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Source: *Language*, Sep., 1990, Vol. 66, No. 3 (Sep., 1990), pp. 475-521

Published by: Linguistic Society of America

Stable URL: <https://www.jstor.org/stable/414609>

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# LINGUISTIC DIVERSITY AND THE FIRST SETTLEMENT OF THE NEW WORLD

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The oft-noted genetic and typological diversity of the languages of the New World is due not to accidents of history but to the operation of regular principles of linguistic geography. Four building blocks of a theory of linguistic diversity are presented here: a classification and measures of diversity, an account of the causes of diversity, measures of rates of differentiation, and means of estimating the age of a linguistic population. On the most conservative archeological view, the New World was first colonized some 12,000 years ago; on the received view, up to 20,000 years ago. But no high-latitude area like Siberia, Beringia, Alaska, or northern Canada could have contributed or transmitted the linguistic diversity to seed the New World in these time frames, and no single dispersing family could have given rise to the attested diversity in these time frames. The unmistakable testimony of the linguistic evidence is that the New World has been inhabited nearly as long as Australia or New Guinea, perhaps some 35,000 years. Genetic unity for 'Amerind' is incompatible with the chronology demanded by the linguistic facts.\*

## INTRODUCTION

1. Austerlitz (1980), in a strikingly original paper, points out the substantial difference in the number of language families in the New World and the Old World, proposes a metric for this diversity, and offers historical explanations: the New World lacks an extended history of empires, and the New World drew its linguistic stocks from the Old World, reducing the latter's genetic variety. The present paper extends Austerlitz's survey to additional continents and concludes that the discrepancy between the Old and New Worlds is an instance of a regular pattern and is due less to the history of the New World than to its geography. A more general conclusion is that the genetic picture for the New World languages cannot be explained internally; explaining it, or for that matter even describing it, requires reference to Siberia and the dynamic of linguistic spreads in central and northeastern Eurasia.

Greenberg (1987, especially 333–4) proposes the following scenario for the colonization of the Americas: Proto-Amerind was the language of the first colonizers of the Americas and is associated with the Paleo-Indian (Clovis) culture of about 12,000 years ago. The next language to enter was Proto-Na-Dene, associated with the Paleo-Arctic or Beringian Culture of 7000–10,000 years ago and subsequently displaced to the south by Eskimo-Aleut. Proto-Eskimo-Aleut

\* Much of the research for this paper was done while I was a Visiting Fellow in the Department of Linguistics (Faculties), Australian National University, in 1989. I am grateful to the Department and the University for hospitality and research facilities. This paper is a companion piece to Nichols 1992, and the two were jointly presented at the Conference on Language and Prehistory (Boulder, Colorado, March 1990). I thank Ives Goddard, Bill Jacobsen, Terry Kaufman, Alan Timberlake, and an anonymous reviewer for comments on an earlier version; Boulder discussants Jared Diamond, Tom Dillehay, and David Meltzer for remarks on the presented version; and Boulder organizer Allan Taylor. My thanks should not be taken to imply that any of these people subscribe fully to my views.

is associated with the Anangula Culture of the eastern Aleutian Islands, some 8500–10,000 years old, and entered the New World later than Na-Dene.

The genetic unity of Amerind is contested by the majority of historical Americanist specialists (see Campbell 1988), but the other aspects of this scenario—a first wave of colonizers reflected relatively soon after entry in the Clovis culture, a first entry not substantially earlier than 12,000 years ago, and subsequent entries by Na-Dene and then Eskimo—are consistent with what has long been the received academic view on the colonization of the New World (see e.g. Sapir [1916]1949:454–5; for a recent archeological overview see Meltzer 1989). On this view, several or many unrelated languages would have entered the New World beginning not greatly over 12,000 years ago. Henceforth I will speak of this date of somewhat over 12,000 years ago as the CLOVIS CHRONOLOGY for entry into the New World. A chronology based on dates of over 17,000 years ago for the Meadowcroft site in Pennsylvania (Adovasio et al. 1990) seems to be gaining ascendance among archeologists, and I will refer to dates of up to 20,000 years ago as the RECEIVED CHRONOLOGY. The route of entry was from northeastern Siberia to northwestern Alaska via what was variously Beringia (crossed on foot) and the Bering strait (crossed by boat). Thus northeastern Siberia, or more generally northeastern Eurasia, provided the seedstock for the languages of the New World. The subsequent differentiation of this seedstock has given rise to the unusually high degree of diversity, both genetic and typological, for languages in the New World.

The diversity bears on the age of settlement, as first pointed out by Sapir (1949) and followed up recently by Goddard & Campbell (1990). The purpose of this paper is to estimate a rough age for the language stocks of the New World taken as a collective (but not, or not necessarily, as an ultimate genetic unity), based on known rates of differentiation and on the expected and attested range of linguistic diversity in the source area, northeastern Siberia. Although we do not have, and can never expect to have, a precise constant for calculating a universal rate of linguistic differentiation, ballpark figures can be given for certain kinds of environmental and cultural conditions. We cannot reckon the exact time of first colonization of the Americas from the present range of diversity, but we can determine whether or not the received view is in the right ballpark. And, as will be shown below, both the Clovis and the received chronology for American settlement are in the wrong ballpark, given what can be determined about rates of diversification and migration in high-latitude areas like northeastern Siberia. Underlying this reference to right and wrong ballparks is the fundamental tenet of science known as UNIFORMITARIANISM—the assumption that, although conditions may vary over time, principles do not. Unless we can demonstrate very different input conditions, we have no business assuming a tenfold discrepancy in the rate of linguistic differentiation between presently attested language stocks and those that must have existed in the same region in the past. But just such a discrepancy—one of at least an order of magnitude—must be assumed if we adhere to the Clovis or the received chronology for the settlement of the New World.

The following geographical terminology will be used here. The OLD WORLD

refers to the continents of original hominid habitation: Africa and Eurasia. The PACIFIC is Australia, New Guinea, and insular Polynesia, Micronesia, and Melanesia; the nearer islands of Malaysia and the Philippines are transitional between the Old World and the Pacific, and their status will be left ambiguous here (it is never crucial). The NEW WORLD is the Americas. I will speak of the New World and the Pacific generically as COLONIZED AREAS, since they were settled later than the Old World (though still quite early) and from it. Most tables and appendices below present areas in their chronological order of human settlement: Old World, Pacific, New World.

#### MEASURES OF DIFFERENTIATION

2. I will use DIFFERENTIATION as a generic term for the following three different kinds of linguistic variety.

2.1. DENSITY OF LINEAGES. This term refers to the total number of different genetic lineages of some uniform age found in an area. In what follows, two different age levels will be used for counting the numbers of lineages in areas. The deepest level is the STOCK, the oldest grouping reachable by application of the standard comparative method (this definition is taken from Austerlitz 1980, who does not use the term 'stock'). Examples of stocks are Indo-European, Uralic, Niger-Congo, Algonquian-Ritwan, Uto-Aztecan, and Austro-nesian; most of these are in the vicinity of 6000 years old since their own internal breakups. A stock displays regular phonological correspondences, although they are not always transparent and the relatedness of members of the stock may not be evident to the nonspecialist. Less deep than the stock is its first-order split, the FAMILY, a grouping of roughly the depth of one of the major branches of Indo-European (e.g. Germanic, Celtic, or Balto-Slavic). Families usually range from 2000 to 4000 years in age since their own (internal) breakups, and from 4000 to 6000 since the split from the parent stock. In linguistic terms, the family can be defined as the depth within which regular sound correspondences and cognates are numerous and genetic relatedness is clear, even self-evident, once the comparative data has been presented.

It matters little what level is used for measurement, as long as the level chosen is reasonably well-defined and the count is consistent. Insofar as possible, stocks will be counted here. I use the term LINEAGE as a generic term for stocks, families, isolates, and other genetic groupings, and also as a cover term where it is not clear whether a grouping represents a stock or a family. No standard term will be used here for groups above the level of the stock; I will distinguish them from stocks and families by putting their names in quotes: 'Altaic', 'Hokan', 'Nostratic', 'Amerind'.<sup>1</sup> (The distinctions between family, stock, and higher group are, of course, only conceptually clear; their actual application

<sup>1</sup> Greenberg (1987) makes clear that he believes such groupings cannot be reached by the standard comparative method; a wholly different method, MASS COMPARISON, is required. Thus not only the distinction between (what I call) stocks and the higher groupings but also the definition of the stock as the highest grouping reachable by the comparative method would seem to meet with the consensus of both Greenberg's lumping approach and the splitting approaches he argues against.

can be problematic, and I claim no more than approximate accuracy for calculations based on them.)

Density of lineages is the ratio of lineages to area within a continent or similar well-defined region. Table 1 shows the lineage density of several continents and subcontinental areas. Here and in subsequent tables, the continents and New Guinea are listed first, then a set of subcontinents, including the areas of high lineage density and also Siberia. California stands for the west coast of the U.S. (California, Siberia, and the U.S. west coast are parts of the continents listed in the first set of areas.) Both stocks and families are shown where the difference is ascertainable. For stocks I give first a low figure and then a high one, the higher one more conservative and the lower one reflecting deeper groupings proposed by comparativists. For instance, for North America the low figure assumes that Hokan and an extended Penutian (California Penutian, Klamath-Modoc, Nez Perce-Sahaptin) are genetic stocks; the high figure does not. (Stocks and families are listed by area in the Appendix, as are the groupings of stocks used for the lower figures.)<sup>2</sup>

The lineage density is the ratio of stocks or families to millions of square miles (the same kind of measure as used in Austerlitz 1980, except that Austerlitz uses square kilometers rather than miles). Also shown in Table 1 is the number of millennia since initial settlement by humans (or, in the case of Africa and the Near East, the number of millennia since the first fully modern human remains). The family-to-stock ratio for the areas for which we have both figures is given in ex. 1. The lower ratio uses the higher number of stocks and is thus more conservative.

