1990), and the composition of the flora and fauna which subsumes extinction of the Australian megafauna. *Cyclical environmental events* include floods and droughts with recurrence intervals measurable in units ranging from weeks and months to centuries and millennia, and the El Niño/La Niña-Southern Oscillation (ENSO) with a variable periodicity of 2-8 years. *Environmental catastrophes* or punctuational events – call them random acts of violence – include meteor impacts, volcanic eruptions, epidemics and invasions (Foley 1994:125). From this perspective, European colonization was not unique, but rather was a member of a small family of highly stressful punctuational events that have impinged on Aboriginal societies intermittently over many thousands of years.

Furthermore, I am concerned with two forms of stochasticity in Aboriginal biology. *Demographic* stochasticity includes random variations in sex ratios and in the number of births and deaths as they impact age structure and population size. *Genetic* stochasticity includes mutations, chromosomal anomalies and inbreeding depression, as well as genetic drift to which Birdsell (1993) devoted a great deal of attention. These internal factors may be less conspicuous than environmental stressors, but they make important contributions to transforming seemingly closed, static social structures into much more open, dynamic social processes.

Much of Australia, especially the interior, has few significant, predictable 12-month weather cycles, so average annual rainfall figures as applied to Aboriginal life may have limited use or be virtually meaningless. A more informative approach to understanding rainfall, drought and surface water availability in the interior is to plot the magnitude of each event or

condition against the recurrence interval of events of the same type and magnitude, and use Extreme Value Analysis (Coles 2001, Gumbel 1958) to project those relationships over very long periods. For example, what are the expected recurrence intervals (Hayden 1975) of rainfall events measuring 1, 10 or 100 cm, droughts with durations of 1, 10 or 100 years, or floods in which rain that falls in the Sandover-Bundey drainage flows as far as Lake Eyre (Trewin 2006). Duguid, et al. (2005) in their recent study of *Wetlands in the Arid Northern Territory* suggest that stochastic environmental events with extreme but still plausible values may happen as rarely as once in 1,000, 10,000 or 50,000 years (e.g., glacial maxima), but can be awesomely destructive or beneficial when they occur. Yet it is events of such great rarity and magnitude, combined with long term climate change, that constitute the ultimate limiting factors for human life deep in the interior, in a region that Gould (1969:273) characterized perhaps hyperbolically as "the harshest physical environment on Earth ever inhabited by man before the Industrial Revolution."

Monitoring long term climatic trends as well as environmental, demographic and genetic stochasticity may have been among the most challenging activities facing Aboriginal people, but it did not present insurmountable problems. The people are accustomed to working with a very long ancestral time scale. The data they might record is coded in the idiom of the ancestors and marked in terms of generations or lifetimes, long in human terms but short in ancestral terms. The idiom is extraordinarily precise in recording and recalling genealogies with anomalous events in them over a period of several generations, and in using songs, narratives and a multitude of images and graphics to organize and manage a vast array of relational data. It is well suited to storing and retrieving records of 1 in 100-year or 1 in 1000-year floods and droughts, as well as atrocities associated with the European invasion. Perhaps at its outer limits it really does record sea level changes and the disappearance of the megafauna.

A different pulsating heart

I suggest that the constant and variable environmental stresses briefly sketched above, combined with stochastic demographic and genetic stresses, shaped the ever changing social relationships outlined in Sections 2 and 3. I further suggest that their operation pertained to a single continent-wide population of 600+ integrated societies with a total population of more than 300,000 people.

In his account of Aboriginal Australia's "pulsating heart", Sutton (1990) explored the possible demographic importance of population migrations motivated by alternating impoverishment and enrichment of neighboring habitats, resulting in migrations of emigrants or refugees toward richer habitats, with special emphasis on conditions and events in Central Australia. Evidence of alternating occupation and depopulation of archaeological sites throughout Australia (Lourandos 1997) suggests that such migrations occurred repeatedly.

Building on Sutton's ideas with which I fully agree, I suggest an additional kind of pulsation that might occur concurrently with or separately from his. I am concerned with regional or

continent-wide long-term pulsations based on environmental, demographic and genetic stochasticity that could yield alternating increases and decreases in the permeability of societal boundaries.

In this scenario, hard times of scarcity would yield more open boundaries that would facilitate exogamous marriages when endogamous marriage partners might be scarce, while rich times would yield less open boundaries that would encourage endogamous marriages when potential spouses were plentiful. These irregular cycles of decreasing and increasing closure would alternately enhance and retard genetic mixing among members of the same or neighboring nations. Given a geological time scale, the combination of Sutton's migratory pulsations with my boundary permeability pulsations would yield both population mobility and genetic mixing right across the continent.

Thus I am concerned ultimately with mobility among ethnographic and archaeological populations. Under this heading, I include directional migrations of Countries or societies, nomadic movements of dispersed foraging groups following the rains, intermittent aggregation of foraging groups in large populations associated with ceremonial cycles, diffusion of skin terms as *wanderwoerter*, long-distance diffusion of affinal kinship terms as evidence of late Holocene changes in marriage systems (McConvell 2010, 2011, forthcoming), and movements along transcontinental Dreaming tracks and trade routes. To these I add genetic mixing among societies and nations based on exogamous marriages and concomitant changes in residential locations.

The irregular cyclical changes in boundary permeability proposed here are based firmly on a comprehensive, definitive cultural commitment to economic *cooperation* during hard times instead of competition, aggression, invasion and warfare. The proposed relationships are the *direct opposite* of the common assumption that scarcity yields competition and possibly conflict (Read and LeBlanc 2003). As such, they are key contributors to continuity and stability over vast stretches of time and space. The pulsations that I propose may leave traces more subtle than Sutton's, but that is an empirical problem for future research.

Firestick farming and the food crisis in prehistory

Opening and closing boundaries under conditions outlined above to achieve flow rates of spouses that vary from 7% and 21% across space and time seems to be neither trivial nor insurmountable. Lacking data on variations in boundary permeability, I nevertheless offer a proposal that integrates firestick farming (Jones 1969; Pyne 1991; Burrows et al. 1990, 2004; Flannery 1993, 2012) with the food crisis in prehistory (Boserup 1965, Cohen 1977, 2009), thereby suggesting one possible scenario in which changes in habitats, subsistence strategies and social organization could have coalesced to insure the survival of Australian Aboriginal societies under conditions that apparently gave rise to food production and increasing social complexification elsewhere.

The concept of Carrying Capacity (CC) has a vexed history associated largely with intrinsic difficulties in measuring it. Since I have not found a suitable replacement, I use it here with considerable trepidation. Whatever its scope and however it is defined, CC is dynamic, always tracking global climate changes, sea levels changes, shifting compositions of biotic communities, megafaunal extinctions, altered fire regimes and so on. If we focus on species, populations or societies at a local level over a short time, we may conveniently ignore some important kinds of changes in CC. But I am concerned here with Australian Aboriginal populations spanning many millennia on a continental scale, so systematic climate change and large scale environmental stochasticity like that outlined above for water availability are major issues.

