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Abstract: The feature of Dravidian kinship terminology is typically that male lines on ego's "side" marry and call their "affines" relatives in a set of opposing male lines. The egocentric versus sociocentric debate in Anthropology over the social network implications of Dravidian terminology is resolved with proof of a single theorem: For a connected network A of marriages between consanguineals, including only the additional ancestral relatives leading back to the consanguineal ancestors of those couples, then if the kin of the couples are consistently sided egocentrically, according to Dravidian kinship terminology, then all relatives in network A are consistently sided sociocentrically, whether sides are defined through opposing sides V of male kin, U of female kin, or both. Two other theorems prove that if all the consanguineal marriages in network A are same generation (same number of generations back to the common ancestor for the husband as for the wife) then if sidedness is V it is also U, if U it is also V. Finally if network A is both U and V then all of its marriages are same generation and the marriage structure of A is one of implicit alternate-generational moieties, as in a Kariera kinship network.

Classificatory kinship systems have been a vexing problem for social anthropology. Lewis Henry Morgan, inventor of kinship studies and discoverer of "classificatory" versus "descriptive" kinship, failed to understand that the South Asian "Dravidian" type of kinship system differed radically from the more common use of kin terms in which father and father's brother are equated (similarly for mother and mother's sister) and opposed to the opposite-sex sibling. Bifurcate merging of this sort (as found for Iroquois terminology, for example) was differentiated from a seventh type of kinship system beyond Morgan's original six by Lounsbury (1964), who mapped the features of the *Dravidian* system. Dravidian not only distinguishes kin in the basis of cross-sex sibling links in the ascending generation, but uses bifurcation of the male descent line of a brother and an opposing male line into which the sister marries. This is called a "two-line" system (Dumont 1953), referring to egocentric kin terms, and implicitly male-oriented. (No empirical cases have been found for the logical possibility of a "two-line" system where the opposing lines are female.) Newer definitions of classificatory and descriptive terms, however, are given by Dwight Read (2001, 2007, 2008, 2009, 2010a, 2010b, Read and Behrens 1990), expert in generative mathematical models that match cognitive processes of language use to linguistic structure in relative products denoting relations such as (brother)°(father)=(uncle) where the output of composition is another term. His findings show that Morgan was intuitively correct that Iroquois and South Asian (Dravidian) kinship terminologies are both classificatory, although with important differences (Inset 1).

Read's definitions (in Inset 1) are stated from an egocentric viewpoint: how does ego generate kin terms as a composition of terms? I will look on these terminologies in the classificatory sense, as usually defining exclusive categories into which one may marry. Dravidian, for example, is associated with a rule of marriage to a classificatory "cross" relative, although not exclusively. Australian systems of classificatory terminologies have an associated marriage rule that one may marry only a person in the proper classificatory "cross-cousin marriage section" that entails a sociocentric view of how actual marriages arrange themselves in relation to the terms used for relatives. From a sociocentric perspective, Australia ethnologists sometimes use "eight line" and "four line" for variants of the Aranda kinship systems, "two line" for the Kariera kinship system and "one line" for the Aluridja kinship system (the latter with an age difference at marriage so great that everyone marries into the same slanting "generation"). These refer to "sections" with classificatory marriage rules that purportedly link actual behavior with kin term categories and thereby define a kinship "system" (Denham and White 2005).

Inset 1: Dwight Read (comments edited by DRW)

Definition: Classificatory terminologies are those that are generated by beginning with both an ascending generating term (e.g. 'parent', 'father' or 'mother') and a "horizontal" (sibling) generating term. The merging criterion is a consequence of having both an ascending and a sibling generating term. The most straightforward logic for generating a structure of (male) ascending and descending kin terms leads to o/y same sex sibling terms in most classificatory terminologies.

Definition: Descriptive terminologies are those that are generated by beginning with just an ascending generating term.

In general, marriage behavior does not form a "system" with respect to kin term categories except in a limited sense. Most societies observe an incest rule, for example, that is linked to kin terms. One might be prohibited from marrying a sister, a first cousin, first to third cousin, certain subtypes of cousins, and so forth. Similarly for marriage with an ancestor or a descendant. The restrictive classificatory marriage rules of the Dravidian or Australian systems, however, might be called "elementary," to rephrase Lévi-Strauss (1949), while Iroquois would be better designated as "semi-elementary" because of fewer marriage restrictions, while societies with only incest prohibitions would fit Lévi-Strauss's kinship designation of "complex systems." Lévi-Strauss (1949) regards as "semi-complex" systems that prohibit marriage so broadly as to become restrictive, as with the Crow-Omaha types of kinship terminology.

The features of classificatory and descriptive kinship listed in Table 1 do not entail a linear evolutionary sequence. Two alternatives for branching proto-evolution might be: (1) from proto-Dravidian (often considered in recent literature an archaic kinship type) to each of the other classificatory types is plausible; (2) from proto-Iroquois (the simplest system) in alternate directions for expanding kin term networks is also plausible – either through extending classificatory terms, or increasing local restrictions to extending marriageable kin at greater distances (Iroquois, Crow-Omaha).

Table 1: *Features of Classificatory kinship*

Classificatory systems	Older/younger distinctions	spouse kin term	marriages
"Elementary"			
Kariera	**sibling, symmetric**	**wife=cross-cousin**	**2 2-line m,f**
Dravidian	**cross-cousin, sibling, symmetric**	**wife≠relative**	**2 line male**
"Semi-Elementary"			
Iroquois	**sibling (same sex, opposite)**	**wife≠relative**	
Oceanic/Polynesian	**sibling same sex, asymmetric**	**wife≠relative**	**ranking?**
"Semi-Complex"			

Mathematical logic and nonmathematical argument. Mathematical inference, however, is stronger than typologies and labels: it offers proofs of equivalence or implications. It may also provide a means to resolve lingering disputes about kinship "systems." The disputes that I resolve here with proofs of mathematical theorems are between views of Dravidian terminologies from "egocentric" and the "sociocentric" perspectives, which differ in the Oceanic/Polynesian, Iroquois, Australian and Dravidian classificatory logics.