(1) Africa	1.8–5.0	Siberia	1.2–1.4
Northern Eurasia	1.5–1.6	Europe	3.0
New Guinea	2.2	U.S. west coast	1.4–2.1
North America	1.3–1.7		

There is too much discrepancy to calculate an average and use it to fill in the missing figures in Table 1. Two points of interest can be noted in ex. 1, however. First, where there are two figures, the low (conservative) ratio is under 2 everywhere except in Europe, consistent with what is mentioned in the next section and in §3.2. Second, except for New Guinea (where the genetic picture is far from clear and the numbers of stocks and families come from different sources, so their ratio may not be meaningful), the higher the lineage density (i.e. the higher the stock/area or family/area ratio), the lower the family/stock ratio. This holds both between continents and (much more subtly) within them. This

<sup>2</sup> The sample of languages and some of the crosslinguistic data are taken from a larger project which samples the world's lineages at the level of the family and compares two dozen grammatical features from these languages. The total number of languages in the sample is 137, of which approximately equal numbers come from the Old World (45 languages), Pacific (41), and New World (51). For most areas the number of languages in the sample is less than the number of families in the area because not all families have published descriptions. Since, due to uneven coverage, South America could not be fully sampled at the controlled time depth used in the project, world coverage was roughly equalized by omitting South and Southeast Asia from the Old World and Eastern New Guinea from the Pacific. For some of the counts to be given here a specially done partial and very thin survey of South America is included, but South America is not in the basic sample.

AREA	STOCKS		FAMILIES	MILLION	RATIO	RATIO	KYR.
	LO	HI		SQ. MI.	(STOCKS)	(FAMILIES)	SETTLED
CONTINENTS:							
Africa	5	14	25	11.5	0.4–1.2	2.2	>100
Northern Eurasia*	14	15	26	10.2	1.4–1.5	2.5	40
Australia		c. 20		2.9	6.9		40
New Guinea**	27		>60	0.3	90	200	50
North America	42	51	69	7.4	5.5–6.9	9.3	?
South America***	>80	>90	115	6.9	12–13	16.7	?
SUBCONTINENTS:							
Ancient Near East		>6		0.5	12		90
Europe		3	9	3.7	0.8	2.4	40
Siberia	7	8	10	5.0	1.4–1.6	20	40
Northern Australia		≈20		0.3	67		40
U.S. west coast	18	29	41	0.2	90–145	200	?
Mesoamerica****		14		0.5	28		?

TABLE 1. Density of lineages. Subcontinents other than the ancient Near East and Mesoamerica also figure in the totals for their respective continents.

\* = USSR plus Europe.

\*\* Number of families taken from Foley (1986:3), where they are called families. Number of stocks taken from Wurm (1982:18–19; they are his phyla and superstocks). (Wurm lists 91 of what he calls stocks.)

\*\*\* Number of families and stocks from Suárez 1987 (low), Kaufman 1990 (high).

\*\*\*\* Number of stocks taken from Suárez (1983:xvi–xvii).

Sources for settlement dates: Tuttle 1988 (Africa, Near East), White & O'Connell 1982 (Australia, New Guinea), Abramova 1984 (Siberia; figure for interior).

tendency could be partly artifactual, the result of differing comparative-historical traditions with different attitudes toward lumping and splitting. But it is likely that at least some of the discrepancy is due to real differences in the next parameter, lineage elaboration.

**2.2. ELABORATION OF LINEAGES.** This term refers to the number of branches at a node of differentiation in a family tree, and here it refers specifically to the number of family-level branches in a stock. For instance, Indo-European has nine surviving family-level branches (Balto-Slavic, Germanic, Celtic, Italic, Albanian, Hellenic, Armenian, Indic, Iranian; Indic and Iranian are separated here on the assumption that the unity of Indo-Iranian would probably not be evident from the modern data alone). Afroasiatic has five surviving families (Semitic, Cushitic, Chadic, Omotic, Berber); Uralic has two (Finno-Ugric and Samoyedic); Basque has one; Burushaski, a radical isolate, is the sole survivor of a stock. Elaboration of lineages for the stocks of northern Eurasia and North America is shown in Table 2.<sup>3</sup> The commonest degree of elaboration is two or

<sup>3</sup> Here and below, the following standard statistical terms are used: MEAN = average; MODE = majority or plurality, i.e. most frequent member.

The survey is limited to these two continents because for other areas the genetic connections are not worked out sufficiently well to allow a survey of all the stocks. Africa is better understood, but the lineages standardly assumed for Africa seem to be older than the stock as described here.

	BRANCHES IN FIRST SPLIT	SURVIVING FAMILIES	SURVIVORS AS % OF INITIAL BRANCHES
STOCK			
Indo-European	ca. 15	8–10	
Uto-Aztecan	2–3	6–8	
California Penutian	4–5	5	
Northeast Caucasian	2	5	
Kartvelian	2	3	
Algonquian-Ritwan	2–3	2–3	
Na-Dene (including Haida)	2	3–4	
Turkic	2	2–5	
Uralic	2	3	
Salishan	2	2–4	
Wakashan	2	2	
Eskimo-Aleut	2	2	
Tungusic	2?	2?	
Achomawi-Atsugewi	2	1–2	
Stock-level families (28; 19 N. Am.)	2–3	1	
Isolates (23; 19 N. Am.)	1	1	
Mean	2.1	1.6	76%
Mode	2–3	1	
Mean, excluding isolates	2.8	2.0	71%
Mode, excluding isolates	2–3	2	
Mean, excluding Indo-European	1.9	1.5	79%
Mean, North America only	1.9	1.4	74%

TABLE 2. Elaboration of lineages.

Number of branches per stock in Northern Eurasia and North America. (For a listing of families, see the Appendix.) STOCK-LEVEL FAMILIES are small families such as Pomoan, Iroquoian, and Siouan, which fall into branches that seem to be of a lower level than what is defined as the family here. ISOLATES include true isolates as well as Basque, Ket, and Yukagir, which are sole survivors of what were stock-level families as recently as the last century. N. AM. = North America. Languages are listed in decreasing order of numbers of families. In calculating the mean the average is used for entries like '4–5'.

three branches, a situation reflected in most of the daughter branches of Indo-European. The Indo-European and Afroasiatic radial divergences are highly unusual, a fact which will be important below.

**2.3. TYPOLOGICAL DIVERSITY.** This term refers to the number of different types or typologically relevant features found in a group of languages, and also to the evenness or unevenness of their distribution. The typological features that will be used to measure diversity here are features which have been shown to be relatively stable and conservative in language groups: head/dependent marking and clause alignment. Head/dependent marking is described in Nichols 1986. Here a language is classified as head-marking if the ratio of head-marking to dependent-marking morphology is 2:1 or greater; as dependent-marking if it is 1:2 or less; and as double- or split-marking if the ratio is more even. Clause alignment is accusative, ergative, or stative-active; other types were not counted. Table 3 shows the following measures of diversity in head/dependent



	FREQUENCY OF TYPES:			TOTAL NO. LANGUAGES	MODE AS %
	HEAD- MARKING	2/SPLIT	DEPENDENT- MARKING		
CONTINENTS:					
Africa	3	4	9	16	56%
Northern Eurasia	3	6	15	24	63%
New Guinea	8	3	4	15	53%
Australia	2	10	7	19	53%
North America	27	8	9	44	61%
South America**	11	3	0	14	79%
SUBCONTINENTS:					
Ancient Near East	0	3	2	5	60%
Caucasus*	1	0	3	4	75%
Siberia*	2	4	3	9	44%
Northern Australia*	2	7	1	10	70%
California*	6	4	5	15	40%
Mesoamerica	6	1	0	7	86%

TABLE 3. Typological diversity: head/dependent-marking. Number of languages of each type in the sample for each area.

\* Subcontinental areas which also figure in the totals for their continents, above.

\*\* Very thinly sampled.

marking (for the same set of areas surveyed in Table 1; see again n. 2): the frequency of each marking type (head-marking, double- and/or split-marking, dependent-marking); the modal type; and the percentage of languages conforming to the modal type. Table 4 shows the same measures for alignment.

	FREQUENCY:			MODE
	ACC.	ERG.	ST.-ACT.	AS %
CONTINENTS:				
Africa	13	0	0	100%
Northern Eurasia	15	6	2	65%
Australia	8	8	1	47%
New Guinea	12	2	1	80%
North America	25	4	12	57%
South America**	6	1	4	55%
SUBCONTINENTS:				
Ancient Near East	2	2	1	40%
Caucasus*	1	2	1	50%
Siberia*	7	1	1	78%
Northern Australia*	6	1	1	75%
California*	13	0	2	87%
Mesoamerica	3	1	1	60%

TABLE 4. Typological diversity: clause alignment.

\* Subcontinental areas which also figure in the totals for their continents, above.

\*\* Very thinly sampled.

Table 3 reveals some similarities in frequencies of types between the New World and the Pacific, but these simple similarities are not at issue here (they are discussed in Nichols 1992); what is relevant here is diversity of types in



areas. Diversity is measured by the strength of the modal type: the lower the percentage represented by the modal type, the higher the diversity in an area. The greatest diversity is found in two subcontinental areas, Siberia and California, in both of which the languages with the modal head/dependent type number under 50% of the total. The lowest figures for diversity also come from subcontinental regions (the Caucasus and Mesoamerica), presumably reflecting homogeneity due to areal diffusion. Continent-sized areas have very similar degrees of diversity. The only exception to the last two statements is South America, sizable but not particularly diverse; but for this area my sample is so thin that it may not accurately reflect the real diversity.

In the distribution of alignment (Table 4), universal tendencies are strongly visible: the accusative is by far the favored alignment everywhere except in the ancient Near East, the Caucasus, and Australia (and specifically only in southern and central Australia; the northern part has standard frequencies). Diversity in regard to alignment then simply means higher frequency of non-accusative alignments. The areas which showed the highest levels of diversity in Table 3 are relatively low in diversity here: California, Siberia, Australia, and New Guinea. The implication is that in areas of high lineage density and typological diversity, the accusative alignment is favored even more strongly than usual.