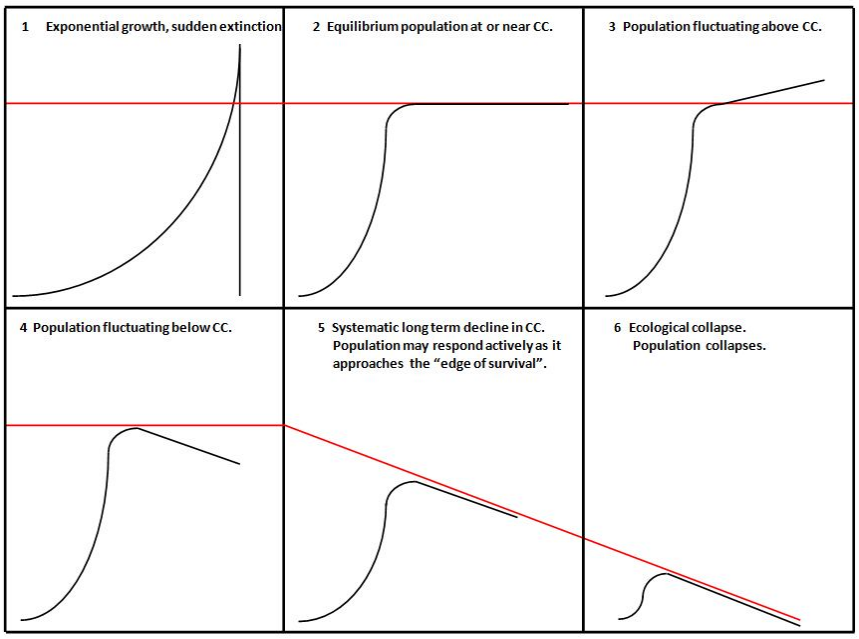


Figure 4.2. Graphic simulation of dynamic carrying capacities.
Hypothetical population responses to external and internal stochasticity.
Red line: carrying capacity; Curves: population trajectories.
(Binford 1968, Birdsell 1993, Lourandos 1997)

Figure 4.2 presents in six panels a brief summary of some common and simple ways in which hunter-gatherer societies can interact with their environments.

Panel 1 depicts a hypothetical population expanding in a habitat with seemingly unlimited resources until it runs out of food, space, etc., whereupon it may overshoot the CC and crash to extinction. Rapid expansion without the terminal crash may describe people who reached Australia before the megafaunal extinction (Birdsell 1985; Malthus 1798; Meadows, et al. 1972).

Panel 2 represents the "standard model" (Read and LeBlanc 2003) of a stable human population (solid line) where births equal deaths and numbers approximate maximum sustainable population size. Population tracks normal variations in CC, increasing during rich times and decreasing during poor times, generally maintaining equilibrium a few (unspecified) percentage points below CC. The panel depicts the fine tuning of endogamous steady state hunter-gatherer societies such as Australia's canonical Kariera **(**Binford 1968, Birdsell 1993, Lourandos 1997).

Panel 3 shows "population pressure" increasing (solid line), perhaps due to stochasticity in births and deaths, then failing to return spontaneously to equilibrium. Two different responses are plausible. One *restricts* population growth by increasing birth spacing and women's age at first marriage.[8] The other *enhances* population growth while increasing CC through increased labor, a broader diet, or improved management of food sources, including the invention or adoption of agriculture in some areas but not in Australia (Boserup 1965, Cohen 1977). If the second option is taken, the solid black population growth curve and the red CC line would be expected to trend higher to the right as management or production of resources replaces their simple exploitation.

In Panel 4, population begins to decrease (solid line), perhaps due to stochasticity in births and deaths or deteriorating environmental conditions, and fails to return to equilibrium spontaneously. Reversing population policies associated with Panel 3 might induce recovery. If the perturbations eventually pass, the numbers return to match CC; if they persist, we can extrapolate from the rate of decline to estimate extinction time as in Panel 6. As resource depletion reduces CC toward zero, human fallibility may hasten population collapse in places such as Greenland, Easter Island and Chaco Canyon, and societies perish (Tainter 1988; Diamond 2005).

Panel 5, like Panel 3, is of great importance in human history, and may serve as a key to understanding Australian Aboriginal societies from the perspective of openness. It depicts a steadily declining CC that still is a long way from causing extinction but nonetheless is placing more environmental stress on the population than the normal stresses implicit in Panel 4. Demand exceeds supply not because demand is increasing as in Panel 3, but because supply is decreasing inexorably over a period of millennia (Cohen 1977, 2009; Lourandos 1997).

Panel 5 is similar to Childe's (1951:23-25) "oasis" or "propinquity" theory (Binford 1968:328), but assumes a broader array of stressors as contributors to culture change and a broader array of strategies for dealing with them. It asks how to *enhance population growth* to forestall extinction due to random variations in birth rates, unavailability of males and females for marriage and reproduction, inbreeding depression, environmental impacts such as long term changes in temperature and aridity, the extinction of Pleistocene megafauna,

[8] Preferential female infanticide is a much touted option (Aboriginal Australia, Birdsell 1968; Inuit, Weyer 1932), but evidence in support of it is extremely tenuous except briefly under extreme crisis conditions.

and the onset of European colonization. When the innate capacity for human population increase is insufficient to compensate for such a broad spectrum of losses, people can respond to the stresses creatively or face extinction. Presumably these people already would have taken preventive measures associated with Panel 4, probably with some reduction in stress but not enough to halt it. As they approach the "edge of survival", they could just give up and "go gentle into that good night" as in Panel 6, or "rage against the dying of the light" (Dylan Thomas 1951/2003). I suggest that they make the latter choice in Panel 5, and at least attempt to forestall extinction.

Once again I offer conjectures and speculations with a solid material basis. Childe's oasis theory has been largely discredited by lack of supporting evidence, but a considerable body of evidence is available that supports Panel 5 as a major contributor to open rather than closed societies in Aboriginal Australia. My extended paraphrase of Lourandos (1997:192-194) summarizes several converging views of the demographic history of Australia's arid zone:

> Citing M. Smith (1986) and others, Lourandos notes that Aboriginal settlement in the semi-arid zone began around 35 kya and in the arid zone before 22 kya. As aridity reached its peak about 18 kya, settlement continued in central Australia. With declining aridity after 15 kya, archaeological evidence of settlement in the arid zone became more conspicuous and widespread. Sutton's (1990) migratory pulsations yielded intermittent depopulation and repopulation of sites. In the early Holocene, climate became more humid, the arid zone remained a region of unpredictable rainfall, and settlement expanded but showed no evidence of major population increases. In the later Holocene, after about 5 kya, settlement spread into the driest areas. By about 3 kya, seed use and new technology including grinding stones appeared, perhaps accompanied by extensive social networks of the ethnographic period that acted as support systems in these harsh environments. Lourandos (1997:192) suggests that population increase may have post-dated or coincided with the onset of seed use rather than preceded it, in which case it may be a consequence rather than a cause of shifts in resource use.
>
> Lourandos frequently notes that significant population increase seems to have occurred in what he perceives as the wrong order. In South Australia, for example, a) "The evidence of more intensive recent settlement is the *reverse* of the climatic trend" (Lourandos 1997:224, *his* italics); and b) "There is no evidence of marked expansion of Aboriginal populations in the early Holocene along with increased precipitation, [or] expansion of wetlands. Instead, evidence of more significant demographic changes, including possible population growth … occur in the more stressful, less humid late Holocene" (Lourandos 1997:241-42).
>
> Summarizing Veth's (1987:109) similar argument, Lourandos (1997:193) outlines the following unexpected sequence of events: a) early Holocene establishment of permanent arid adaptations featuring large social networks providing reciprocal access to vital resources in marginal environments; b) mid-to-late Holocene increase in population; and

c) late Holocene increase in the intensity of occupation of sites reflecting an elaboration of previously established social relations.