Sidedness: Egocentric and Sociocentric

Egocentric sidedness: **Definitions**. Individual consanguineal marriages may be viri-sided and/or uxori-sided or neither, as defined by Houseman and White (1998a). For spouses with a common ancestral couple, counting male and female links to that ancestor (including the husband and wife themselves as links) let F be the sum of female links, $F = \mathbf{f_m} + \mathbf{f_w}$ for the man$_m$ and woman$_w$ respectively. A viri-sided marriage is one where F **= even**. A uxori-sided marriage is one where $G = \mathbf{g_m} + \mathbf{g_w}$ **= even**, with g and G terms being male links for the man$_m$ and woman$_w$ respectively. Thus for FZ/BS G **= 2 = even** and F **= 1 – odd**, which is uxori-sided and not viri-sided. $F = G$ **= odd** is a marriage that is neither uxori- nor viri- sided (e.g., FFZDD, $F = G$ **= 3 = odd**). $F = G$ **= even** is both uxori- and viri- sided (e.g., MBD and FZD, $F = G$ **= 2**). Figure 1 (left) shows a viri-sided marriage with ***G = odd*** heavy lines for sons and ***F = even*** light lines for daughters. The first and third line of males form *side 1* and the middle two classificatory lines of males form *side 2*. Figure 1 (below) shows a uxori-sided marriage, where ***G = even***. It is not required that there be as many lighter lines as heavier lines defining ascending generations as descending from the common ancestral couple.

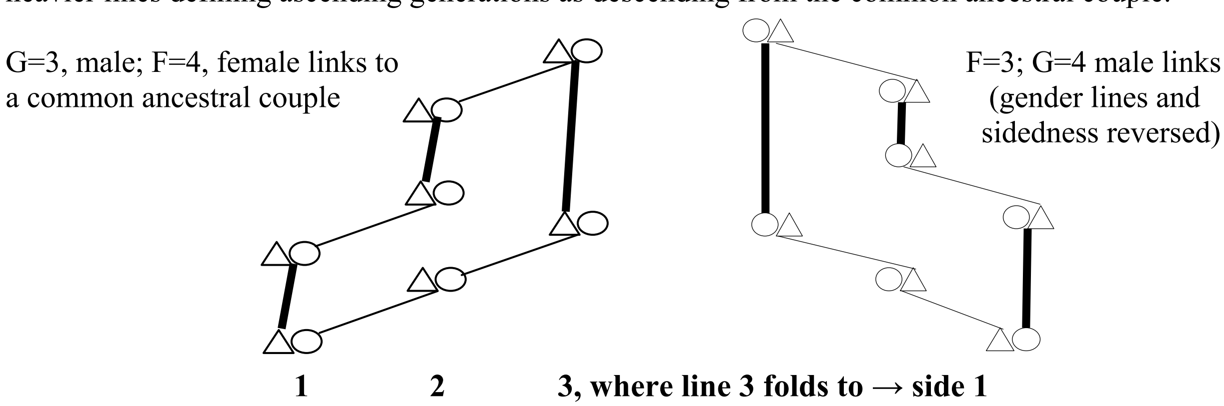

Figure 1: A viri-sided marriage, *F* = even Uxori-sided marriage, *G* = even

Definitions: CCMN. A connected consanguineal marriage network or CCMN (with "consanguineal endogamy") is a kinship network or subnetwork defined by (1) one or more consanguineal marriages, e.g., the lowermost couples in Figure 1, and (2) each of their ascending relatives leading back to and including their common ancestor(s), e.g., the uppermost couples in Figure 1. There is no requirement that the ascending couples have married consanguineals. In a viri-sided network, the same-sided ancestral couples (e.g., of couple A_0) are those that are linked by an ancestral path with an even number (including zero) of female links (i.e., couples B_0, E_0, F_0), as defined by the lighter lines. Those linked by an ancestral path with an odd number of female links (i.e., couples C_1, D_1, G_1) are opposite-sided.

Definitions: Sociocentric sidedness. The network is viri-sided (uxori-sided) to the extent that its individual marriages are consistently viri-sided (uxori-sided), as in Figure 1 (the right graph reversing the genders of the left, with same-sided defined by ancestral paths with an even numbers of male links, opposite-sided by odd numbers of those paths with male links).

There may be many columns of the ancestors of couples that have consanguineally viri-sided relatives within a kinship network, those that have couples in common will be included in a connected (thus "consanguineally endogamous") consanguineal marriage network or CCMN. There may also be columns of the ancestors of couples that have consanguineally uxori-sided relatives within a kinship network. One of the proofs in this paper is that if "same generation" marriages are defined formally, the consanguineally viri-sided relatives within a kinship network will also be consanguineally uxori-sided relatives, and vice-versa. If not all consanguineal marriages are same generation, this cannot be true. Further, consanguineal marriages need not and do not, in general, satisfy either criteria: the ancestors leading to their common ancestral couple may satisfy neither viri-sidedness nor uxori-sidedness.

Sociocentric sidedness, however, requires that the egocentric sidedness of individual marriages are aligned so that "same" and "opposite" sidedness form a binary product, like equal/unequal. Any x as self, is in the "same" category $s(x)$, and not x in the "opposite", $o(x)$ category. Further, $s(x) \supseteq s(s(x))$, $s(x) \supseteq o(o(x))$, $o(x) \supseteq \boldsymbol{s}(\boldsymbol{o}(\boldsymbol{x}))$, and $\boldsymbol{o}(\boldsymbol{x}) \supseteq \boldsymbol{o}(\boldsymbol{s}(\boldsymbol{x}))$, i.e., sociocentric sidedness is associative and commutative. The "same" viri-sided relatives of A_0 in Figure 1, have the "same" viri-sided relatives, for example. Thus for the three columns of ancestors for the viri-sided graph in Figure 1, columns one and three are "same" sided, and those in column two are their "opposite" viri-sided relatives. Sidedness distinctions overlap with but differ from those of cross/parallel relatives, one being that we measure sidedness for couples rather than individuals. In Figure 1, the ascendants for the man in couple A_0 are parallel (B_0) and cross (G_1) while their ascendants are also parallel and cross for the wife. Couple C_1 is cross (and opposite sided) for the man in A_0 but neither cross nor parallel in a Dravidian terminology because they are in a grandparental generation.

Proof of Theorem 1.