Table 5 lumps some of the information from Table 4 by larger areas. The Old World has lower average diversity (higher percentage in modal type) than either colonized area. The New World has the highest diversity (lowest percentage in modal type), as well as the highest consistency in achieving this diversity level, of any part of the world. Diversity means a higher frequency for the ergative alignment in the Old World and the Pacific, but a higher frequency for the stative-active type in the New World. A comparison with Table 4 will show that California and Siberia resemble their host continents and not each other, and are both low in diversity. Thus there is a deep gap in typological profile and internal diversity between the New World and the Old World.

Another example of typological diversity comes from frequencies of inclu-

AREA	MODAL ALIGNMENT	SECOND MOST FREQUENT	MODE AS %
Old World:			
Africa	Acc	—	100%
N. Eurasia	Acc	Erg	65%
mean			83%
Pacific:			
New Guinea	Acc	Erg	80%
Australia	—	Acc = Erg	47%
mean			64%
New World:			
North America	Acc	Stat-Act	57%
South America*	Acc	Stat-Act	55%
mean			56%

TABLE 5. Alignments in continents of the Old World and colonized areas.

\* Very thinly sampled.

AREA	% FAMILIES WITH INCLUSIVE/EXCLUSIVE	DEVIATION FROM 50%
Africa	14%	36
Near East	20%	30
Europe	10%	40
Siberia	21%	29
Old World mean	16%	34
New Guinea*	13%	37
Australia	89%	39
Micronesia and Melanesia	71%	21
Pacific mean	58%	32
North America	36%	14
Mesoamerica	43%	7
South America*	71%	21
New World mean	50%	14

TABLE 6. Frequency of inclusive/exclusive oppositions.

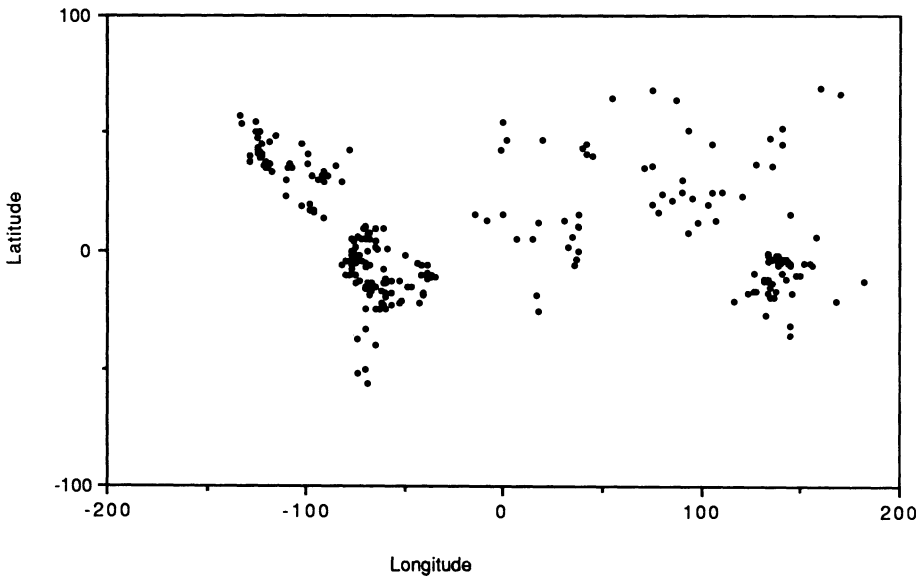
\* Areas incompletely surveyed

sive/exclusive oppositions in first-person pronouns. Table 6 shows the percentage of sample languages having inclusive/exclusive oppositions in each continent. Percentages close to 0 or 100 show high consistency, since the languages in such an area either uniformly lack or uniformly have inclusive/exclusive oppositions; percentages close to 50 show low consistency, i.e. high diversity, since the languages are strongly divided. (For convenience, the last column of Table 6 gives the distance from 50%. A higher number in this column means less diversity.) The figures of 10% for Europe and 89% for Australia show very high consistency in pronoun categories, while the Mesoamerica figure of 43% shows great diversity. The New World figures, individually and collectively, show the greatest diversity of all, and can therefore be taken to indicate either less genetic interconnectedness or deeper connections and longer differentiation than among the stocks of any other area.

#### CAUSES OF DIFFERENTIATION

**3.1. DENSITY OF LINEAGES.** Density of lineages is not evenly distributed over the globe, as linguists have long been aware. Map 1 gives a schematic diagram of lineage density. It was created by plotting latitude and longitude, which were determined by eyeballing maps to spot the approximate center of the range of each language, on a roughly square grid, and it is therefore highly approximate as well as clumsy in its projection. There is one plot point per family of languages. For languages in the sample (see again n. 2), the location of the individual sample language is plotted; for the nonsample areas of South America and Southeast Asia, the center of each family's range is plotted. Despite its cartographic drawbacks, this plot gives a graphic demonstration of the commonplace observation that density of lineages is high in such areas as the Pacific and Gulf coasts of North America, Mesoamerica, tropical South America, New Guinea, and northern Australia.

The distribution of lineage density is uneven, but it is regular. It is affected



MAP 1. Plot of language families.

by several geographic factors determining availability of resources, and by one economic factor having to do with distribution of resources. The following list brings together more or less commonplace observations, and is offered as an exhaustive listing of contributory factors which favor or disfavor high density of lineages. None of them is sufficient to trigger high lineage density, but there are two of them which may each be sufficient to preclude it.

**3.1.1. LATITUDE.** Other things being equal, density of lineages is substantially greater at low latitudes than at high latitudes. Compare the lineage densities of New Guinea and the U.S. Pacific coast: the two areas are of similar size and both, for reasons of topography and microclimates, offer rich and varied resources; but New Guinea, almost at the equator, has three times the density of the western coastal U.S., which is located above the tropics. Along the western North American coast, the density of lineages thins out considerably from California, Oregon, and southern Washington to northern Washington, Canada, and Alaska: the southern half of the area contains 23 stocks, while the northern half contains only six or seven (Eskimo, Na-Dene, Tsimshianic, Wakashan, Chimakuan, and Salishan; also Haida, if it is not included in Na-Dene). The lineage density of South America is approximately twice that of North America, and is concentrated in the tropical areas.

Very high latitude, perhaps  $55^\circ$  or more, may be sufficient to preclude high lineage density or to predict very low density. Mid to low latitude may be necessary for high lineage density to develop.

**3.1.2. COASTLINE.** Other things being equal, the coastal area of a continent will generally have substantially greater lineage density than the interior. Not every coastal area is high in lineage density, but the extensive areas of high

density are all on or near coastlines. Jacobsen 1989 shows that the western coastal strip of North America, a small fraction of the continent's total area, contains the great majority of its language stocks. In northern Eurasia, the Pacific coastal region contains representatives of the Tungusic family, which covers most of central and eastern Siberia, plus several lineages found only on the coast: Chukchi-Kamchatkan, Ainu, Gilyak, and Eskimo-Aleut. The northeast Eurasian situation, then, is similar to that of North America as described by Jacobsen. In northwestern Eurasia, the isolate Basque and the Celtic family of Indo-European survive only near the Atlantic coast, the Baltic family of Indo-European survives only on the Baltic coast, and the Germanic family originated there. In Australia, the vast interior of the continent is taken up by a single family, Pama-Nyungan, while the other families are clustered in the northwestern and southeastern areas on and near the coastline.

An explanation for the diversity found in coastal areas is straightforward. The ocean offers year-round rich sources of protein, ocean currents reduce climatic extremes, and the coast itself may offer harbors and other opportunities for trade connections. Thus seacoast offers the possibility of economic self-sufficiency for a small group occupying a small territory.<sup>4</sup>

**3.1.3. RAINFALL.** The discrepancy in the lineage density of coastline and interior is most pronounced where the interior is relatively dry, as in Australia and the western U.S. Where coastline is dry, density of lineages can be low even at relatively low latitudes, as in western Australia and western South America. Thus rainfall and/or availability of water in general may be a separate factor, although here it will often be lumped with the coast/interior distinction.

**3.1.4. MOUNTAINS.** The best-known example of the influence of mountainous terrain on lineage density is the Caucasus, where in a small territory we find some thirty languages from seven stocks—three of them found only in the Caucasus (Northwest Caucasian, Northeast Caucasian, Kartvelian or South Caucasian) and the other four also found elsewhere (Turkic, Mongolian, Indo-European [Iranian, Greek, Armenian; now also Slavic], Afroasiatic [Semitic]). Clustered in the mountains of Central Asia are representatives of all families found in the nearby lowlands, plus a subbranch of Indo-European (Dardic) largely limited to the mountains and the isolate Burushaski (Édel'man 1980).

The cause of high lineage density in mountain areas is generally attributed to the fact that mountainous geography naturally isolates populations, resists large-scale economic integration, and creates refuge zones.

**3.1.5. SCALE OF ECONOMY.** By this term is meant not so much the magnitude of production and/or extraction (although that too is relevant), but the natural territorial scope of the economy: a large-scale economy (e.g. one based on mounted nomadic stockbreeding, urban trade centers, or industrialization) inherently spreads out over a substantial territory. Scale of economy is obviously not a primitive, but has to do with such factors as population density, geog-

<sup>4</sup> Terrell (1986:159) notes that villages are small (from 50 to a few hundred individuals) and fairly autonomous in a high-diversity area of Melanesia.

raphy, mode of subsistence, political organization, and exchange. I use the notion here only as a black box, as a way of identifying rather than describing or explaining distributions due to economic and cultural factors.

Density of lineages is low in areas dominated by large-scale economies, higher in areas with smaller-scale economies. In western Eurasia, large-scale economic systems have long dominated large parts of the continent, and lineage density is very low. Reduction of lineage density in response to increased scale of economy is not immediate, as shown by the ancient Near East. At around 2000 B.C., several millennia after the rise of agriculture and two millennia after the rise of civilization, there was still high density of lineages in ancient Anatolia and Mesopotamia. The attested written languages alone give us a ratio of 12 stocks/million sq. mi., higher than the average for the New World; and if we assume, as we must, that there were additional unwritten languages in the area, we easily reach a density comparable to that of Mesoamerica or northern Australia.