In addition to resembling Childe's oasis theory, Panel 5 resembles conditions that characterized the "food crisis in prehistory" (Boserup 1965, Cohen 1977) in Panel 3, and contributed to the emergence of food production in the millennia following northern hemisphere megafaunal extinctions and the retreat of the Pleistocene glaciers. "Such widespread common events require relatively simple common core events and causes" (Cohen 2009:591), but the transition did not happen everywhere in the same way or at the same time. In Asia, Europe, Africa and the Americas, people in many but by no means all societies seem to have responded to "population pressure" (Cohen 1977, 2009) by using their linguistic and problem solving abilities to initiate the transition from foraging through food management to food production, developing diverse technologies and methods, and using an amazing diversity of plants and animals to generate regionally specific solutions to the same general problem.

A similar response may have occurred in Australia, but with a significant twist. Cohen (2009:591) acknowledges that increasing population and decreasing resources have different etiologies but equivalent implications. Thus I cautiously speculate that gradual environmental degradation had the same effect in Australia that gradual population growth had elsewhere. My speculation is subject to revision as more complete and precise data on the timing of events in human and climate history in Australia become available.

In Panel 5, as in Panel 3, the solid black population growth curve and the red CC line would be expected to trend higher to the right as food management and food production replace simple exploitation of resources. Smith, Veth, Lourandos and others have described the relationship embedded in Panel 5 but seem to have disregarded it, perhaps because of the common assumption that, at least among hunter-gatherers, population pressure as depicted in Panel 3 is the driving force underlying enhancements to the management and production of food.

There is a fine line here: too much population growth hastens the exhaustion of resources and the people vanish sooner; too little growth slows the exhaustion and they vanish a bit later. Since an error in the compensating percentage would be fatal, they would vanish either way. Under these conditions, they most assuredly could not adopt infanticide to keep their populations in balance with declining resources for that would simply hasten their extinction. Instead of killing babies, I suggest that they would devise and use some combination of the strategies introduced in Section 3 to adjust their populations as needed, including establishment of continent-wide exogamy at a modest rate of about 15% ±7% as one of many ways to delicately regulate population growth.

Nowhere in Australia did indigenous people using indigenous technology invent and sustain food *production* in the traditional sense of that term. But under deteriorating environmental conditions in various habitats, they developed diverse skills that enhanced the *management* –

both production and harvesting - of existing resources. A major example was the development of firestick farming in the arid and semi-arid interior, combined with increasing reliance on grass seeds for nutrition, which presumably enhanced diets significantly with new technology limited to millstones and the controlled use of fire, a readily available natural resource (Hough 1926:65-67, Stewart 1956, Jones 1969, Pyne 1991, Flannery 1993, 2012; Lourandos 1997).

Thus I cautiously suggest that Aboriginal Australians, having the same intellectual abilities that characterized Pleistocene foragers worldwide but living in an intrinsically harsh environment that gradually became more stressful in the later Holocene, made the transition from a) pure foragers who took no active role in food production to b) firestick farmers who used anthropogenic fire that enhanced the management of resources (Lourandos 1997:95-97). In the process, they had major ecological impacts on flora and fauna without generating domestication in the sense in which that term is applied on other continents. Flannery (2012: Kindle locations 655-668) more audaciously speculates that "fighting fire with fire" began in Aboriginal Australia as early as 40 kya, shortly after the extinction of the megafauna.

Using firesticks to ignite grasslands or woodlands in controlled burns is a necessary component of such a strategy, but it is not sufficient. Especially during its early years, decades or centuries, this food management revolution could not significantly contribute to the viability of Aboriginal populations confined to small, closed, isolated societies in highly volatile, arid, nutrient poor habitats. Rather, the gradually increasing positive value of the strategy would be based on embedding it in open societies that participated collectively in this highly dispersed kind of resource management, that shared collectively in the enhanced productivity and harvesting of resources, and that took care of each other during exceptionally hard times.

Perhaps most importantly, I suggest that the small, closed, isolated societies so long depicted in models of Australian Aboriginal kinship – if they ever existed - almost certainly became integrated into regional networks (perhaps Nations) of egalitarian firestick food managers, ultimately coalescing to form a continent-wide network. By its very nature, firestick farming would require generalized, extensive, diversified modification of the habitat in a region as a whole, rather than localized changes such as those that led to the emergence of point-location gardens on other continents.

Clear evidence of the precise nature of these practices and the catastrophic result of terminating them appear in military and satellite photographs and field observations of Pintupi burning patterns in the Great Sandy Desert from 1953, 1973, 1977 and 1988 (Burrows and Christensen 1990; Burrows, Burbidge and Fuller 2004; Flannery 2012). The region was:

> "… photographed from the air in great detail as early as 1953. … The [photographs] reveal a landscape patterned into a fine mosaic of vegetation, in various stages of recovery from fire. This had resulted from the burning of small patches – most only a few

> hectares in extent – by the Pintupi. … Aerial photographs taken in 1973 reveal that there were then too few people to maintain the tight mosaic of small burns, so larger fires were beginning to break out. By 1981, large, hot fires had gained such a hold on the landscape that four huge ones burnt 90 per cent of the study area. As the Pintupi left the desert, the vegetation built up until large fires became inevitable. … [In an area west of Lake Mackay the average fire size increased [almost a thousand times] from 34 hectares in 1953 to over 32,000 hectares in 1986 (Burrows and Christensen 1990:297).] Some of the wildfires that erupted in central Australia following the end of Aboriginal fire management were large enough to burn through three Australian states … And with them went the fertility of the soil, the variety of vegetation so many creatures needed to survive, and the tight mosaic of old and newly burnt vegetation that provided food and shelter" (Flannery 2012: Kindle Locations 833-850).

In this context, the social network of networks predicted by M. Smith (1986), Veth (1987) and Lourandos (1997) did not culminate in social stratification, monotheistic religions and architectural monuments as they did in the early empires of Asia and elsewhere; rather they yielded a monumentally complex social organization featuring radical egalitarianism, ancestral Dreamings, multiple levels of flexible, reticulate kin relationships, and economic relations based on cooperation rather than competition. This social transformation in Australia did not lead to technological innovations associated with increased utilization of energy, but, in keeping with the traditions of the ancestors, had the more modest and benign impact of imparting stability and persistence to ever changing and previously fragile Aboriginal societies continent-wide.

Ecological and social cycles

I suggest that the structures and processes proposed here operated over a period of many millennia to maintain population stability continent-wide under conditions that otherwise could have extinguished the Aboriginal Australians long ago. Quantifiable, measurable processes may push Australian Aboriginal societies toward openness when stresses increase, and pull them toward closure when they decrease, thereby enabling societies to create and maintain a "small world" (Watts and Strogatz 1998) with stable populations in a large space of continent-wide connections. I suggest an integrated mechanism for coping not just with the "background stress" that characterizes the Australian habitat at all times, but also with changes in levels of stress, and aim for a synthesis that pulls the pieces together and sets the system in motion.

I speculate that the structures and processes depicted above constitute a continent-wide societal foundation of considerable but uncertain antiquity measured in millennia. The tripartite foundational structure of descent and generation moieties emerged early in Aboriginal history as a mechanism that integrated and stabilized the demography of small societies. Skin terms and rules, plus optional Omaha kin terms and rules, diffused on top of the stable tripartite moiety structure. I am not qualified to say whether the presence of 14 unambiguous cognates among Northern Aranda and Alyawarra kinship terms (Denham,

McDaniel and Atkins 1979:7, Green 1998:79-94) represents diffusion from a common source or dialectal differentiation of common terms within the Arandic language family (McConvell p.c.).