If ***F*** **= even** then for a consanguineal marriage the Hu's side (parallel kin) will include his patri-ancestors (PAs) and there are ***S*** PA groups including and from the Wi's PA to new PAs through other maternal links, terminating in Hu and Wi's common ancestral couple, as in Figure 1 (***S*** = 2), and then ***S'*** PA groups from the ancestral couple through daughter and son links back to and including the Hu's PA (***S'*** = 2 in Figure 1). In Figure 1 ***S*** **+** ***S'*** = 2 + 2 = **even**, so every even numbered PA in the cycle of PAs from Hu's to Wi's common ancestral couple back to Hu's PA can be folded into *side 1*, and every odd numbered PA in the cycle can be folded into *side 2*.[1] Thus, ***every sided consanguineal marriage folds into two sides***. Because any consanguineal marriage folds into two sides, any two such marriages having a person C in common will fold into two sides: C's side, and the opposing side. In a connected consanguineal marriage network, for each consanguineally married couple, the PAs in the entire network, all of which are by definition connected will fold into two sides. The same proof follows if ***G* = even** or ***F* = *G* = even**. **Q.E.D.**

That is, egocentric sidedness will produce a consistent sociocentric sidedness structure where consanguinity is the basis of reckoning sidedness. Figure 9-2 in Houseman and White (1998a), including the consanguineally endogamous CCMNS for the Makuna, is a perfect example for ***F* = *G* = even** for the consanguineal marriages (100% viri- and uxori-sided), i.e., ***F* = *G* = even** for all these marriages, which also implies they are all same-generation (see Theorem 2). For all Makuna marriages ***F* = even** with a single (1%) nonconsanguineal marriage exception. Houseman and White (1998a) found "sided" kinship networks similar to the Dravidian (i.e., Dravidianate) in Amazonia, and created percentage measures for the extent to which they were sociocentrically viri-sided, uxori-sided, or both.

Kinship Terminologies. Read details the differences among classificatory kinship terminologies as shown in Inset 2, on the next page

Sociocentric sidedness: **Theorem 1**. A consanguineally endogamous CCMN with ***F* = even** or ***G* = even** or both ***F* = *G* = even** for all its consanguineal marriages and their ancestors that link to the ancestors in common for each consanguineally married spouse will be sociocentrically (in turn) viri-sided, uxori-sided or both.

Proof. If ***F* = even** then for a consanguineal marriage the Hu's side (parallel kin) will include his patri-ancestors (PAs) and there are $\underline{S}$ PA groups including and from the Wi's PA to new PAs through other maternal links, terminating in Hu and Wi's common ancestral couple, as in Figure 1 ($\underline{S}$ = 2), and then $\underline{S'}$ PA groups from the ancestral couple through daughter and son links back to and including the Hu's PA ($\underline{S'}$ = 2 in Figure 1). In Figure 1 $\underline{S} + \underline{S'}$ = 2 + 2 = **even**, so every even numbered PA in the cycle of PAs from Hu's to Wi's common ancestral couple back to Hu's PA can be folded into *side 1*, and every odd numbered PA in the cycle can be folded into *side 2*.[2] Thus, ***every sided consanguineal marriage folds into two sides***. Because any consanguineal marriage folds into two sides, any two such marriages having a person C in common will fold into two sides: C's side, and the opposing side. In a connected consanguineal marriage network, for each consanguineally married couple, the PAs in the entire network, all of which are by definition connected will fold into two sides. The same proof follows if ***G* = even** or ***F* = *G* = even**. **Q.E.D.**

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[1] Because ***F* = even** requires ***S* + *S'* = *J* = even** then if ***S* = even**, ***S'* = even** links through daughters and their PAs back to Hu's PA. If ***S* = odd** then ***S'* = odd**. For every j=1,…, ***J*** the j = even PA's are on the Hu's side and the j = odd PA's are on the Wi's side.

[2] Because ***F* = even** requires ***S* + *S'* = *J* = even** then if ***S* = even**, ***S'* = even** links through daughters and their PAs back to Hu's PA. If ***S* = odd** then ***S'* = odd**. For every j=1,…, ***J*** the j = even PA's are on the Hu's side and the j = odd PA's are on the Wi's side.

Inset 2: Dwight Read: (comments edited by DRW)

All classificatory terminologies are generated with an ascending and a sibling generator that combine to generate bifurcate merging and, with few exceptions, to generate o/y same sex sibling terms (more accurately, "ascending", "descending" sibling distinctions).

Dravidian terminologies are distinguished from the Iroquois not by the generators, but a further step in the generation of a terminology in which a structure of male terms and structure of female terms are linked to form a single structure. This accounts for the symmetry in o/y cross-cousin and sibling terms. Like Iroquois, Dravidian lacks the terminological equation of spouse = 'cross cousin.' A "marriage rule" that does not require same-generation marriage is emergent through a "two line" male-sided marriage opposition in the middle three generations (as discussed by Dumont, who does not translate marriage opposition into sociocentric sides)*****. The terminology constrains marriages to 0 generation with cross-cousin, -1 generation marriages with "ZD", and +1 generation marriages with classificatory "MB" ("FZ" in a female-sided "two line" marriage opposition is also possible but is highly unlikely if only for demographic reasons).

Kariera, and presumably other Australian terminologies, have two logics:****** (1) The generating logic equates, spouse = 'cross-cousin' and child of 'cross-cousin' as 'child' as part of the terminology and thus a cross-cousin marriage rule and section system, reversing the logic of Iroquois. (2) A sociocentric logic of section systems as an intersection between a “two line” male-sided marriage opposition cross-cut by a "two line" female-sided marriage opposition, thus closely related to Dravidian.******* In either case the structure has the section system as an emergent sociocentric property and accounts for the symmetry in the o/y sibling terms.

The Iroquois terminology has o/y sibling terms and is generated (in contrast to Kariera) with the child term for male and female cross-cousin terms distinct from own child. (This obviates the cross-cousin marriage rule in the Kariera terminology and eliminates an emergent section system structure). It entails that the Iroquois terminology has no cross-cousin marriage rule, and no sociocentric sides.

The Polynesian and Oceanic terminologies and kin terminology lack a cross cousin marriage rule as part of the terminology structure. (In fact they typically do not have cross cousin marriage or marriage rules.) This also accounts for the asymmetry of o/y sibling terms (only for same sex siblings, but not for opposite sex siblings) in these terminologies.

The generative logic of these systems accounts for precisely the properties of the terminologies, the presence/absence of a marriage rule framed or not around cross-cousin, the pattern of o/y sibling terms and, perhaps most important, has ethnographic support for the different ways in which the structures of male and female terms are joined through ethnographic observations that show that the logic is realized concretely in conceptualizations about siblings in societies with these kinds of terminologies.