Large-scale economies bring with them linguistic spreads, and the result in Eurasia has been the dramatic spread of Indo-European, the disappearance of almost every pre-Indo-European language, and consequent genetic homogeneity over much of the continent. In Africa, where agriculture and stockbreeding are also ancient, the lineage density is again low. New Guinea, where agriculture goes back some 9000 years and which may be the world's earliest center of plant domestication (Golson 1977, 1989), has relatively low lineage density in the agricultural highlands but the world's highest density in the coastal lowlands, where geography and climate disfavor agriculture and where endemic malaria favors small and discrete populations (Riley 1983).<sup>5</sup> In Central America and parts of North America, agriculture was widespread but large-scale economies were only beginning to develop in the Andes and Mesoamerica at the time of contact. Hence the lineage density of Central America is most comparable to that of the ancient Near East.

The reason for the connection between scale of economy and density of lineages is straightforward: as with the spread of Latin over western Europe, or the earlier spread of Indo-European over most of Europe, the spread of a large-scale economy is likely to bring about the spread of the language of its bearers. Scale of economy, at least when the scale is large enough, appears sufficient to preclude high lineage density.

**3.1.6. OLD WORLD VS. COLONIZED AREAS.** Table 1 showed that Africa and Eurasia have much lower lineage densities than the other areas; that is, the Old World has much lower lineage density than the Pacific or the New World. Furthermore, the New World and the Pacific have extensive regions of extremely high lineage density—northern Australia, all of New Guinea and insular Melanesia, the coastal western U.S., Mesoamerica. In the Old World comparable density is to be found only in the Caucasus, a much smaller area. In

<sup>5</sup> The New Guinea highlands agriculture is not grain-based, a fact which may account in part for its failure to spread widely; Rindos (1984:171) points out that grain-based agricultural systems are selected for dispersal.

the entire Old World there are no extensive coastal regions of high lineage density like those of the Pacific and the New World.

Austerlitz (1980) sees the difference in density of lineages between Eurasia and the New World as a problem to be explained, and he offers two explanations. Eurasia, but not the New World, has had a number of large empires, and consequent linguistic spreads, in its history; and the New World, colonized from Siberia, has drawn a number of stocks off of the Old World. The first explanation is obvious historical truth, and I suggest we raise its status to that of an explanatory principle: the colonizing center will necessarily have a larger average scale of economy, and hence lower lineage density, than a colonized area. In part this may be because the colonized area attracts refugees from the expanding economies (and/or their attendant expanding populations), but chiefly it is because the colonized area is peripheral to the centers of economic spread.

While islands often contain species not found on the mainland, colonization in biogeography is (as far as I know) never depicted as depleting the genetic pool of the mainland. In linguistics, the few examples we have of recent colonization of islands have not removed stocks from mainlands: the spread of Austronesian languages through Oceania has not resulted in the removal of the Austronesian stock from the near-mainland islands from which the family originally dispersed; the historical colonial languages English, Spanish, Portuguese, etc., remain in their Old World homelands while spreading to the New World and the Pacific; the back-migration of Siberian Eskimo to the Old World does not remove its stock from the New World. The available evidence suggests that it is most typical for movements into new territory to produce distributions like those of Eskimo-Aleut and Austronesian, where part of the group moves and part stays behind. Colonizations, in short, are probably more often spreads than emigrations.

Bougainville Island, northeast of New Guinea, presents evidence that higher lineage density per se, without depletion of the mainland, is typical of colonized areas. With at least two 'Papuan' (i.e. non-Austronesian) lineages and several representatives of the Austronesian stock on an area of 3,880 square miles, Bougainville has a lineage density of 750 (3 lineages/0.004 million sq. mi.). The density of lineages in New Guinea is 200 families/million sq. mi. or 90 stocks/million sq. mi. New Britain, midway between New Guinea and Bougainville, has a lineage density of 133 stocks/million sq. mi. (two stocks—Austronesian and one 'Papuan' stock—and 14,600 sq. mi.). Thus Bougainville has a substantially higher lineage density than its immediate or ultimate source; and, while the two 'Papuan' stocks of Bougainville apparently lack kin on either New Britain or New Guinea, emigration of those two stocks has obviously made no dent in the density of lineages in New Guinea or New Britain. Although more such examples are needed, I suggest that the Bougainville situation is typical of colonized areas—that, other things being equal, they will normally have higher lineage density than their source areas, and that even in cases (which must be frequent) where colonizing languages subsequently survive only in the colonized area and lack mainland kin, there is no consequent depletion



of lineages in the source area.<sup>6</sup> In fact, density of lineages is constantly renewed as languages split to generate new daughter lines. Thus it is unlikely that out-migration could deplete lineage density, which must have been fairly stable in all inhabited areas for all but the first stages of colonization (until the dawn of history and the rise of civilization, when lineage density began to drop).

Another example is the island of Sakhalin off the Pacific coast of Siberia. It contains three stocks, Tungusic (primarily a mainland stock), Gilyak (primarily an island stock, though also spoken on the mainland), and Ainu (entirely an island stock), and with 29,700 sq. mi. its lineage density is 101 stocks/million sq. mi. (cf. Siberia at 1.6).

Of course, none of the islands Sakhalin, Bougainville, and New Britain is large enough to absorb much of the lineage density of Siberia or New Guinea, while the vast uninhabited New World could in principle have absorbed a good deal of the Old World's lineage density. But there is no reason to assume that colonized areas act as wicks or sponges, drawing off entire lineages. (The rates of colonization to be established in §4 below make it quite unlikely that colonized areas could act as wicks.) They are better viewed as reservoirs or traps preserving lineages whose mainland lines have been lost. If the greater density of lineages in colonized areas is attributed to their peripheral location, then it would follow that high lineage density is a conservatism preserved only in colonized areas, rather than an innovation which arises only in colonized areas. Thus the high density of lineages in the coastal New World is probably not a recent development.

**3.1.7. DISCUSSION.** The geographical factors enumerated above—latitude, coastline, rainfall, mountains, and mainland vs. colonized areas—can probably be reduced to the cultural factor of economic scale. As described above, low latitudes, coastline, and mountains inherently favor small-scale economies for geographical reasons, and colonized areas will tend to show smaller economic scales than mainlands for combined historical and geographical reasons. Any further systematization and any explanation of the causes of differentiation must come from other disciplines; to linguistics they are either commonplace raw observations or black boxes.

When a language or family is distributed over an area favoring high density and one favoring low density, we can expect to see corresponding changes in

<sup>6</sup> This principle may be generalizable beyond linguistics: Terrell (1986:155–79) shows that the cultural and human genetic diversity of Bougainville are also remarkably high. However, certain hedges need to be made. First, the principle holds only for colonized areas whose size is sufficient to hold a number of stocks; we will never see high density of lineages, for instance, on a one-village Micronesian island. Second, some of the lineage density in Melanesia is due not to migration of 'Papuan' lineages from New Guinea but to colonization by Austronesian groups in the last few millennia. The Austronesian languages have made considerable inroads into the Melanesian islands, so it is reasonable to assume that they may have absorbed 'Papuan' lineages and hence made no net addition to lineage density (and in fact must have decreased it in most places, e.g. New Ireland, now entirely Austronesian-speaking except for one 'Papuan' enclave). Thus I assume that the present figures are representative of prehistory. (The large Melanesian islands, incidentally, from New Ireland to the Solomons, have been inhabited for 30,000 years or more, nearly as long as New Guinea itself [Allen 1989:151].)



the rate or geographical scale of differentiation. As mentioned above, Uralic, a high-latitude stock, has a low lineage density (measured in languages) throughout most of its spread, but the density rises sharply in the vicinity of the Baltic coast. Jacobsen 1989 presents a series of examples from North America showing that several stocks with ancient differentiation in the coastal area of high lineage density have interior branches with vast eastward spreads. In Australia, the Pama-Nyungan family is represented in the high-density area of the northwest, shows a good deal of internal differentiation in the vicinity of the coast, and then thins out in a vast spread of few subgroups through the interior desert. In northern Eurasia, the Tungusic family consists of a cluster of languages near the lower Amur and the Pacific coast, and a substantial spread of one language, Evenki, across much of Siberia. Thus a language spreading from a high-density area into a low-density area can be expected to undergo a form of thinning out which I will call *ELONGATION*, and a language spreading from a low-density region into a high-density one can be expected to undergo the reverse process, which I will call *COMPRESSION*. We can speak of the Tungusic family, for example, as compressed around the lower Amur and elongated in interior Siberia. The examples cited in this paragraph show that elongation and compression apply within linguistic groups, and the earlier parts of this section show that they apply between linguistic groups as well.

**3.2. ELABORATION OF LINEAGES.** As was shown in §2.2 and Table 2, elaboration of lineages appears to proceed at a fairly consistent rate: most branchings are binary, and the usual result of branchings over time is the survival of one to three families per stock; isolates and one-branch stocks are common, representing over half of the total lineages. Groupings with three or more branches are not uncommon, but for the most part they represent relatively recent splits at the family level or lower. For example, all nodes within the Uralic family tree split into two branches until about 1000 A.D., when West Finnic (Baltic Finnic) split into a number of closely-related languages (Finnish, Estonian, Livonian, Vepsian, Votic, etc.). This example suggests that more elaborate splits may be fairly common, but over time some consolidation and/or extinction takes place to reduce the survival rate. This is precisely what we see in the history of Indo-European, whose initial split created more branches than presently survive (the extinct branches include Anatolian, Phrygian, Venetic, and Tocharian).