With the structures and processes in place, I speculate further that people and societies could respond to changes in stress levels in accordance with the following 4-part scenario:

a) Optimal conditions, with the lowest levels of demographic and environmental stress, would have been characterized by a maximal reduction in W<H age differences, a downward shift in the number of skins, a corresponding acceptance of reproductive closure, and reduction in or disappearance of Omaha skewing. At this lower limit the descent, marriage and kinship system would have "relaxed" to show flat stratification, becoming symmetrical, closed, bounded, isolated and minimal. Under these conditions members of a society could have congregated now and then to perform initiations and increase activities at which times marriages could have been arranged. Although marrying across societal boundaries would not have been prohibited, there would have been little or no motivation in this scenario to seek mates outside one's own endogamous society. Simultaneously, polygyny would have become less frequent and inbreeding depression more intense thereby keeping population growth in check. The situation described here corresponds to canonical Kariera and Aranda models. Due to the serious environmental stresses that characterize much of Australia under the best of conditions, this configuration would be unlikely in the real world today, but is the theoretical optimum or minimum.

b) As chronically stressful genetic, demographic and/or environmental conditions intensified, societies would have adjusted to suboptimal - but not critical - conditions. The phase transition from horizontally stratified to age-biased helical structures in endogamous societies would occur with increasing mean W<H age difference. Adjustments to marriage rules would have begun to push people outward from close kin to distant kin and the number of skins would have increased as sibling-in-law generations lengthened. As men's age at first marriage increased, reaching out to exchange with other societies might become more likely but would not have been required for the survival of an endogamous society. Perhaps this was a transitional phase historically.

c) As conditions further deteriorated across the desert, perhaps with the extinction of the megafauna or long term trends toward increased aridity, a phase transition from endogamous closed helices to exogamous open lattices would have facilitated intersocietal marriages. As assembling large congregations of members of one's own society became less viable, opportunistically arranging marriages between neighboring groups would have become more viable and the small-world network would have become increasingly important. Counterintuitively, I suggest that these changes, at least among the Alyawarra, probably would have been associated with an *increase* in the frequency of polygyny based on young women remaining in their natal societies and young men dispersing to find wives elsewhere, but that is a matter for which my data are incomplete (Jack 2003). Likewise, the society would have experienced further increases in the frequency of Omaha kin term usage and the

number of skins, all of which would have directed marriages outward rather than inward. Men's age at first marriage would have increased and inbreeding depression among children would have decreased, thereby allowing more babies to survive and compensate for losses associated with harsh conditions. The actual frequency and extent to which societies might have opened or closed under the prolonged stresses is a different and more challenging question that I cannot answer now.

d) As the cycle reverses and conditions improve, the motivation to reach out diminishes. At least in principle the lattices could disengage from their neighbors and fold in endogamously upon themselves again while W<H age differences decrease. The number of skins, the frequency of polygyny, the frequency of Omaha kinship term usage, and men's age at first marriage all decline, and inbreeding depression increases, thereby slowing the rate of population growth and maintaining its stability when it might otherwise begin to expand.

Dousset (p.c.) says:

> In my opinion (based on research experience in the Western Desert), phases a), b) and c) coexisted until the 1960s in the Western Desert. These are not necessarily successive phases, but may simultaneously appear at different but nevertheless close geographic locations.

I agree that neighbouring societies need not be synchronized. Just as the complexity continuum proposed in Section 3 is not offered as a directional evolutionary sequence, so too the dynamic scenarios proposed here constitute a range of possibilities available to all societies at all times.

In these scenarios, each society could develop its own unique local variation on the global system of kin and skin, perhaps by tinkering with its cultural models, classificatory systems, marriage rules, and ways of instantiating marriage choices, perhaps by instituting large scale changes such as the transformation of a 4-skin society into an 8-skin society, or an Ambrym-type (Lane and Lane 1958, Denham 2012) into an Alyawarra-Wikmunkan-type (McConnel 1930, 1939-40, 1950, 1951; Tjon Sie Fat 1983a, 1990; Denham 2012) or *vice versa.*

If under conditions of reduced stress a society's local network disengaged from the global network, it could reach out again when conditions deteriorated so long as local changes did not result in incompatibility with the global network. But if incompatibility developed, the local group probably would become permanently isolated and more susceptible to extinction. Hence after millennia of natural selection, it is not surprising that we find an enormous diversity of local kin and skin that are "free variations" on the global theme, and very few local examples that are incompatible with that theme.

5. Testing the proposal

Detecting hypothesized cyclical changes between more closed and more open societies in Aboriginal Australia will be difficult. If the reconstruction of 50 millennia of Australian Aboriginal history succeeds in the 21st century, I suspect that it will say little or nothing about major, long term, large scale, cumulative changes in technology, energy utilization, plant and animal domestication and other activities sometimes used as indicators of Sahlins (1960) "general evolution", but will focus on endless proliferation of variations on common themes, Sahlins (1960) "specific evolution". No doubt recent and future research in fields such as genetics (Rasmussen, et al. 2011), paleontology (Miller et al. 2005), paleodemography (Johnson and Brook 2011), historical linguistics (McConvell and Evans 1997) and archaeology (Lourandos and Ross 1994) will contribute to a better understanding of the history of the Aboriginal people.

I suggest that the history may reveal a social structure with three distinct levels. The bottom or foundational level manifests itself in a permanent global network of sibling-in-law chains right across Australia with local helical or lattice structures embedded in it. The middle level holds adaptive mechanisms, viz., regional social and demographic processes that maintain population stability and interconnect the bottom and top levels. The top level contains an unstable cognitive superstructure in which traditional anthropological models of descent, marriage and kinship within individual societies display and diffuse local interpretations of the more enduring structures at the lower levels.

How well do these levels work, separately and together? This is an intrinsically statistical question concerning events for which statistics are exceedingly rare. The possibilities that I mention here are not a definitive list, but rather are suggestions of places to begin.

Locally, fieldwork informed by this proposal might enable us to collect datasets in individual societies that could address some of the questions raised here. (I do not share the pessimism of doomsayers, including Spencer and Gillen (1899), Strehlow (1947) and Birdsell (1993), whose dire predictions concerning the demise of Aboriginal Australians have been wrong for more than a century.) I suggest that many of the discrete cognitive models now in existence can be brought into conformity with the structures and processes introduced here. Would such efforts demonstrate that my proposal is incorrect *in toto*, in part, or in some of its details? If the process succeeds, it should refine both the local cognitive models and the proposal offered here.

Regionally, work such as Dousset's (2005) on the diffusion of section terms in the Western Desert, Koch's (1997) on the diffusion of subsection terms in Central Australia, and McConvell and Alpher's (2002) on the diffusion of Omaha terms across much of northern Australia should enable us to better understand interactions among nations or other groups of societies.

Globally, the structures and processes proposed here should be testable in their entirety. In its simplest preliminary form, the procedure might be as follows:

- Define S (stress index: low, medium, high)
- Test its covariance with
  - SR (Stress Response rates for age bias, Omaha kin terms, polygyny, etc.)
  - E (Exogamy rates within and between nations; percentages of marriages with proper, close, distant and remote kin; inbreeding coefficients; etc.)
  - C (Cognitive matters such as preferential marriage rules, the complexity continuum associated with skins, etc.)

Although the procedure seems to be rather straightforward, finding adequate statistical data to test it will be exceedingly difficult. My efforts using Alyawarra data constitute a beginning. The next step might be to expand, refine and analyze Keen's (2004) reconstructions of contrastive Australian societies at the time of European colonization.