*Conditions for this are proven by White, above.
** (1) Read’s view, (2) In White’s view: proven below to be convergent, the discrepancy disappears.
*** The proofs herein show conditions under which any two of the two forms of sidedness and same generation marriage entail the third.

That is, egocentric sidedness will produce a consistent sociocentric sidedness structure where consanguinity is the basis of reckoning sidedness. Figure 9-2 in Houseman and White (1998a), including a consanguineally endogamous CCMN for the Makuna, is a perfect example for ***F* = *G* = even** for the consanguineal marriages (100% viri- and uxori-sided), i.e., ***F* = *G* = even** for, which implies that all these marriages are same-generation (see Theorem 2). Makuna nonconsanguineal marriages have one exception 1% of the total to ***F* = even**. Houseman and White (1998a) found "sided" kinship networks similar to those of Dravidian societies (i.e., Dravidianate) in Amazonia, and created percentage measures for the extent to which they were sociocentrically viri-sided, uxori-sided, or both.

Theorem 1 simply says that since all connected consanguineal marriages in a kinship network must be sided or unsided, then if they are all consistently sided (***F* = even** or ***G* = even** or both ***F* = *G* = even**) egocentrically, they will be consistently sided sociocentrically. Statistically, however, if we count the number of independent genealogical cycles of common ancestries for the consanguineal marriages, we would want the numbers of those that are consistently sided to be significantly greater than the expectation that in random cycles, half will be sided and will not. If **Theorem 1** *does not extend to nonconsanguineal marriages* it is because sidedness in these more complex nonconsanguineal marriages is not easy to compute and not that consanguineal marriages have a more powerful force of norms.; this is not because there are pairs of marriages connected in cycles with two common ancestral couples where ***F* = even** or ***G* = even** does not imply sidedness.

Practical decision making. The practical explanation as to why the ***F, G*** types of sidedness rules among Dravidians are dependent on consanguineal marriages is simply for reasons of *kinship reckoning*. Dravidians in general, and Pul Eliya in particular, do not consciously attempt to construct sociocentric sides to extend the coherence of their egocentrically sided kinship terminologies. Nor are sociocentric sides "governed" by adherence to social norms. The **Sidedness Theorem 1** proves that when individuals are consistent in their egocentric behavior – the type of consanguineal marriages shown in Figure 1 – sociocentric consequences are automatic and inevitable even if unintended. The theorem simply defines objects that have necessary connections between parts and wholes, which also demonstrates why anthropologists cannot afford to ignore mathematics. This insight is particularly appropriate in the case of networks (Chapter 1 of White and Johansen 2005 dwells on this at length).

The intentional component to sidedness in consanguineal marriages, which is the generator of sociocentric sidedness, arises under conditions of uncertainty, when the parents of a potential bride and groom (i.e., those who usually arrange marriage) have no preexisting kin terms for one another, and so are uncertain about whether their children are marriageable. It is attested by various South Asian ethnographers (personal communications from Lehman 2010, Leaf 2010, and Kolenda 2010), that in conversations between parents of prospective bride and groom the search for a common ancestral couple on which to round a proper relation of opposite sidedness is to count the *numbers* of ***F* = {*fm, fw*}** of female(-cross) links to ancestral couple. Then if ***F* = *even*** they are properly viri-sided and eligible to marry.

This viri-sided Dravidian marriageability decision rule, or one comparable, does not extend to nonconsanguineal marriages. Mathematics provides the clue as to why this is true. Our hypothetical pair of parents arranging a marriage need only search among their two sets of parents (matching in a space of 2^2), their two sets of grandparental couples (matching in a space of 4^2), or their two sets of great-grandparental couples (matching in a space of 8^2), a well-defined problem. When there are no common ancestors, they could consider whether there are cycles of marital relinking (like sister exchange or marriages of two brothers to two sisters, where marriage between offspring is proper). Beyond that short range of affinal kin, however, there are too many possibilities and in no particular order to formulate a consistent and effective decision rule.

One might apply the Harary (1953) balance theorem of signed graphs to whether a marriage graph is viri-sided, using Figure 1 as an example, by labeling the heavy lines as positive (+) and the light lines as negative (-1), and then verifying whether the product of signs in every cycle is positive. This implies that the signed network consists of two sides, each connected internally by positive links and externally, between sides, by negative links. This is easy to conceptualize, prove, and compute with appropriate software, but is hardly something that can be implemented as a decision rule. Its import is that if sidedness (as an instance of a balance principle) is implemented locally then the network structure is globally sided. Conversely, global sidedness entails that every cycle is balanced in terms of an even number of crossovers between two sides.

The rule of Dravidian sidedness computation according to common ancestral couples is thus a practical and effective solution to a complex problem. It leaves uncertain whether a potential bride and groom are marriageable when they have no common ancestors. This is often the situation when outsiders marry into a local Dravidian community. Here sociocentric sidedness will be lacking, which is exactly what we find in the Pul Eliyan marriage networks. All Dravidians have a term for wrong or improperly sided marriages and also a term for proper marriages (e.g., *murai* in Nattathi Nadars Tamil). Two brothers from a remote village might marry women from opposite sides of the Pul Eliyan village sidedness structure, and these might be recognized as "wrong" marriages. In cuse cases, Pul Eliyans may choose to ignore issues stemming from the same-sidedness of brothers from another village, however, since this has no practical effect in terms of local Pul Eliyan sidedness or inheritance.

Kariera and Dravidian: Definitions relevant to proofs of further Theorems

P-graph. White and Jorion (1992) follow Weil (1949) in defining marriage networks in terms of relations between families or marriages (P-graphs), except that P-graphs refer to concrete marriages rather than marriage-types. "Let the number of types of marriages be *n*", and let each marriage be numbered from 1-*n*, as in Figure 1 (left, *n* = 7 marriages with 14 spouses), where ♂ links (agnatic descent lines) are denoted by heavier lines and ♀ links by lighter lines. A *P-graph* has *vertices* that represent unmarried children or couples (with or without children) and *P-links between vertices* directed from child to parent(s). The inverse links, parent(s) to offspring, are given by $p=P^{-1}$. Vertices represent single individuals in the case of unmarried children, whose type of P link (♂male, ♀female) depends on their gender. All other vertices represent either a single parent (partner unknown) or a parental couple. Their P links to parents again depend on gender: husband to parents, wife to parents; son to parent, daughter to parent. A *sub-P-graph Q* consists of a set Q of vertices and all the P links between vertices in QxQ. Although one may have more than one marriage, P-graphs normally represent (1) real, ascribed, or fictive genealogy wherein no-one is their own ancestor, (2) two-parent opposite-sex marriages, (3) only one set of parents for a child. Thus: (4) no vertex will have more than two parental links, one to a male's parent(s) (for a couple: husband's), the other to a female's (for a couple: wife's) parent(s). Other variants of P-graphs may be defined.