There are two conspicuous counterexamples in my database, ancient groups with elaborate first-order branchings: Indo-European and Afroasiatic. (Nilo-Saharan may be another; although it is older than the typical stock and its subgrouping remains to be fully worked out.) These are groups whose breakup and spread were precipitated by the development of nomadic or seminomadic stockbreeding, which rapidly increased the scale of the economy. (The spread, at least in the case of Indo-European, involved not so much migration and displacement of previous populations but language switch on the part of previous populations.) An analogous, though low-level, elaborate split affected the West Finnic languages when they entered the Baltic coastal cultural sphere

and their speakers adopted agriculture. A group not surveyed here, the Eastern New Guinea Highlands stock, has six branches (for a diagram see Haiman 1980:xxx) and is located in an agricultural area.

We can therefore expect to find high elaboration of lineages only where the archeological or historical record indicates rapid expansion of economic scale, as with a cultural leap like the appearance of stockbreeding. Otherwise, the normal situation is a very modest degree of elaboration, and numerous isolates and one-branch stocks are part of the normal situation.

The foregoing has presented linguistic analogs to the biological notions of rate of speciation and rate of extinction. The typical rate of linguistic 'speciation'—elaboration of lineages—is two to three (see Table 2), and the typical rate of extinction of lineages depresses 'speciation' by about one quarter (in Table 2, for each row of means, the number of surviving branches is about 75% of the number of initial branches). Elaboration and extinction of lineages may therefore conveniently be regarded as applying at a roughly constant rate, so that within the time frame defined by the age of the average stock—some 5000–6000 years—stocks split into an average of less than two surviving daughter branches, with a typical range of one to three.

The one situation that departs from standard rate of elaboration is the case of spreads like that of Indo-European, where the elaboration of the spreading group is great and the extinction rate of languages in the vicinity is high (their speakers having switched to Indo-European). Tables 1 and 2 and accompanying discussion show the high elaboration of Indo-European and the low lineage density in its vicinity (see e.g. the figures for Europe in Table 1). Historical records attest the existence of several extinct languages (among them Pictish, Etruscan, and Iberian) whose speakers' descendants now speak Indo-European languages. The Indo-European-like situation is readily identifiable on linguistic grounds, and contributory factors such as stockbreeding are readily identifiable in the archeological record. These are situations where natural linguistic differentiation is overridden by cultural factors, and they are easily recognizable.

In §2.1 it was found that family-to-stock ratios differ from continent to continent (highest in Africa and Europe, lowest in North America) and that these ratios vary inversely with lineage density. Africa, where density of lineages is unusually low and the family-to-stock ratio is unusually high, has been affected over the great part of its territory by the development of large-scale economies at early dates, with the result that we have few but extremely widespread genetic lineages. (In addition, a substantial portion of the area of Africa is desert or grassland, and this may be sufficient to account for low lineage density in those areas.) The same can be said for Europe, where the lineage density is low and the family-to-stock ratio, dominated by elaborately branched Indo-European, is high.

The measure of elaboration of lineages counts surviving families, thereby building in standard rates of both initial branching and extinction. The world-wide average rate of elaboration is 1.6, or under two surviving branches per node (see again Table 2). The figure for North America is nearly the same as the figure for the entire northern hemisphere less Indo-European—1.4 and 1.5.

These figures can be taken as approximating a constant. A precise universal constant will never be statable, since the fates of languages are dependent not only on purely linguistic factors of differentiation but also on the fates of societies, which act randomly on languages. Nonetheless, the rough constant for elaboration can provide a basis for calculating ages of linguistic populations and assessing the plausibility of proposed genetic trees.

The rough constant for elaboration can be used as a test for the plausibility of proposed ancient groupings. The method of mass comparison (Greenberg 1987) and the search for macrostocks such as 'Nostratic' or 'Amerind' implicitly assume that extremely ancient groupings have broken up to leave large numbers of constituent stocks. 'Nostratic' on its more conservative definition consists of four to eight stocks: Indo-European, Kartvelian, Uralic, 'Altaic' (now more often viewed as three separate stocks—Turkic, Mongolian, and Tungusic), and often also Afroasiatic and Dravidian; recent investigators add also Eskimo-Aleut, Chukchi-Kamchatkan, Niger-Kordofanian, Nilo-Saharan, and Sumerian (Kaiser & Shevoroshkin 1988:309–10) to form a larger group I will henceforth call 'Macro-Nostratic'. Greenberg's 'Amerind' has the branching structure shown in Table 7 (based on Greenberg 1987:66ff.). There are seven (out of 18) prefinal groups (e.g. Macro-Ge, Hokan) with Indo-European-like elaboration. The mean elaboration of fourth-order lineages is eight families.

FIRST ORDER	SECOND	THIRD	FOURTH	FINAL (NO. OF FAMILIES)
Ge-Pano-Carib	Macro-Ge	—	—	15 (p. 66)
	Macro-Panoan	—	—	3 (?) (p. 74)
	Macro-Carib	—	—	5 (?) (p. 78)
Equatorial-Tucanoan	Equatorial	—	—	21 (p. 83)
	Tucanoan	—	—	20 (p. 93)
Andean	—	—	—	4–6 (p. 99)
Chibchan-	—	Chibchan	—	16 (p. 106)
Paezan	—	Paezan	—	13
Central Amerind	—	—	—	3 (p. 123)
Northern Amerind	Hokan	—	—	24
	[Macro-]Penutian	?	?	9 (p. 144)
	Almosan-Keresiouan	Almosan	Algic + Beothuk Mosan Kutenai	[3–4] (pp. 162f.)
		Keresiouan	Caddoan + Adai Iroquoian Keresan Siouan-Yuchi	1–2 (pp. 162f.)
Total families				145–149

TABLE 7. Subclassification of 'Amerind' (Greenberg 1987).

But the elaborate branching routinely assumed in mass comparison is unrealistic and violates uniformitarianism. Stock-level genetic groupings ordinarily leave 1.6 surviving branches on the average, and there is no reason that deeper groupings should leave more. If anything they should leave fewer, just as stocks leave fewer branches than families. If stocks like Indo-European have

deeper connections, we should expect to find only one surviving sister stock for a first-order connection. Greenberg (1987) correctly criticizes the use of binary comparison within elaborated stocks, but the search for distant connections is different from comparative work within known stocks: the initial search for older connections might start with mass comparison but should soon progress to binary comparison, because the expected survival rate is two or fewer deep branches. Furthermore, the high number of isolates and other one-branch lineages found among the world's languages shows that at least half of the searches for deeper connections should be expected to lead nowhere. As a rule of thumb, then, any methodology that always or usually leads somewhere is suspect, and any multiple reconstruction that posits no isolates is pathological.

If large groups of modern stocks are indeed related, the only plausible structure for the relatedness is one of consistent branching into two or three groups. The connection occasionally proposed between Uralic, Yukagir, and Eskimo-Aleut stands out as a model of plausibility in the search for deeper connections. Uralic and Yukagir form a binary subgroup, one whose plausibility is taken for granted by many Uralicists; then Eskimo-Aleut is a more speculative sister to Uralic-Yukagir. Thus we have a proposed subgrouping which coincides well with perceived plausibility of connection, as well as with geographical distribution of the stocks: the entire group is consistently left-branching, with two-way splits and roots to the east, as the Uralic stock within it is. Another well-designed hypothesis of relatedness is the Na-Dene grouping, within which Eyak and the close-knit Athabaskan family form a clear branch, Tlingit is a much more distant relative to Eyak-Athabaskan, and Haida is a more speculative sister to the entire branch consisting of Tlingit and Eyak-Athabaskan. In contrast, 'Nostratic' and 'Amerind' as proposed are not well-designed hypotheses of relationship.

The assumptions underlying the method of mass comparison and the procedures usually applied in the search for deep genetic connections are fundamentally mistaken. They presuppose a high degree of genetic elaboration, when that is in fact rare and found only under specific and readily identifiable economic and cultural circumstances. The mistaken assumptions, of course, trace their origin back to the expectation that Indo-European would provide a model for other historical work; but the elaborate radial branching structure of Indo-European proves to be highly unusual, perhaps even unique. The time depths required for ancient groupings like 'Nostratic' or 'Amerind' would take us back to the Mesolithic or upper Paleolithic, times for which there is no basis to posit an economic quantum leap comparable to that which gave us the modern distribution of Indo-European. To assume an Indo-European-like radiation of preagricultural or pre-Neolithic stocks, given what can now be known, is to violate uniformitarianism.

There is one uncertainty in this picture: we do not know how elaboration of lineages proceeds when a group enters a large uninhabited area. The closest known analog is the spread of the Polynesian family to previously uninhabited eastern Oceania. But this spread is recent, specifically post-agricultural, and

it involves islands, factors which render it of limited applicability to the colonization of the New World. There is no reason not to assume that migration into an uninhabited territory would soon produce a pattern of compression at the coast and elongation in the interior, with the first interior languages likely to be submerged or displaced by subsequent spreads. There is also no *a priori* reason to assume that an uninhabited territory would be covered rapidly just because it was previously uninhabited. It is probably safest to assume that the time required for the first colonizers of interior North America to fan out over the northern interior was approximately that required for the Athabascan or Algonquian languages to assume the same distribution much later. (Goddard & Campbell 1990 argue that the present spreads of interior and eastern languages in North America are recent and must have replaced earlier languages, although they do not explicitly argue that the earlier languages must also have been spread out in a pattern of elongation and low diversity.) In fact, since the first colonizers would have had to adapt to any new environments without help, while groups displacing or absorbing other groups could in principle profit from their predecessors' knowledge of the environment, initial colonizations of all but the most homogeneous territories are likely to have gone more slowly than noninitial colonizations (David J. Meltzer, personal communication, 1990).

**3.3. TYPOLOGICAL DIVERSITY.** To judge from classic examples such as the Caucasus, indigenous California, and northern Australia, typological diversity is correlated with density of lineages: these areas of high typological diversity are also areas of high lineage density, and vice versa.