I suspect that a great deal of relevant data can be extracted from ethnographic archives throughout Australia. Also, since many or most of the relationships discussed here are amenable to mathematical modeling, using such an approach offers a potentially valuable way to test my proposal.

To all of this Watson says, "Surely we have a case." But Sherlock replies, "Not a shadow of one – only surmise and conjecture. We should be laughed out of court if we came with such a story and such evidence. … We have to prove all this, and we are not in a position to do it" (Doyle 1902/2006:567). Although his use of "prove" is problematic, his message is clear, the challenge is formidable, and Sherlock did not give up.

Needless to say, if this proposal unequivocally fails fair tests and is demonstrably beyond salvage once the evidence is in, then it must be rejected in whole or in part. At the very least, it may facilitate an escape from the fiction of closure.

6. Summary and conclusions

How might Australian Aboriginal societies have achieved a balance between the ancestral law that stipulates canonical Kariera and Aranda descent, marriage and kinship or something like them, and the biological law that demands a viable inbreeding coefficient? The canonical patterns appear to be embedded deeply and broadly in the ancestral traditions (Spencer and Gillen 1899, 1927; Stanner 1965, Strehlow 1947, 1971) and to reject them would be to reject the ancestral law. But if Australian Aboriginal people actually married in accordance with those canonical patterns, they could have become extinct many millennia ago due to extreme inbreeding. In other words, we can be certain that tiny, isolated Australian Aboriginal societies with 100% endogamy are not the norm, but are fleeting anomalies generally headed for extinction. Hence I focus primarily on what people do rather than on what they say they do.

Demographic data show societal exogamy rates of 7-21% with a mean of perhaps 15%. A small-world network (Watts and Strogatz 1998) based on those rates is sufficient to reject Birdsell's (1993:7) claim that "the tribe is an essentially endogamous genetic unit in Australia, in fact, a genetic isolate or a deme". The geographical distribution of societal exogamy at that rate in Central Australia suggests that the pattern characterizes Australian Aboriginal societies continent-wide. Detailed analysis of descent, marriage and kinship among the Alyawarra shows that 49% of their marriages are between proper kin, 28% are between close or distant tribal kin and 21% are between remote tribal kin, thus rejecting Tindale's oft repeated assertion that Aboriginal people marry close and distant tribal kin to the exclusion of proper kin and remote tribal kin.

Although canonical Kariera and Aranda patterns preclude parent-child and sibling incest, they presuppose generational closure (systematic bilateral sibling exchange marriage) and societal closure (no alternative to endogamous marriages) which together yield extreme inbreeding in tiny societies. But mechanical, statistical and network models demonstrate how Australian Aboriginal societies and nations systematically reduce the inbreeding that canonical Kariera and Aranda models imply.

Three simple options entail incremental modifications to marriage patterns based on individual discretion. They include marriage with tribal kin instead of proper kin, marriage outside one's own generation level, and optional usage of skewed Omaha kin terms that preclude marriage with otherwise marriageable cross cousins.

A considerably more complex series of options entails movement along a conceptual continuum of increasingly complex variations on sections and subsections, using indigenous mathematical methods to multiply or divide by 2, thereby transforming the terms and logic of 2 moieties into 4 sections in a single step, or those of 4 sections into 8 subsections, or *vice versa*. Transitions at some but not all points on the continuum increase genetic separation between spouses. The points on the continuum include: a) simple 4-skin societies east of the Alyawarra in Queensland; b) complex 4-skin societies such as the Alyawarra with implicit 8-skin anonyms; c) simple 8-skin societies such as the Northern Aranda; d) complex 8-skin societies such as the Kukatja, recently borrowed from the Warlpiri (McConvell p.c.), with gender prefixes yielding a total of 16 skins, half of them masculine, the other half feminine; e) hyper-complex 8-skin societies such as gender prefixing Wailbri and Warumungu in which different sets of gender-prefixed skin terms are used to mark social maturity distinctions between pre-pubescent girls and uninitiated boys on the one hand, and marriageable women and initiated men on the other. Movement in either direction along this continuum, with or without discontinuous jumps, could occur as a result of spontaneous internal changes within societies where such transformations originate, merger of section systems that yield subsections systems, or diffusion to destination societies after new configurations become established in source societies.

The most complex and far reaching options entail phase transitions that transform societies as wholes, including the elimination of generational and societal closure. These three options include transforming bilateral marriage patterns among Kariera and Aranda to unilateral patterns in circulating *connubia*; replacing flat, stratified symmetric generations with age biased endogamous helical generations; and concluding with a radical conversion of endogamous societies to a global network of exogamous societies that are horizontally and vertically asymmetric. In their most extreme form, these transformations could yield a single continent-wide population of Aboriginal people living in an integrated network of societies, which is fundamentally different from a fragmented population of the same size living in tiny, isolated societies. These options and strategies are not mutually exclusive but can be implemented singly or in almost any combination.

I do not suggest that the various transitions sketched above constitute a cumulative evolutionary sequence, although that may be a possibility. Rather, inspired by Sutton's pulsating heart, I am concerned with regional or continent-wide long-term pulsations based on environmental, demographic and genetic stochasticity that could yield alternating increases and decreases in the permeability of societal boundaries. In this scenario, times of scarcity would yield more open boundaries that would facilitate exogamous marriages when endogamous marriage partners might be scarce, while times of plenty would yield less open boundaries that would encourage endogamous marriages when potential spouses were plentiful. Unlike Sutton's pulsations, mine are not associated with unidirectional flows of people. Rather they are cycles of decreasing and increasing boundary closure that alternately enhance and retard genetic mixing among people of the same or neighboring nations. I speculate that dynamics such as these, in conjunction with progressive ecological impoverishment, might have contributed to the emergence of firestick farming as a solution to Australia's food crisis in prehistory.

If my arguments have any connection with reality, the hypothetical open structures and processes that I have proposed demonstrate that traditional Australian Aboriginal people had a great deal of freedom in controlling vital aspects of their own societies based on oral traditions, distributed cognition and collective intelligence (Heylighen et al 2004). That freedom is manifested in variability rather than stasis and complexity rather than simplicity; in the intellectual creativity displayed by the all-encompassing ancestral traditions and the arts through which they are visualized; not least in the creation of two distinctly different reticulate, complementary and simultaneously applicable kinship systems in the face of conflicting demands from ancestral laws and natural laws. It would be extraordinarily difficult to conceptualize, implement, activate and sustain this remarkable congeries of concepts in virtually freestanding, isolated, endogamous societies with mean population sizes of 500 people. Despite 100% recruitment of young men into 15 years of intensive "learned studies" (Wachter 1985:130) upon initiation, I suggest that reliable transmission of the vast store of knowledge and understanding required to sustain these societies would be inconceivable in such a fragmented social universe.

Treating each society as a closed and isolated entity has encouraged research on the inner workings of individual societies but has not fostered comparable research concerning relations among societies. Rather than focusing on 600 autonomous and disjointed units scattered across the continent, I advocate focusing on a single integrated unit with 600 semi-autonomous nucleations embedded in it, thereby encouraging research on structures and processes spanning the entire field of Aboriginal societies that hosted the emergence of both subsection systems and firestick farming.

Notions of boundedness and horizontal separation, which are deeply embedded in economic, demographic and evolutionary legacies of A. Smith, Malthus and Darwin, commonly are expressed in terms of territoriality, competition, land ownership, exclusivity, natural selection, endogamous genetic units, demes, Westphalian states as political entities as opposed to Howitt's nations as cultural entities, and an enormously broad range of related concepts. Although those notions have legitimate roles to play in the biological and social sciences, they no longer dominate theorizing in those fields.