P-graph generations. The P-graph defined by 1-4 above is a directed asymmetric graph (DAG) with $1 \leq gen \leq g$ generations, g equal to the length of the longest directed path (e.g., $g = 4$ in the Figure 1 marriages), which insures that every generation will have at least one parent in the preceding generation. Program Pajek (Batagelj and Mrvar 2008) computes g generations for P-graphs.

Sides and sidedness. These are implicit moiety structures in the marriage network, wherein a P-graph can be uniquely partitioned into two sets of vertices such that within each set the vertices are connected by the links of one gender and between sets they are uniquely connected by the links of other gender.

V = Viri-sides. Here, a P-graph or sub-P-graph Q is split into two sides, uniquely determined, within which vertices are connected by ♂son/parent links and between which they are uniquely connected by ♀daughter/parent links.

U = ***Uxori-sides***. This is a P-graph or sub-P-graph Q that is split into two sides, uniquely determined, within which vertices are connected by ♀daughter/parent links and between which they are uniquely connected by ♂son/parent links.

S = Same-generation marriage. In general, siblings do not all have to marry spouses of the same generation; neither does "same generation marriage" imply that generations partition by time periods, nor that men and women share the same temporality of generations. Women often marry on average at a younger age than males, so that their average generational time is faster than males, for example. Nonetheless, a P-graph component (connected graph) connected only by P°p (sibling or parent's child) links among marriages (recalling that marriages are the nodes of a P-graph) constitutes a *pure generation* if and only if it contains no connecting parents P-connected to other connecting parents within it (i.e., no grandparents). If the *pure generations* of the P-graph are partially ordered by the g generations in the P-graph, then the P-graph has property **S**, same generation marriage. A sub-P-graph Q may also have property ***S***.

A = A***lternate generational moieties*** are implicit when a sub-P-graph Q is same-generation but a larger subset $R \supset Q$ has some marriages with both same-generation marriages and ones between individuals +2 and -2 generations apart, reciprocally but none at +1 and -1 generations apart.

B = Bicomponent. A *bicomponent* of a marriage network P-graph containing marriages x and y is a maximal sub-P-graph ***B*** containing x and y in which for any node z there are two or more disjoint paths between very pair of nodes in ***B***. (All links between nodes in ***B*** that occur in the main graph are by definition also in the P-graph).

C_k connected consanguineal marriage network = A P-graph or sub-P-graph network Q as defined previously (CCMN, P-graph) with a limitation k on the deepest common ancestor, less than k generations back, of its *consanguineal marriages*. (Recall that not every marriage in a CCMN need be consanguineal, only the generating marriages linked through their ancestors to a common ancestor of the husband and the wife). Such a network has consanguineal endogamy.

Sociocentric sidedness: Theorems 2-4.

The presence of both viri-sides (condition ***V***) and uxori-sides (condition ***U***), for a sub-P-graph marriage network C_k with consanguineal endogamy, in a bicomponent ***B*** of a marriage network, logically entails alternate generational moieties (conditions ***S*** and ***A***) in ***B***. This includes the possibility of an ego at generation i, $1 \leq i \leq g$, marrying someone at generation j, $1 \leq j \leq g$, where the absolute difference $|i - j|$ is an even number, e.g., +2 or -2 generations (condition ***A***). Further, the presence of ***S***, same-generation marriage, and either viri-sides ***V*** or uxori-sides ***U*** logically entails the complementary type of sidedness.

Theorem 2. ***U***, ***V***, and C_k, consanguineal marriages => ***S*** and ***A***: implicit alternate-generational moieties.
Theorem 3. ***V*** and ***S*** => ***U***
Theorem 4. ***U*** and ***S*** => ***V***

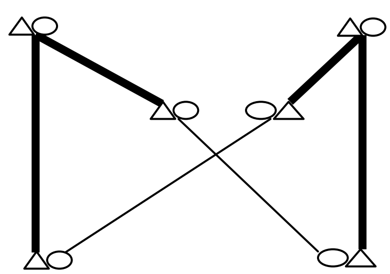
Proof of Theorem 2.

Suppose a Pgraph or sub-P-graph is one with C_k, consanguineal endogamy and all its marriages are both ***U*** and ***V***, uxori- and viri-sided. Then the cycles formed by consanguineal marriages with ancestral links to common ancestors are both ***U*** and ***V***, and each such cycle will have even number of female links, an even number of male links, and, adding the two, an even number of total links. Thus, if the ancestral graph for each such cycle is drawn, from parent to child in adjacent generations, then either husband and wife will be of the same generation or one is an even number of generations above the other. This will apply to all such marriages, and conditions ***S*** and A will be satisfied: implicit alternate-generational moieties. **Q.E.D.** (This proof generalizes to Australian section systems.)

Counterexample viri-sided and uxori-sided nonconsanguineal marriage lacking the feature of same-generation marriage

Suppose ***U*** and ***V*** and a marriage network in which a man marries a BDHBD, as in Figure 2, implying two nonconsanguineal marriages linked by two distinct ancestral couples, not a common ancestral couple. Then the number of males is even (4) as is the number of females (2), qualifying for ***U*** and ***V*** but ***S*** (same-generation marriage) and ***A*** (alternate-generation moieties) are violated.

Figure 2: BDHBD as an example of a nonconsanguineal viri-sided and uxori-sided marriage (F = 2, G = 4) violating same-generation marriage for siblings



Lemma 1.

Suppose A (Implicit alternate generational moieties). This may apply so that the generation number of each marriage is the required minimum of one below the generation number of the parents of the husband and that of the wife, the other alternative being an odd number below. This entails that any marriage cycle will have an even number of links because for any distance *d* (odd) from one spouse to the common ancestral couple, the distance is a *d'* (odd) for the other spouse, for a sum of two odd numbers, which is an even number of total links in every such cycle.