**3.4. SUMMARY AND IMPLICATIONS.** This section has argued that the distribution of lineage density and typological diversity is not an accident of history but reflects factors that are broadly geographical and economic. Two other explanations of high lineage density have been offered in the literature, and both are essentially historical. Gruhn 1987, 1992 and Rogers 1985, 1987 interpret the high density of lineages on the Pacific coast of North America as reflecting long inhabitation of this region relative to the interior (Gruhn interprets it as reflecting early coastal colonization, Rogers as reflecting settlement of refugia during glaciation). Mulvaney (1975:136–7) interprets high lineage density in Australia as caused by the postglacial sea-level rise: the areas of high lineage density (the north and the southeast) are areas where loss of land surface was greatest, and the lineage density is the result of groups retreating before the advancing sea and piling up on the nearby coast. These explanations are incompatible with the one offered here. Coastal colonization, spreads into previously glaciated areas, and retreat before the rising sea are indeed likely to have produced short-term irregularities in lineage density, but that density could not have lasted for millennia unless it was sanctioned by geographical conditions—in which case it would have arisen in any event. The high lineage density of Australia many well antedate the sea-level rise, and that of coastal North America is independent of colonization routes and glacial refugia.

The New World, with its high density of lineages and high typological diversity, including extensive coastal areas of high lineage density and high di-



versity, is similar to New Guinea and Australia and quite different from the continental Old World. New Guinea and Australia are long-inhabited areas without large-scale economies. All three of these areas—Australia, New Guinea, and the New World—are colonized areas, populated by immigrants coming ultimately from the mainland Old World. Colonized areas can be regarded as zones of peripheral archaism, relative to their source lands: they preserve the lineage density that antedates the spread of large-scale economies, and in some cases they preserve lineages no longer found in the source areas. (Nichols 1992 argues that certain grammatical features in Pacific and New World languages are also peripheral archaisms.)

#### RATES OF COLONIZATION AND DIFFERENTIATION

4. Prehistorians, linguists included, have traditionally looked to archeology to establish dates of earliest inhabitation. But there are also ways in which linguistic data can be used to estimate the ages of linguistic populations. Six measures are described here which either bear on the age of a population or give estimated relative or absolute ages. All of them are independent of archeological evidence for settlement age (although some of them make use of other kinds of information that can be gathered from archeology). They require only basic descriptions and genetic affiliations (up to the stock level) of modern languages.

**4.1. DIVERSITY AND AGE OF POPULATION.** In biogeography, diversity of speciation in colonized areas such as islands is dependent on the number and variety of colonization attempts, and these in turn depend on the distance to the mainland and the genetic diversity on the mainland. (For these principles, see MacArthur 1972.) The same principles can be assumed to hold for linguistic colonization: the density of lineages in a colonized area is dependent on the lineage density and nearness of the colonizing source, and the typological profile of the colonized area is dependent on that of the source. (Although linguistic colonization is not always mainland-to-island, both the colonization of the New World and that of the Pacific involved circumventing such barriers as water, bottlenecks, and/or glaciers, and can thus be likened in some respects to biological colonization of islands.) Only when a colonized area has been inhabited for a very long time can we expect the density of lineages to be dependent only or primarily on climatic, geographical, and economic factors, i.e. to be internally conditioned.

Unfortunately, we have no test case that would tell us exactly how much time is required for lineage density to revert to purely internal conditioning. New Guinea has been inhabited for at least 40,000 years. It can be assumed to have been colonized more than once from Malaysia and/or the Philippines, tropical areas whose lineage density can be assumed to have been high at the time (it has subsequently been lowered by the spread of the Austronesian languages). The present high lineage density of New Guinea can then be attributed to a combination of multiple colonizations and sheer length of time. Australia can be safely assumed to have undergone multiple, even numerous, overland migrations from New Guinea until about 12,000 years ago, when rising sea

levels cut the two apart. There is no evidence of Australia-New Guinea genetic connections now (although see Foley 1986:269ff. for some lexical resemblances).

It can generally be assumed, then, that both genetic and typological diversity in colonized areas are due to a combination of diverse colonizations and time since colonization. Now, in several relevant respects the New World is to Siberia as Australia is to New Guinea: there is no trace of genetic connections between New World and Old World stocks (except for Eskimoan, which straddles the Bering Strait), just as there is no evidence of connections between Australia and New Guinea. There is some typological continuity in both cases. The fairly sparse density of lineages in Alaska and Canada mirrors that of Siberia. However, the density of lineages on the Pacific Coast and mid-latitude to tropical portions of the New World is indistinguishable from what we find elsewhere—in Australia and New Guinea—only in areas inhabited, and almost certainly continuously colonized, for at least 40,000 years.

This measure provides relative ages of settlement of different areas, and on this measure the linguistic age of the New World is not distinguishable from that of the long-inhabited Pacific areas.

**4.2. TYPOLOGICAL PROFILE AND LENGTH OF SEPARATION.** Table 3 in §2.3 showed that each continent has different frequencies of the three head/dependent types. We may now ask how long a period of (more or less) independent development is required for the frequencies of head/dependent types in a continent to depart appreciably from those of other continents, giving the continent in question a head/dependent statistical profile of its own. Australia and New Guinea are both high in diversity and their modal head/dependent types are different (head marking is the modal type in New Guinea, double/split in Australia), although adjacent on the continuum of types. The modal type of Australia is well represented in northern New Guinea, and the modal type of New Guinea is represented in the far north of Australia, so the typological difference can be described as a shift in the frequencies of two well-represented and taxonomically adjacent types. Australia and New Guinea, formerly contiguous, have been separated by the postglacial sea rise, in a process that began 16,000 years ago and was completed 8000 years ago when the isthmus that once continued north of Cape York was breached (White & O'Connell 1982:98). The minimum time required for a typological frequency shift like that between Australia and New Guinea is therefore probably between 8000 and 16,000 years, and probably closer to the latter figure, since the part of Australia where the head-marking type is well represented was the first to be distanced from New Guinea by the encroaching ocean. Of course, the shift in frequencies could have begun earlier; for all we know, the rising sea could have physically separated areas that were already linguistically distinct. It may not have begun substantially earlier, however, since the continuity of diversity and adjacency of types holds specifically between New Guinea and NORTHERN Australia and is therefore likely to reflect former areality.

The head/dependent typological distance between North America and northern Eurasia is much greater than this: diversity levels for both continents are



lower than for Australia and New Guinea, and the modal types are not taxonomically adjacent. Diversity levels and type frequencies between Siberia and California are about as close to each other as those between northern Australia and New Guinea; but the larger continents are quite distinct, and Mesoamerica and South America resemble interior North America and not California. This picture could be interpreted as indicating a time separation of 8000–16,000 years or more for the upper-mid-latitude coastal areas, but substantially more for the interior and southern parts of the New World. This discrepancy between interior and coast is compatible with the model of coastal colonization discussed below, and the discrepancy between north and south is consistent with any model of colonization from Siberia. As measured here, the time separation even between the temporally closest parts of the New World and the Old World is greater than the Clovis chronology for the entire New World and may be greater than the received chronology.

Similarly, Tables 4 and 5 in §2.3 were interpreted as showing that, with regard to alignment, there is a deep typological gap between the New World and the Old World, a gap which is not lessened along the Pacific coast, where Old World influence should be greatest. If the typological gap is to be attributed to sheer passage of time, the temporal distance between the New and Old Worlds must be substantially greater than that between Australia and New Guinea. Table 6 above showed that the New World has more diversity in inclusive/exclusive oppositions (or their absence) than any other area, which indicates a lengthy and complex colonization period, long internal differentiation, or both.

This measure gives relative lengths of periods of separate development for different areas. Australia and New Guinea, since the length of their separation is known, provide a reference point with a rough absolute chronology.

**4.3. CHRONOLOGY FOR COLONIZATION BASED ON POPULATION SIZE.** Boas ([1888]1964:11–62, 166ff.) shows that the Central Eskimo were grouped into what he calls tribes numbering some 300 individuals and each comprising a number of settlements of shifting size and location. For some of the groups Boas posits substantially higher precontact numbers. His description makes it clear that the tribe functioned as the unit within which reproduction, subsistence, and cultural activities took place; trade took place between tribes within what I will call the LANGUAGE GROUP (in this case, Inuit Eskimo); feuds took place between kinship groups within tribes, while war, to the extent that it occurred at all, took place between language groups. Hunger was never due to a shortage of game but rather to temporary inaccessibility of game (because of atypical weather, local ice conditions, etc.). It was a constant background threat to settlements and smaller parties, but not to whole tribes. Subsequent ethnographic work supports this picture, though not all ethnographers use the term ‘tribe’ (see the ethnographic chapters in Sturtevant 1984). The minimal more or less autonomous group numbered a few hundred individuals, living in a single village in the case of sedentary whalers (Spencer 1984) but more often non-sedentary and distributed over several settlements. Burch (1984:303–5,

316–17) presents a particularly clear picture: local groups or extended families were linked by marriage, shared territory, support obligations, and a subdialect into what he calls SOCIETIES, which, prior to contact, ranged from 225 to 775 individuals and averaged 395 (p. 316). Occasional catastrophic events could almost exterminate an entire society, and recovery required refuge in and/or immigration from an adjacent society. Four such catastrophes, one of them a famine affecting four societies, struck the Kotzebue Sound area during the nineteenth century (Burch, p. 317). This picture of the Arctic is fully consistent with that for the Subarctic as summarized by Szathmari (1984:89, based on Meiklejohn 1974).

From these facts we can draw the following hypothesis: the smallest viable population at high latitudes is a set of groups, each numbering some 300 individuals distributed among several settlements. The total population would be at least some 600 for a two-group set, and probably more (the four-group famine described by Burch indicates that two groups would not be enough to guarantee viability). There is a hierarchical organization of at least three levels, for which I will use the following terminology: the SETTLEMENT is the lowest grouping, the SUBTRIBE (Burch's society) the set of settlements, and the MINIMAL ARCTIC TRIBE the set of subtribes. (The terminology is ad hoc and is not proposed as an emendation to the technical ethnographic term TRIBE.) The settlement was more or less self-sufficient on a day-to-day basis, the subtribe was viable on a year-to-year basis, and the minimal arctic tribe could recover from catastrophes which struck every few decades. If this hypothesis, drawn only from New World ethnography, stands up more generally for the Arctic and Subarctic, it can be concluded that any successful colonizers of the New World must have entered in groups no smaller and no less hierarchically organized than minimal arctic tribes. Since catastrophes were natural events (rather than manmade as in war), the requirement of the minimal arctic tribe applies even to the initial colonizers of a previously uninhabited area.