The approach that I have taken leads to horizontal openness and cooperation. Precedents include Margulis (1970) on endosymbiotic theory, Woese (2004) on horizontal or lateral gene transfer, Flannery (1993, 2012) and Pyne (1991) on coevolution of Australian ecosystems, Burtsev and Turchin (2006) on the evolution of cooperative strategies, Wade (2007) on coevolutionary genetics of ecological communities, and Wilson and Wilson (2007) on multilevel selection theory.

Both Stanner and Strehlow conclude that "general evolution" (Sahlins 1960) is absent from Australian Aboriginal cultures, but they value its absence quite differently.

Stanner (1965:166-67) says:

> "The more one sees of Aboriginal life the stronger the impression that its mode, its ethos, and its principle are variations on a single theme - continuity, constancy, balance, symmetry, regularity, system, or some such quality as these words convey. … The result is a homeostasis, far-reaching and stable. … Equilibrium ennobled is 'abidingness'."

Strehlow (1947:35) says:

> "… the native follows tradition blindly: he clings to the primitive weapons used by his forefathers, and no thought of improving them ever enters his mind. In all his mode of living and in all his multifarious occupations, there is everywhere evident the same depressing inertia, the same mental stagnation that has stifled so completely all his literary endeavors. … Central Australia sleeps heavily under the all-oppressive night-shadow of tradition."

From one perspective, Aboriginal societies and the continent-wide environment in which they exist appear to have been in a stable but constantly shifting equilibrium in which

extraordinary diversification and complexification occurred repeatedly but cumulative linear change – "progress" that was the *sine qua non* of "civilization" for European colonists - was absent. But from another perspective, the hypothesized invention of open societies, firestick farming and subsection systems suggests that Strehlow's remarks about "depressing inertia", "mental stagnation" and "the all-oppressive night-shadow of tradition" were simply wrong. These were truly remarkable social inventions, but they did not introduce a new social order; rather, they enhanced the equilibrium and prolonged the abidingness of an ancient social order. Hence looking to Aboriginal Australia to better understand human social or cultural evolution in the ethnocentric European sense that equates "abidingness" with "failure to thrive" probably will continue to fail as it has since 1788. But understanding how this continent full of societies maintained its equilibrium for so long by means of several remarkable social changes may be far more important and interesting than trying to squeeze information about general evolution from societies that "took the [road] less traveled by" (Frost 1916).

The transition from a closed world to an infinite universe (Koyré 1957) was not easy for Medieval and Renaissance cosmologists, nor did it happen in a single leap, nor did it happen in a gradualistic evolutionary straight line. Rather, it advanced on many fronts as multiple working hypotheses (Chamberlain 1890) were offered competitively to escape the limits of earlier theories. Such is the spirit in which I offer these ideas concerning societal and generational openness as one of many possible ways to escape the long tradition of building closed models of open Australian Aboriginal systems of descent, marriage and kinship.

> "[P]lausible stories can always be told. The key to historical research lies in devising criteria to identify proper explanations among the substantial set of plausible pathways to any modern result" (Gould and Lewontin 1979:586).

This paper has obvious weaknesses. For example, a concept that is more robust than inbreeding avoidance might have informed my argument better, but I was unable to find one.

My data did not "drive" me inexorably to my conclusions. Alyawarra data pointed strongly in the direction I have taken, but my own values led me to additional data that are compatible with assumptions of freedom and abidingness in Aboriginal Australia. Among the endless ambiguities of the real world, had I sought traditional data supporting closure I am certain I could have found it as have so many others. Instead I pursued a scenario that carries an open and positive interpretation in hopes of solving or bypassing the multifaceted problem of closure.

My decision to focus primarily on semi-arid and arid zones placed a great deal of emphasis on the largest and harshest habitats in Australia while failing to give due consideration to the regional diversity that characterizes coastal Australia. The predominance of arid conditions during the late Pleistocene may help to mitigate this weakness. Furthermore, focusing exclusively on Australian Aboriginal societies shortened the paper, but many issues raised

here pertain to similar societies worldwide. Exploration of their broader relevance will be welcomed.

Relationships discussed here are amenable to mathematical modeling, but that task requires another person and perhaps another lifetime.

Most importantly, I am painfully aware of my failure to master the literature in all of the fields that are important for my argument. *Mea culpa.*

Appendix 1. Glossary of basic concepts in inbreeding avoidance

When I use an abbreviation or define a word idiosyncratically, I include my definition with it the first time I use it. Otherwise, I assume that you will use your web browser to find definitions and discussions of problematic words.

Here I introduce my possibly idiosyncratic understanding of basic concepts that underlie Sections 3-6.

The Westermarck hypothesis. The absence of a modicum of realism in Figures 1.1 and 1.2 does not mean that Australian Aboriginal people failed to behave in ways that reduced potential inbreeding. In its simplest form, the "Westermarck hypothesis" (Westermarck 1891:320), as recently examined sympathetically from many perspectives (Wolf and Durham 2005, Durham 2005), argues that early childhood association inhibits sexual attraction (Wolf 2005:5). In keeping with expansions of this hypothesis, inbreeding avoidance is interpreted as a nonverbal biological phenomenon that is demonstrably ubiquitous in most sexually reproducing plants and animals (Pusey and Wolf 1996, Pusey 2005) including humans, whereas incest prohibitions are uniquely human verbal epiphenomena. Sesardic (2005:112) clarifies this basic distinction when he says that, "The crucial idea in Westermarck's account of incest taboos is that the biological inhibition gives rise to the cultural prohibition". Although Freud (1913), Levi-Strauss (1949), Leavitt (2007) and many others may reject the argument that biology is basic and culture is derivative, I accept it, build my case around it and shall not attempt to resolve the nature-nurture controversy here. I invite you to suspend your disbelief temporarily if that is needed.

Glossing the Westermarck hypothesis in nontechnical terms, biology tells us *that* we will avoid inbreeding *globally*, while culture tells us *how* we as humans will avoid it *locally*. If there is merit in this position, as I believe there is, it makes no difference that verbal folk theories in Aboriginal societies disagreed with European folk theories; or that some Aboriginal people said they "threw away" the father when reckoning section and subsection memberships (Elkin 1964); or that denial of a male role in paternity in favor of spirit children was pervasive (Malinowski 1913:209, Corcos 1982); or that group marriage, "one of the most notable fantasies in the history of anthropology" (Hiatt 1996:56), was imputed to them; or that canonical Kariera and Aranda kinship in its most literal sense would have reduced inbreeding in some ways but intensified it in others. Clearly the Westermarck hypothesis does not mean that societal openness and exogamy are important only in a reproductive sense. They have obvious benefits in terms of integrating disparate societies, sharing economic resources among societies during hard times, taking care of the Dreamings, etc. But the problem of biological survival is fundamental, while alternative means of conceptualizing and achieving it, and the positive and negative cultural implications of those procedures, are derivative. From this perspective, biology is of primary importance even though the secondary cognitive superstructure that rests upon it is quite remarkable.

Kin terminologies. Most Australian Aboriginal kin terminologies are members of the Iroquois-Dravidian-Kariera kinship family with ancient roots (Allen 1998, 2007) possibly in South India (Pugach et al. 2013) Although each society seems to have its own kin terms and rules, almost all of them may be viewed as variations on the same theme. I deal primarily with Dravidian-like or Kariera kinship as it is practiced in Pama-Nyungan speaking societies in the southern two-thirds of Australia, but the phenomena I address may be found also in conjunction with non-Pama-Nyungan speaking societies in the northern third of Australia. Due to unrealistic fictions that surround canonical Kariera, its relationship to traditional Dravidian models is ambiguous at best.