Proof of Theorem 3.

Suppose V and A. By Lemma 1, A requires that every marriage cycle will have an even number of links e_c, while U entails an even number of male links e_m, so the remaining female links $e_f = e_c - e_m$ must be even, and the network is U. **Q.E.D.**

Proof of Theorem 4.

Suppose U and A. Exchanging U and V above: then V and A entail V. **Q.E.D.**

Evidence that Dravidian is viri-sided and not uxori-sided.

(1) Ethnographers report that the Dravidian marriageability decision rule is viri-sided and not uxori-sided. (2) Trautmann (1981) reports that MB/ZD marriages, which are viri-sided and not uxori-sided, occur in Telugu and Tamil (core Dravidian) systems, and White (1999) and Houseman and White (1998b) show extensive classificatory ZD marriage in the connected consanguineal marriage networks (consanguineally endogamous CCMN) of Pul Eliya, a Sinhalese society of Indo-European language stock that has long been assimilated to the Dravidian kinship terminology of its Sri Lankan neighbors. (3) All of the Dravidian kinterm systems reported in Trautmann (1981: 121, 134, 135, 138, 141, 144, 150:Tamil, 154: Sinhalese, 156, 157, 159, 162, 163, 165, 166:Telugu, 170, 188) show ZD as "cross" (consistent with viri-sidedness) while BS (consistent with uxori-sided marriage) is "parallel" and thus unmarriageable. All the evidence from triangulated sources (actual marriages, kin terms, marriageability decision rules) points to Dravidian as viri-sided in terminology, actual marriages, and decisions rules – and contradicts the possibility that any if the Dravidian kinship systems are uxori-sided or that they necessarily prescribe same-generation marriage only.

A Sinhalese Example of the Dravidian Kinterm Systems

Figure 3 illustrates one of the Dravidian kinterm systems, that of Sinhalese, with notes on the male terminology and kin behavior given by Leach (1961:126) and the Tamil terminology studied by Read (2010b). It will be noted that the MB/ZD reciprocal terms are both cross and allow marriage while the BS/FZ terms disallow marriage because BS is parallel. Here, as in Dravidian generally, wife="woman" and there is no further designation of a kin term for wife or husband (also confirmed by Kolenda 2010, along with Tamil ZD marriage). Hence cross-cousin marriage is not prescriptive and there is flexibility in the possibility of classificatory MB/ZD $G^{+/-1}$ marriages that do not disrupt prior kin term usage.[3] A classificatory MB marrying a ZD, however, will call her mother X- "aunt"

[3] The lack of kin terms for husband's relatives also facilitates the retention of prior kin terms for consanguineal relatives of different generations who marry, such as MB/ZS. Thus, after marriage, the husband is still MB.

Figure 3. Paradigm of Sinhalese kin terms (Trautmann 1981:154; Figure 3.20) and Pul Eliya. Reciprocal kinship behaviors between males (Leach 1961:126) are described in the footnotes.

		♂		Sinhalese			♀
		X cross	// parallel				X cross
G^2		kiriättā [4] FF, MF			kiriamma FM, MM		
G^1	e	māmā [5] MB,FZH, WF	loku appā [6] FeB, MeZH	appā [7] F	amma M_0	loku MeZ_0, $FeBW_0$	nändā [8] FZ_1,MBW_1, WM_1
	y		bāppa [3] FyB, MyZH			kuda MyZ_0, $FyBW_0$	
G^0	e	massinā [9] MBS, FZS, WB, ZH	ayiyā [10] eB, e(FBS), e(MZS),e(MBDH), e(FZDH)		akkā eZ_0, e(FBD_0), e(MZD_0),e($MBSW_0$), e($FZSW_0$)		nänā [11] MBD_3, FZD_3, WZ_3, BW_3
	y		malli [6] yB, y(FBS), y(MZS), y(MBDH), y(FZDH)		namgi yZ, y(FBD), y(MZD),y(MBSW), y(FZSW)		
G^{-1*}		bänā [2] ♂?ZS, DH [12]	putā [3] S, ♂?BS [9]		duvā D_0, ♂?BD_0 [9]		leli [2, 13] ♂?ZD_4, SW_4 [9]
G^{-2}		munburā (miniburā) [1] SS, DS			minbiri SD, DD		

after marriage ("FZ") as if the wife's mother were the "FZ" and not the "Z," a convenient omission for a viri-sided system. Trautmann (1981:206-207), in salvaging his "cross-cousin only" marriage

4 Kiriättā / miniburā: Friendly informality. $G^{+/-2}$. Divisions (♂ and ♀) apply to ego's and spouse's grandparents in Tamil. All underlined kin terms are general Sinhalese but also hold for Pul Eliya.
5 Māmā / bänā: Respect but much less than between father/son (extreme when son-in-law is *binna*-married). $G^{+/-1}$. Divisions (♂ and ♀) apply to ego's and spouse's parents in Tamil. The reciprocal ♂Māmā / ♀leli *classificatory* category for Pul Eliya contains distant consanguineal marriages that are properly viri-sided.
6 Loku appā or bāppa / putā: Respect relationship rather lacking in feeling on both sides. $G^{+/-1}$. Divisions (♂ and ♀) apply to ego's and spouse's parents' siblings in Tamil.
7 Appā / putā: Extreme respect tending to avoidance. $G^{+/-2}$. Divisions (♂ and ♀) apply to ego's and spouse's parents' siblings in Tamil.
8 The opposite-sex reciprocal of FZ (X cross) is ♂BS=puta (//=parallel) hence unmarriageable, unlike MB. No term for HM is attested by Trautmann, who uses seven different sources, including Leach (1961:126), which allows G^{+1} consanguineal correctly-sided marriages to be contracted without a conflict in egocentric kin terms.
9 Massinā / massinā: Familiarity tending to joking relation. G^0. Divisions (♂ and ♀) apply to ego's and spouse's cross-cousins in Tamil.
10 Ayiyā / malli: Marked respect, formality. G^0. Divisions (♂ and ♀) apply to ego's and spouse's siblings and parallel-cousins in Tamil.
11 There is no determination of the position of wife. Nänā≠wife. In Dravidian generally, wife="woman", as in: Baiga (dauki=wife, woman), Vedda (gani= wife, woman), Kondh (ayal= wife, woman). In Nakarattar, a merchant banking class we find descriptive term wife=pentir. There are many colloquial terms and ways of referring to wife, however, for example the Sinhala terms mahattaya ("husband") and nona ("wife"). These are actually status terms such as (doctor sir/lady) conveying the sense of not only husband and wife, but also master and mistress. G^0.
12 Question marks for G^{-1} are imputed by consistency with other Dravidian systems (Trautmann 1981:40, 103, 121, 134, 135, 138, 141, 144).
13 It is the ♂eZD that is eligible for marriage with ♀MyB in Tamil and Karnataka but not in Sinhala/Pul Eliya.