Table 8 shows the five smallest coastal and the five smallest interior language groups in Siberia, plus one (Ainu) that is marginal to Siberia. These figures show that coastal language groups can be smaller (mean of 860, not counting the nearly extinct Ainu) than interior groups (mean of 3640). The smallest groups, both coastal and interior, were yielding numbers aboriginally and must therefore not have been viable. Nganasan, apparently stable (Harms 1987:702, Wixman 1984:145) at about 900 people, is the smallest stable arctic language. Only much farther south, at the mouth of the Amur, do we find a smaller group: Negidal, with only some 500 individuals. I have no information on the stability or organization of Negidal, but assume that its numbers indicate that the minimal coastal subarctic tribe could comprise fewer societies and/or fewer levels of organization than the minimal arctic tribe.

In the entire arctic region of both hemispheres there are only two language isolates, both Siberian: Yukagir (spoken mostly north of the Arctic Circle in eastern Siberia) and Ket (spoken just south of the Arctic Circle in western central Siberia). The Yukagir are distributed in enclaves and are known to have been losing numbers aboriginally. Both of these languages had near relatives

LANGUAGE	FAMILY	NUMBER	NOTES	LATITUDE (DEGREES N.)
COASTAL:				
Ainu	isolate	few	yielding to Japanese	45
Enets	Samoyedic	300	yielding to Yurak, Yakut	72
Negidal	Tungusic	500		53
Nganasan	Samoyedic	900		75
Oroch	Tungusic	1200	perhaps ethnically Nanai	48
Itelmen	Chukchi-Kamchatkan	1400	strong Russian admixture	58
INTERIOR:				
Yukagir	isolate?	800	enclaves (one coastal); yielding to Yakut, Even, Chukchi	65, 70, 72
Ket	isolate	1100		64
Selkup	Samoyedic	3600		58
Dolgan	Turkic	5100	perhaps a dialect of Yakut	70 ?
Mansi	Ugric	7600		64

TABLE 8. The smallest language groups in Siberia.

Figures from Comrie (1981:302) and Wixman 1984 (1979 census figures for ethnicity), except Enets (Harms 1987:702, number of speakers; Wixman 1984:62–3) and Ainu (Ruhlen 1987:286, number of speakers). Entries are ranked by number of individuals or speakers. Oroch and Dolgan may not be independent ethnic groups.

which have become extinct in the last centuries; this suggests that Ket too was receding aboriginally (although it has been stable for the last few decades). That is, at least one and perhaps both of these isolates are lineages on the way to extinction. The northernmost stable isolate and true isolate (without recently extinct sister languages) in the Old World is Gilyak at 52° N (and coastal). The northernmost candidate for an isolate in the New World is Haida (included in Na-Dene by some), at a similar latitude: 52°–56° N (and also coastal). The smallest high-latitude stable group is the Nganasan with approximately 900 individuals, not an isolate. (The Nganasan, at over 75° N on the Taimyr peninsula, are the northernmost ethnic group in Eurasia.)

Thus 55° N can be taken as the approximate northern limit for stable isolates and for stable language groups of under about 900 individuals. North of this limit, and in general at arctic latitudes, we do not find viable language isolates or viable languages with under 900 speakers (and the only such languages that approach the 55° limit are coastal). It must therefore be inferred that the colonizers of the New World—who had to subsist in and move through arctic Beringia—numbered at least 900 individuals (in a minimal arctic subtribe with three levels of organization) and did not speak a language isolate. Jacobsen 1989 argues for multiple entries into the New World of the same language or closely-related languages, and consideration of the size and genetic connectedness of high-latitude groups shows that he is almost certainly right: a successful survivor at high latitudes, hence a potential colonizer, would have been no less than a minimal arctic tribe, each of whose subtribes may have had its own dialect; and behind it, susceptible to being pushed or drawn into the New World by the same forces, would have been a sister language.

If entering groups were no smaller in size than the minimal arctic tribe and their source was a region of low lineage density and thinly-spread languages, the rate of linguistic colonization cannot have been rapid. It cannot have been more rapid than the rate of language succession at high latitudes, and the time required to replace or displace an entire language group appears to be many centuries to a few millennia. The archeological record for the Arctic as reviewed by Dumond 1984 shows, for all parts of the Arctic, cultural successions at the rate of one every 1000–3000 years throughout the Neolithic. Some of these cultural successions involve pan-Arctic spreads, the last of which, the Thule culture (spread ca. 1000 A.D.), is clearly identified with the modern Eskimo. One gets the impression of alternating periods of spread and differentiation, with a spread every few millennia that can be understood as the expansion of a language group, replacing or displacing previous diversity. In the Mesolithic, the extent of spread is greater and the rate of succession slows down; also, any hope of linking archeological cultures to languages vanishes. The archeological record for northeastern Siberia (Abramova 1984) is consistent with this picture for the Mesolithic: the Diuktai culture extended from the north coast of Siberia through interior northeastern Siberia to the eastern Kamchatkan coast, and its dates range from ca. 18,000 years ago to ca. 12,000 years ago.

The same rate of linguistic succession is confirmed by northeast Siberian protohistory (Woodbury 1984:51, Ackerman 1984:115). The Chukchi were actively, even aggressively, expanding eastward, displacing and peripheralizing the Siberian Eskimo. It took them a millennium to expand from the Anadyr' lowlands to the Chukchi peninsula, and three to four centuries after adopting a maritime economy to cover the Chukchi peninsula. When modern political boundaries were drawn up, the Chukchi were on the verge of entering the New World. Their continued expansion would have given the Eskimo-Chukchi succession, measured from initial spread (equating this with the Thule culture for the Eskimo) to initial spread, a depth of over a millennium and probably closer to two millennia in any one place. This chronology lengthens if pre-Thule cultures were also Eskimo, as is sometimes maintained (see again Dumond 1984).

This measure bears on the absolute chronology of earliest settlement: if multiple colonization is posited for the New World, then many millennia must be allowed for entries at one- to three-millennium intervals. The total number of millennia depends on the number of colonizations, and the exact number of colonizations cannot be determined from the modern linguistic data (although Nichols 1992 argues that whether they were many or few can be determined from modern data). This measure will prove most useful when combined with the next two.

**4.4. CHRONOLOGY FOR COLONIZATION BASED ON LINGUISTIC STRATIFICATION.** It seems to be widely agreed that we can read a relative chronology of colonizations off the stratification of stocks in the New World, at least for the northern part of the continent where some stratification is assumed to be apparent. Thus it seems to be generally accepted that Eskimo-Aleut is the most

recent stock to enter the New World, Na-Dene is the next most recent, and the stocks to the south were earlier still. This interpretation goes back to Sapir [1916]1949. Although, as mentioned below, this interpretation of Na-Dene can be disputed, in this section I will simply assume the stratification just described.

Stratification provides a means for calculating a rough colonization rate from the ages of the stratified stocks. The colonization rate will be defined here as the average time separating any two adjacent surviving stocks. (Since it is calculated from surviving stocks only, the colonization rate is a rate not of colonization attempts but of successful colonizations.) Especially when a colonization rate is calculated for an entire area by extrapolating from the reconstructible history of only the last few, clearly stratified, stocks, an appreciable difference will be made in the colonization rate depending on whether the stock delimiting the area is or is not included with those averaged to give the colonization rate. I call this stock the *DELIMITING STOCK*. The colonization rate will also be affected by whether one is generous or stingy in estimating what I will call the *TIME FRAME*, the age of the delimiting stock.

In the case of the extreme north of the New World, Na-Dene is the delimiting stock, the time frame is the age of Na-Dene, and the colonization rate depends on the age of Na-Dene and on whether we do or do not include Na-Dene itself among the stocks which have entered during the time frame. Krauss 1979 describes Na-Dene (from which he excludes Haida) as about 5000 years old (its Eyak-Athabaskan branch is at least 3000 years old), and places the proto-homeland for Eskimo-Aleut in Beringia and that for Na-Dene in eastern Alaska. If Na-Dene broke up in the New World, then its age defines a range within which one group, namely Eskimoan, has entered the New World. The shortest time frame is the time since the Na-Dene breakup (5000 years ago if Haida is not included in Na-Dene; longer if it is). The longest time frame is the time since the split of Na-Dene from its parent stock (this time is unknown, since no parent stock can be identified) or the entry of Na-Dene into the New World (also unknown). Since Na-Dene is the delimiting stock in this case, the colonization rate is drastically affected (halved, in fact) by a decision to include Na-Dene in the stocks averaged over the time frame. If it is not included, the result is a minimal colonization rate of one stock (in this case, Eskimo-Aleut) in 5000 years; if it is included, the result is a maximal rate of two stocks (Eskimo and Na-Dene) every 5000 years, or one every 2500 years. Both of these rates use the shorter time frame. They slow down if we lengthen the time frame by pushing back the chronology for Na-Dene.