Kin types. Kin *types* are standardized Anthropological English designations of specific kinds of individual genealogical relationships between Ego (self) and Alter (other). For example, mother, father, son's wife, sister's husband's mother, etc., may be described by codes that indicate actual biological, genealogical, affinal relationships. Kin type codes include: ♂=male, ♀=female; E=ego/self/speaker, Alter=other; F=father, M=mother, B=brother, Z=sister, S=son, D=daughter, H=husband, W=wife, Sp=spouse, plus composite forms such as MBD=mother's brother's daughter, etc.

Kin terms. Kin *terms* (specifically kinship *reference* terms) are highly variable indigenous language labels for categories of relatives that may include one or more kin types. For example, in colloquial English, "aunt" is a kin *term* that encompasses multiple kin *types* such as mother's sister and father's sister. Kin terms or their abbreviations appear within quotes as in "aunt" and "cousin".

Descriptive vs. classificatory kin terms. American English kin terms for primary kin are *descriptive*; i.e., they apply to only one kin type such as "F"=♂parent and "M"=♀parent. Dravidian terms for those same people are *classificatory*; i.e., they apply to multiple kin types such as "F"=F, FB, FFBS and "M"=M, MZ, MMZD. Comparable classificatory principles seem to apply to virtually all Australian Aboriginal kin terms.

Kin and skin. Australian Aboriginal societies often use two types of kinship simultaneously, one being egocentric and employing *kin terms*, the other being sociocentric and employing *skin terms* (sometimes called marriage classes). These two ways of reckoning kin appear to be quite different from each other on the surface but are tightly interconnected structurally and statistically. Whether they are independent inventions that have converged or coordinate parsings of the same conceptual universe remains unclear. I deal with this distinction in much greater detail in Section 3.

Kinship range and universality. Traditionally, all members of Australian Aboriginal societies were termed and treated as kin (Barnard 1978:69; 2002) and "society" was defined globally. In principle the scope or range of kin and skin was universal among Aboriginal people. Thus all marriages were between kin regardless of how genealogically or topographically remote from each other the two parties might have been.

Classificatory kinship continuum. Universal classificatory kinship in Aboriginal Australia is a continuum whose full range is segmented into four categories: *Proper Kin* and three degrees of *Tribal Kin*: *close, distant* and *remote* (Green 1998:13-15). *Proper kin* are closest kin, one step removed from Ego, to whom descriptive-like terms marked for closeness are applied (e.g., "proper F"=own ♂parent; "proper W"=own ♀spouse). *Tribal kin* is a residual category all of whose members are classificatory kin ranked in three subcategories based on increasing distance from Ego. *Close tribal kin* include proper siblings of proper kin and other genealogically close relatives who are two steps removed from Ego. *Distant tribal kin* include members of one's own society who belong to parallel ancestral descent lines (clans) that are treated as "siblings" of one's own descent line even though genealogical relationships may be indirect and tenuous. *Remote tribal kin* are at the outer end of the continuum, and are related through ancestors or Dreamings but not through living or deceased ordinary humans. *Proper* and *tribal* are emic terms in Aboriginal English, while "*close – distant - remote*" are etic terms of my own making.

Just as I cannot solve the nature-nurture problem here, I cannot solve the myriad of intricate problems associated with definitions of classificatory kinship or the nuances of Iroquois, Dravidian and Kariera terminologies (Morgan 1871, Trautmann 1981), all of which have taxed the patience of experts for more than a century and lie beyond the scope of this paper.

Biological inbreeding continuum. The biological inbreeding continuum, somewhat analogous to the classificatory kinship continuum, is a characteristic of reproductive behavior among all sexually reproducing organisms. It reaches from "too close" (mating that yields high inbreeding coefficients with harmful birth defects) (Bittles 1994, 2001, 2009), through "optimal", to "too distant" (mating between members of two different species that cannot interbreed and produce fertile offspring). A high level of natural selection maintains biological discrimination at both ends of the inbreeding continuum, yielding little reproductive behavior between normal organisms that are too closely or too distantly related. The end points of the European biological inbreeding continuum correspond to the end points of the Aboriginal classificatory kinship continuum

Cultural incest-to-miscegenation continuum. Human verbal expressions (folk theories, rules, laws, taboos), typically in the kinship idiom, apply to both ends of the inbreeding continuum. At the "too close" end, incest taboos systematically and almost universally restrict mating among proper kin (parent-child and siblings) and much less systematically restrict mating among certain cousins and many others who are defined locally as being too close (e.g., Lancaster 2007). At the "too distant" end they focus haphazardly and opportunistically on biological or cultural boundary violations such as bestiality, miscegenation, inter-faith and morganatic marriages that collectively have resulted in vigilante hangings, Stolen Generations, honor killings and disinheritance depending upon where and when they have occurred. Traditionally in Aboriginal Australia, "too close" generally was defined in terms of membership in a prohibited descent moiety (or side) or generation moiety; "optimal" meant proper or tribal kin who stood in or near the MBD-FZS relationship; and "too distant" traditionally was defined to exclude mating with non-

Aboriginals. "Too close" and "too distant", at opposite ends of the cultural continuum, are two sides of the same coin and should be treated as such by theoreticians.

Endogamy - exogamy continuum. Here I am not concerned about descent group exogamy (moieties and clans are exogamous) or residential group exogamy (aggregate and dispersed camps are not exogamous except fortuitously). Rather I am concerned with exogamy at the level of societies however they may be defined. The distinction between endogamous and exogamous marriages in the context of universal kinship among Australian Aboriginal societies is not simple and may be misleading. Birdsell (1993), being aware of extreme inbreeding within societies fostered by the canonical Kariera model in its strictest form, argued that marriage between tribal kin was *de rigueur* throughout Aboriginal Australia. But that was a fiction used to save the appearances (Grant 1978:280-284) of the canonical models. In fact this is a statistical matter, with appropriate marriages occurring on a continuum from closest, in which people marry their proper 1st or 2nd cross cousins in genealogically closed chains called directed marriage cycles (Harary and White 2001:40), to most remote, in which people marry remote tribal cross cousins from other societies to whom they are related only through Dreamtime ancestors with no known genealogical linkages.

Skin terms and kinship range. Skin terms when used *within* individual Australian Aboriginal societies seem to be a kind of "shorthand" for membership in proper and tribal sibling sets, dividing a society into named categories using labels for moieties, sections, subsections, etc. Skin terms when used *between* societies collapse Dravidian kin terms into compact packages that facilitate societal exogamy.

Although I focus primarily on sections throughout this paper, subsections are not fundamentally different in principle. Unlike Lawrence (1937) and others who have examined skins through a metaphorical microscope, I use a similarly metaphorical wide angle lens. In a society that uses section terms, members of each section are proper or tribal siblings of each other in even or odd generation levels, while the other three sections contain, respectively, their fathers, their mothers and their spouses, plus more distant categories of relations in even or odd generation levels. Thus skin terms collapse Dravidian kin terms into a much more compact "package" that gains in simplicity and comprehensiveness what it loses in precision. Among recent developments in Aboriginal English, members of societies with sections or subsections use their own section or subsection terms in a manner analogous to White Australian surnames.