rule assertion for Dravidian, brushes away all ZD marriages in Dravidian societies as if they were Brahmin exceptions or as if ZD marriage was an anticipation of a FZD marriage. Marriageable categories are shown in heavy outline in Figure 3. Unlike Kariera, with four $G^{+/-2}$ distinctions reflecting viri-sided and uxori-sided section systems, there are only two $G^{+/-2}$ distinctions that do not neutralize the existence of viri-sidedness in the sociocentric structure of viri-sided marriages in the consanguineal network but do neutralize the possibility of $G^{+/-2}$ marriages. The e/y (o/y) relative age distinctions for same sex siblings, typical of classificatory kinship, are present and are extended to the parental generation.[14]

Trautmann's (1981) characterization of Dravidian terminologies as accompanied by a "same generation" marriage rule and a "classificatory cross-cousin" marriage rule is very likely incorrect. It would follow that the Tjon Sie Fat and Trautmann (1998) formal analysis of Dravidian terminologies is also wrong as it follows the "same generation" marriage rule and "classificatory cross-cousin" marriage rule assumptions of Trautmann (1981). In turn, the Barbosa de Alameida (2010) formalization of Tjon Sie Fat and Trautmann's (1998) Dravidian semantic logic is wrong. White (2010) addresses these issues and offers repairs. These repairs are needed for the viewpoints on Dravidian terminologies made by Godelier, Trautmann and Tjon Sie Fat (1998) in their edited book.

Conclusions

The intent of this ethnological survey, and of the mathematical theorems that help explain some deep anthropological issues as to egocentric terminology and sociocentric network structure, is to convince anthropologists and historians of the evolution of kinship systems that proofs of convergence between different concepts that have common logical and empirical foundation are useful in understanding cultural phenomena, including the links between kinship terminologies, decision rules, marriage behavior, and culturally shared linguistic and cognitive processes.

Theorem 1 is a proof of something long denied in the social and historical anthropology of South India, and applying equally elsewhere: the egocentric sidedness of classificatory Dravidian kinship terminologies, when put into consistent practice among consanguineally related kin, is strictly equivalent to sociocentric sidedness whereby connected consanguineal marriage networks (which form the core of many Dravidian communities) divide into an empirical "two line" system, with male lines between which females marry, i.e., between sides.
Houseman and White (1998a) define this type of "two line" system as viri-sided, and distinguish it from uxori-sided "two line" systems. No genuine case of uxori-sided "two line" kinship systems have yet been discovered, although there do exist many cases of named matrimonial moieties in which moiety membership is transmitted matrilineally. The Dravidian viri-sides are typically unnamed, and are not associated with patrilineages but rather with cognatic descent. In the case of Pul Eliya, females may inherit what is normally agnatic property (compounds and irrigation rights) when brothers are lacking.

Houseman and White (1998a) and White (1999) show that the viri-sidedness of connected consanguineal marriage network or CCMN (with "consanguineal endogamy") in Pul Eliyan is 100%

[14] The question marks (?) before kin terms at G^{-1} could be removed if we rely on consistent patterns from other Dravidian terminologies as to distinctions among these terms.

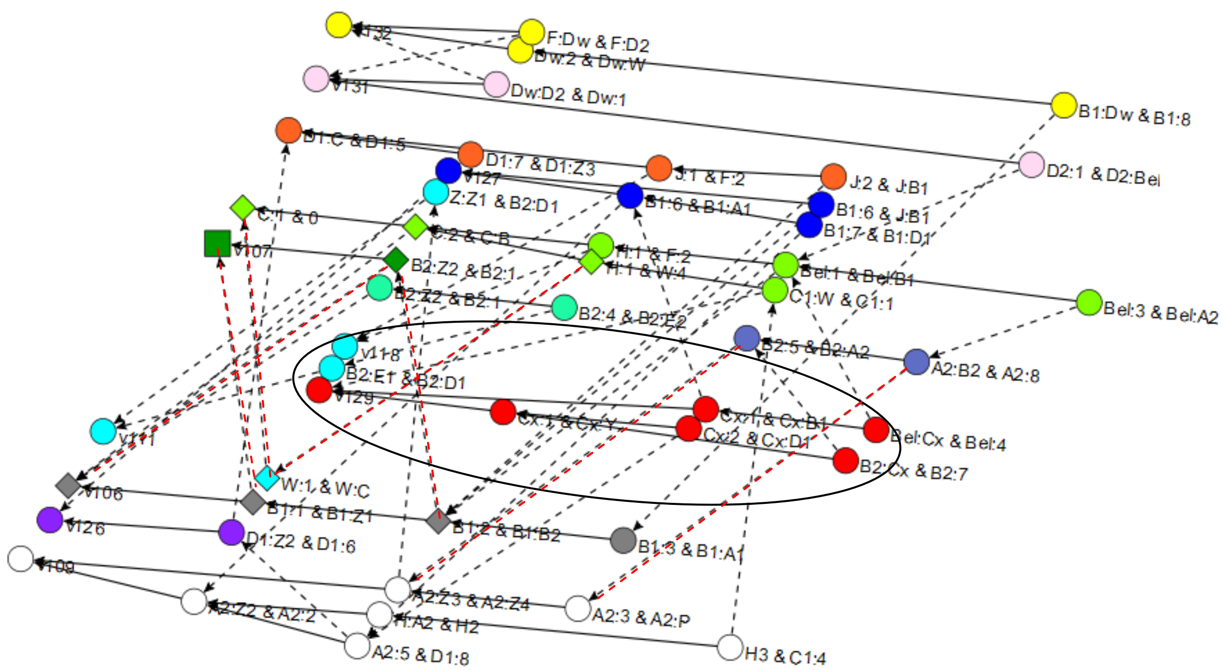
consistent with Leach's (1961) marriage data. Outside of the Pul Eliyan core of marriages between descendants of common ancestors, as shown in Figure 4, viri-sidedness is commonly violated. Most of these violations are for marriages with outsiders or members of specialized occupational castes joining the community. The female inheritors of agnatic lands, however, whose marriages could violate the connection between agnatic landholding groups that are consistently "sided" across generations, commonly adopt the sidedness of their missing brothers and avoid making "wrong marriages" by marrying men from distant villages whose "sidedness" with respect to Pul Eliya need not be recognized. These marriages are among those that Leach noted were uxorilocal-residence "binna" marriages (sisters retaining the agnatic compound) as opposed to the "diga" virilocal-residence marriages normally practiced by sons of compound-owning families. Considerations of cognatic inheritance makes it evident why the "sides" of Pul Eliyan kinship were neither formally named nor inherited patrilineally as named moieties.