Appendix 2. Alyawarra data used in preparing this paper

1971 Alyawarra Ethnographic Archive (compiled 1971-1976; published online 2007)
2007 Hard copy and online interactive database includes user manual and approximately 440,000 data items from the Alyawarra including text files, numerically coded data files, photographs, maps, music, etc. Introduction to the Alyawarra Ethnographic Data Base and Alyawarra Ethnographic Archive

1972 Alyawarra 1971 AU01 (compiled 1972; published online 2007; to KinSources 2010))
2007 Numerically coded vital statistics, genealogical, demographic and census dataset (n=377 cases) for the
2010 Alyawarra of Central Australia in 1971.
Alyawarra 1971 User Manual: Alyawarra1971ManualREADFIRST.pdf
Alyawarra 1971 VitalStatistics/Genealogical/Demographic/Census data: Alyawarra1971data.txt

2005 Alyawarra 1818-1979 AU10 (compiled 2005; published online 2007; to KinSources 2010)
2007 Numerically coded vital statistics, genealogical, demographic and census datasets (n=1361 cases) for the
2010 Alyawarra of Central Australia spanning the period 1818-1979.
Alyawarra 1818 User Manual: Alyawarra1818ManualREADFIRST.pdf
Alyawarra 1971 VitalStatistics/Genealogical/Demographic/Census data: Alyawarra1818Data.xls

1972 Alyawarra kinship dataset (compiled 1971-1972; first used in Artificial Intelligence (AI) research 2004;
2004 published online 2007). The Alyawarra Kinship Dataset has been used frequently in AI research since
2007 2004. The main objectives have been to develop and test higher order pattern detection algorithms, but the research may yield new ways to analyze relations between kin and skin. Access the dataset here:
Alyawarra 1971 User Manual: Alyawarra1971ManualREADFIRST.pdf
Alyawarra 1971 VitalStatistics/Genealogical/Demographic/Census data: Alyawarra1971data.txt
Alyawarra 1971 Kinship Manual: Alyawarra1971KinDataKey.pdf
Alyawarra 1971 Genealogical diagrams: Alyawarra1971GenDiag.pdf
Alyawarra 1971 Kinship Data in Excel format: Alyawarra1971KinData.xls
Alyawarra 1971 Kinship Data in MatLab format by Charles Kemp: http://charleskemp.com/code/irm.html

EXAMPLES OF ARTIFICIAL INTELLIGENCE RESEARCH USING THE ALYAWARRA KINSHIP DATASET:

Kemp, Charles, Thomas Griffiths and Joshua Tenenbaum 2004. Discovering latent classes in relational data. MIT Computer Science and Artificial Intelligence Laboratory Technical Reports MIT-CSAIL-TR-2004-050. http://hdl.handle.net/1721.1/30489 (view .pdf version)

Kemp, Charles, Joshua Tenenbaum, Thomas Griffiths, Takeshi Yamada and Naonori Ueda. 2006. Learning systems of concepts with an infinite relational model. AAAI *Proceedings: 21st national conference on Artificial Intelligence*. 2006: 381-388 http://cocosci.dreamhosters.com/tom/papers/irm.pdf

Kok, Stanley and Pedro Domingos 2005. Learning the structure of Markov logic networks. *Proceedings of 22nd International Conference on Machine Learning: ICML* 2005:441 – 448 http://dl.acm.org/citation.cfm?id=1102407

Kok, Stanley and Pedro Domingos 2007. Statistical predicate invention. *Proceedings of the 24th International Conference on Machine Learning: ICML* 2007:433-440 http://dl.acm.org/citation.cfm?id=1273551

Roy, Daniel M., Charles Kemp, Vikash K. Mansinghka, and Joshua Tenenbaum 2007. Learning annotated hierarchies from relational data. *Advances in Neural Information Processing Systems 19*: NIPS 2007:1-8 http://danroy.org/papers/RoyKemManTen-NIPS-2007.pdf

Miller, Kurt T., Thomas Griffiths and Michael Jordan 2009. Nonparametric latent feature models for link prediction. *Advances in Neural Information Processing Systems 22* (NIPS), 2009:1-9. http://books.nips.cc/papers/files/nips22/NIPS2009_0960.pdf

Appendix 3. Preferred and traditional spellings with locations

Australian Institute of Aboriginal and Torres Strait Islanders Studies (AIATSIS) language codes and preferred spellings. [9]		**Sorted by traditional spellings**	**General locations:** **NT = Northern Territory** **WA = Western Australia** **QL = Queensland**
C.14	Alyawarr	Alyawarra, Alyawara, Iliaura	NT – Central
C.08.1	Anmatyerr	Anmatjera	NT – Central
C.08	Arrernte	Aranda	NT – Central
G.12	Jaroinga	Jaroinga	NT – East Central
C.13	Katetye	Kaititja	NT – Central
A.04	Kalaamaya	Kalamaia	WA - Western Desert
A.64	Karajarri	Karadjeri	WA - West Coast
W.39	Kariyarra	Kariera	WA - West Coast
A.16	Koara	Koara	WA - Western Desert
C.07	Kukatja	Kukatja	NT - West Central
A.33	Mandjindja	Mandjindja	WA - Western Desert
A.65	Mangala	Mangalal	WA - Western Desert
A.06	Martu	Mardu	WA - Western Desert
N.116	Murngin Yolngu	Murngin	NT - Arnhem Land
A.43	Ngaatjatjara	Ngaatjatjarra	WA - Western Desert
A.48	Innawonga	Ngaiwongga	WA - Western Desert
C.02	Ngalia	Ngalia	NT - West Central
K.18	Ngarinyin	Ngarinjin	WA - West Coast
W.40	Ngarla	Ngarlawonga	WA - Western Desert
A.61	Nyangumarta	Njangamarda iparuka	WA - Western Desert
A.61	Nyangumarta	Njangamarda undal	WA - West Coast
?	?	Njikena	WA - Western Desert
C.10	Bintubi	Pintubi	NT - West Central
C.06	Pitjantjatjara	Pitjantjara	NT - West Central
C.16	Wakaya	Wagaya	NT – East Central
C.15	Warlpiri	Wailbri	NT – Central
A.11	Waljen	Waljen	WA - Western Desert
N.151	Anindilyakwa	Wanindiljaugwa	NT – Groote Eylandt
C.18	Warrumungu	Warramunga	NT – Central
Y.57	Wik-Mungkan	Wikmunkan	QL - Cape York Peninsula
N.153	Yanyuwa	Yanyula	NT - Gulf of Carpentaria Coast
N.116	Murngin Yolngu	Yolngu	NT - Arnhem Land
A.67	Yulparija	Yulbaridya	WA - Western Desert

[9] See sources online at: AIATSIS Language and Peoples Thesaurus; Norman B. Tindale (1974) *Tribal Boundaries in Aboriginal Australia;* many other maps of Australian Aboriginal societies and languages at web sites of the South Australia Museum and the Australian Institute of Aboriginal and Torres Strait Islanders Studies.

References

Note: References to and citations of works by kinship theorists of algebraic and symbolic persuasions are rarer than they might have been in this paper. Certainly their works are important and relevant, but, to be painfully honest, I often find them to be incomprehensible. That is *my* problem. Partly it is a matter of style. I much prefer to use the natural or ordinary language in which I speak, write and think rather than a constructed or formal language. Among the advantages of using English, it is immediately compatible with visualizability, intuitively understandable analogies and apt expressions from literary sources. Furthermore, is not a barrier that deflects most potential readers. I understand Heisenberg's dissatisfaction with classical mechanical models and his point that "… when it comes to atoms, language can be used only as in poetry" (Heisenberg 1971:41, quoted in Baggott 2011:47), but I am not convinced that the same is true at this time with regard to descent, marriage and kinship in human societies.

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