The theorems proven here about sidedness in connected consanguineal marriage networks (consanguineally endogamous CCMN) by no means imply that larger marriages networks with egocentric sidedness consistent with Dravidian terminology will be sociocentrically sided. Figure 4 shows an example of how the theorems apply for the case of Pul Eliya (Houseman and White 1998b). In this figure male lines connect identically colored marriage nodes that are identified with Leach's (1961: flyleaf genealogy) compound number identifiers for husband & wife in each marriage. At the lower right, for example, couple H3&C1:4 refers to a Compound H:3 grandson of H:1 married a Compound C1 great-granddaughter. Dotted arrows link daughters in a lower generation marriage to her parents; solid lines do so for sons to their parents in a higher generation. Parallel red lines emphasize two MBD marriages. Triangular red lines emphasize two FZD marriages. These marriages form a consistently two-sided sociocentric pattern consistent with Theorem 1. The solid oval encloses a set of marriages that are not consistently sided but they do not form a connected consanguineal marriage network (consanguineally endogamous CCMN) and are not expected, by Theorem 1, to be sociocentrically sided. The non-sided male line that is colored red, for example, has ancestor v129 from an unknown outside village. A number of wrong-sided marriages are discussed by Leach but not are part of the CCMN.

The Pul Eliyan ethnography of Leach (1961) was the basis for a successful critique and deconstruction of the fundamental concepts of the Descent Group theory of British Social Anthropology (Dumont 1971) but the implications of Leach's work were never fully understood until network analysis of actual genealogical and marriage data was implemented by White and Jorion (1992) and Houseman and White (1998a, 1998b). This approach is now widely understood[15] but has lacked the formal mathematical proofs supplied here for South Asian Dravidian and that also apply to Dravidianate kinship systems elsewhere. There remains a need for social anthropologists to recognize the existence of moiety-like marriage structures that are unnamed, distinct from descent groups, even if they are only partially implemented within a community.

[15] See http://kinsource.net/kinsrc/bin/view/KinSources/, where scores of genealogical datasets prepared for purposes of network analysis have been posted.

Figure 4. The p-graph of the Pul Eliya genealogy shows three MBD marriages (red and double black parallograms) and one FZD marriage (a two–generation same-side male line in black, and a two–generation between-side female line in red). $G^{+/-1}$ marriages are not shown. Generations slope to upper right and male descent slopes to bottom right. The center oval shows immigrant families whose marriages mostly violate sidedness. Consanguineal marriages occur in both early and later generations.



The more full Pul Eliya 2nd version data with off-generation marriages is available at Kinsources: http://kinsource.net/kinsrc/bin/view/KinSources/PulEliya2ndversion.

Theorems 2-4 are proofs of concepts long discussed by anthropologists but brought to the fore by Dumont (1983), who provides a series of essays on Dravidian kinship systems and comparisons with Kariera and other Australian systems of kinship. Kariera is often called a two-line system, referring to male lines or "sides," in contrast to three line (Ambrym), four line (Aranda), and eight line systems (an Aranda variant, or hypothetical Murngin). The common "two line" feature of Dravidian and Kariera has been the basis for some theorists to claim an identity between them. This is disputed by Dumont (1983:200), who sees Kariera section system as clearly "built on two complementary oppositions operating crosswise: (1) between two kinds of local groups, ideally affines to each other [the "two sides" of male lines]; and (2) between two kinds of generations which bisect each local group and which, as particularized in each kind of local group, are linked one to one by intermarriage" (i.e., intermarriage between local groups within generations). His logic, as opposed to other hypotheses, is that "More probably, these characteristics [generational moieties, widespread in Australia] are aspects of a universal tendency to group together alternating generations, a tendency which would have found its perfect development in Australia."

Theorems 2-4 offer a simpler explanation, one which again applies only to the case of connected consanguineal marriage networks (consanguineally endogamous CCMN). Theorem 2 shows that in the case of CCM networks, the intersection of viri-sided (***V***) and uxori-sided (***U***) networks entails ***S***, same generation marriages, hence alternate-generation moieties. Theorem 3 identifies Trautmann's (1981) error of assuming that Dravidian terminological systems are consistent, at least in a historically reconstructed proto-Dravidian, with same-generation marriage. The theorem shows that if ***S*** is true and ***V*** is true sociocentrically (which Theorem 1 shows is true in CCM networks that have egocentrically viri-sided terminology), then ***U*** is also true, so that Trautmann's disputed hypothesis about Dravidian (as having same-generation marriage) would consist of an intersection of ***V*** viri-sides and ***U*** uxori-sides, along with alternating generations.

Trautmann's controversial schema for Dravidian, then, would entail a section system, one that is structurally equivalent to the Kariera system, with the difference that the four types of grandparent terms that are present in Kariera kin terms are latent in Dravidian. There is ample evidence that Dravidian systems are viri-sided and not uxori-sided, which makes them distinct in three ways from Kariera: (1) kinship terminology, e.g., Dravidian with two grandparent/grandchild terms, Kariera with four, (2) actual marriages, both allowing classificatory cross-cousin marriages, but Dravidian allowing $G^{+/-1}$ marriages, and (3) marriageability decision rules, which prescribe classificatory cross-cousins only for Kariera, but for Dravidian viri-sided marriage in both G^0 and $G^{+/-1}$ marriages.

Finally, these results presented here push well beyond Dumont's notions of sociocentric structure to actual sociocentric network divisions, but demolish many of Dumont's (1983) specific conjectures.

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