One way to lengthen the time frame is to work not from the Na-Dene breakup but from the first existence of Proto-Na-Dene. If we assume (with Greenberg 1987:333ff.) that Proto-Na-Dene is associated with the Bering culture of 7000–10,000 years ago, then we have a minimal colonization rate of one stock per 7000–10,000 years and a maximal rate of two every 7000–10,000 years, or one every 3500–5000 years. Another way to push back the chronology is to move back the date of the internal Na-Dene breakup. If Haida is added to the Na-Dene stock, then 1000–2000 years must be added to the age of Na-Dene (Greenberg, 335), and this slows down the colonization rate to a minimum of one



stock per 7000 years and a maximum of one per 3500 years using the short time frame. Conversely, we could raise the colonization rate by assuming that Haida is not part of the Na-Dene stock but nonetheless lies within it in our stratigraphy; then we have not two stocks but three (Eskimo-Aleut, Haida, and Na-Dene proper) to average over the time frame, and furthermore, excluding Haida from Na-Dene has shortened the time frame. This last example demonstrates an important generalization: lumping (in this case, inclusion of Haida in Na-Dene) entails slowing down the colonization rate, and splitting entails speeding it up. This is because lumping simultaneously decreases the number of stocks and lengthens the time frame, while splitting increases the number of stocks and shortens the time frame. In the most general terms, then, lumping entails commitment to a slow rate of colonization while splitting entails commitment to a faster rate of colonization.

All of these colonization rates—lumped and split, with and without delimiting stocks—are of the same order of magnitude: one successful colonization every couple to few millennia. This figure is consistent with what can be assumed about the rates of linguistic and cultural succession at high latitudes (§4.2).

Let us assume a colonization rate for Alaska in the vicinity of one stock per 3000–5000 years. Providing for the Eskimo-Aleut and Na-Dene entries then takes us back to 6000–10,000 years ago. On the Clovis chronology, whereby New World settlement goes back only some 12,000 years, at this colonization rate there remains time for only one or two more stocks, for a total of three or four within the entire span of New World settlement. Three colonizing stocks is exactly what Greenberg's model proposes, and his claim of genetic unity for 'Amerind' is entirely consistent with the Clovis chronology and the estimable colonization rate: there is time for approximately one more colonizing stock before Na-Dene, and that stock is 'Amerind'.

Breaking 'Amerind' down into separate lineages makes it impossible to accommodate it in the Clovis time frame and difficult to accommodate it in the received time frame. But there are good reasons for breaking it down into separate colonizations (regardless of whether one subscribes to its ultimate genetic unity). First, the six or eleven first-order branches of Greenberg's 'Amerind' (see Table 7) are controversial and regarded as linguistically unjustified by many Americanists. Second, in Greenberg's model 'Amerind' is older than Na-Dene by 3–5 millennia. But those 3000–5000 additional years must account for the order of magnitude more stocks and the full range of typological diversity found in 'Amerind', compared to the three or four families and relative typological homogeneity of Na-Dene and the two transparently close families of Eskimo-Aleut. 'Amerind' comprises over a hundred stocks, each of them comparable to Na-Dene or Eskimo-Aleut. Third, proponents of Greenberg's model have argued (to opponents who raise the objection of diversity just given) that Proto-'Amerind' could have broken up in Siberia at some early date, so that several of its daughter stocks entered the New World independently. Thus an assumption of multiple colonization seems reasonable, even working from Greenberg's data.

Let us use the linguistic data to estimate the number of colonizations. The

stocks of 'Amerind' number about 50 for North America alone, 14 for Mesoamerica, and over 80 for South America (for these figures see Table 1), a total that can be rounded down (allowing for overlap of stocks between areas) to 140. Still assuming Greenberg's framework, a figure lying somewhere between six and 140 represents the number of colonizations by daughter stocks of 'Amerind'; I will choose 6, 11 (the number of Greenberg's first-order branches, with and without reductions he proposes), and 73 (the average of 6 and 140) to use in the following estimates. Colonization rates are calculated by dividing 6, 11, or 73 into the number of years remaining between the Na-Dene entry and the first settlement. That number of years (assuming an age of 7000–10,000 for Na-Dene, consistent with Greenberg's figures) is 3000–5000 years for the Clovis chronology and 10,000–13,000 years for the received chronology. Assuming (as Greenberg does) the Clovis chronology, the colonization rate for six entries is one every 800 years; for 11 entries, one every 300 years; for 73 entries, one every 41–68 years. The last figure is patently unrealistic, given that the smallest viable immigrant is the minimal arctic tribe consisting of several settlements. All three figures are greatly inconsistent with the colonization intervals reconstructed independently from linguistic and archeological data. Even the rate based on Greenberg's six first-order macrostocks requires a tribe-sized immigration and major displacement every few hundred years over a period of many millennia, a process unprecedented in recorded history and reconstructible prehistory. Thus even a first-order breakdown of 'Amerind' cannot be accommodated in the Clovis chronology.

The received chronology would allow up to 13,000 years after the Na-Dene entry. The colonization rate for six entries during this period is one per 2200 years; for eleven, every 1200 years; for 73, one per 180 years. Of these figures, only 2200—for six lineages over 13,000 years—is plausible; and it assumes a generous 20,000 years for the received chronology and the minimum of 7000 for Na-Dene.

In summary, even minimal splitting of 'Amerind' gives, for the Clovis chronology, a colonization rate that is one or even two orders of magnitude too great. For the received chronology, a plausible colonization rate is obtained only by taking the minimal breakdown and the longest time frame, and that colonization rate is at the rapid end of the independently reconstructible rate.

Let us now view the situation from the perspective of Siberia. Siberia is a high-latitude region with low lineage density. The overall dynamic of migration in northern Eurasia has been expansion outward from the steppe, with resultant peripheralization of the indigenous Siberian stocks on the northern and eastern coast. The most recent expansions, by Turkic and Tungusic stockbreeders, have taken place within the last two millennia; before that the last major spread seems to have been the more modest one of Samoyedic (Uralic) in western Siberia. Samoyedic is over 2000 years old since its own breakup, and its split from Proto-Uralic dates back some 6000 years (Gulya 1974:39). When minimal and maximal rates of spread are calculated in the same way as colonization rates were calculated above, the result is a minimal rate of two stocks (Tungusic



and Turkic) in the 6000 years since the Samoyed split, thus one stock per 3000 years on the long time frame; and a maximal rate of three stocks (Tungusic, Turkic, Samoyedic) in 2000 years, thus one stock per 700 years on the short time frame. The Turkic and Samoyedic spreads may actually have been manifestations of a single spread (Janhunen 1989), in which case the maximal rate is one stock per 1000 years on the short time frame and one per 6000 years on the long frame. These figures are for southwestern Siberia; at higher latitudes there may be some extinction of lineages (as with Yukagir) and some changes in direction of spread (Samoyedic continued to spread predominantly northward, not eastward, and is unlikely to have ever colonized the New World). On the whole, then, the rate at which stocks spread into northeastern Siberia appears to be comparable to the colonization rate that can be calculated for the New World: one every couple to few millennia. To provide six Siberian colonizers of the New World would require at least 12,000 years.

The colonization rate is affected by the number and accessibility of entry routes. If both coastal and interior routes were passable during glaciation, the colonization rate can be doubled (although, since Siberia may not have been able to provide colonizers at the double rate, double entry routes might mean double entries by the same lineage, hence a two-way split of the lineage upon entry into the New World). On the other hand, colonization would have been halted for any period when an entryway was closed off by glaciation, so that even occasional closure of entryways would have slowed the overall colonization rate. The internal route is likely to have been passable intermittently at best; the coastal route may have been continuously open to overwater entry by refugium-hopping on the coastal islands (Fladmark 1979, 1986). But refugium-hopping by whole arctic tribes seems unlikely to have enjoyed a high success rate, since the few refugia were not large enough to hold two minimal arctic tribes. In short, glaciation would have slowed the colonization rate in more than one way.

This measure, like that presented in §4.2, can give an estimate of the absolute chronology of settlement, but requires that some assumption be made about the number of colonizations. Taking all factors into account, this measure and the preceding one point to a colonization rate of once every two to three millennia since the end of glaciation, and once every three or more millennia during glaciation.

**4.5. CHRONOLOGY FOR INTERNAL DIFFERENTIATION.** Expected rates of lineage elaboration were calculated in §2.2: the average is 1.6 surviving families per stock, or 1.4 for North America; stocks run from about 5000 to 8000 years in age. Let us assume, then, that on the average every 5000–8000 years every language splits into what will eventually be 1.6 major branches or 1.6 surviving daughter families. Working backwards, on the average the number of stocks in a genetic lineage is divided by 1.6, or slightly less than halved, every 5000–8000 years. This yields a crude half-life with which to calculate the amount of time it would have taken a putative ‘Amerind’ to reach the present levels of

genetic differentiation. The half-life varies depending on the rate of differentiation (1.4, 1.6, 2.0, or some other figure) and the presumed average age of stocks (8000 years, 6000 years, 5000 years, etc.).

Assume a branching rate of 2.0 (chosen for ease of illustration; it is actually too high) and an average stock age of 7000 years. There are approximately 140 ‘Amerind’ stocks now, so 7000 years ago there were only half that number, or 70 stocks, 14,000 years ago only 35 stocks, 21,000 years ago only 17.5, and so on. At this rate it takes 49,000 years to reach a figure of under two stocks, and this can be taken as the amount of time it would have taken Proto-‘Amerind’ to split into its approximately 140 daughter stocks. Table 9 shows some times to Proto-‘Amerind’ (and also some times to Proto-Northern ‘Amerind,’ proposed as ancestral to most of North America and thus to about 50 stocks) using various rates and ages. Ages consistent with the received and Clovis chronologies can be reached only by assuming unrealistic conditions such as an average age of 3000 years for stocks (an age in this range defines a family, not a stock) or an average rate of branching of 2 or more (higher than the survival rate demonstrated in Table 2). But assuming the more realistic ages (5000, 7000) and rates (1.4, 1.6) requires a minimum of about 50,000 years—a figure greater than the received ages of inhabitation of any part of the Pacific, hence unlikely to represent the real age of New World settlement unless the picture for the Pacific is revised.

RATE OF BRANCHING	AGE OF STOCKS (years)	TIME TO PROTO-	TIME TO PROTO-‘AMERIND’ (years)	
		NORTHERN ‘AMERIND’ (years)		
1.4	7000	70,000	91,000	
	5000	50,000	65,000	
	3000	30,000	39,000	
1.6	7000	49,000	70,000	
	5000	35,000	50,000	
	3000	21,000	30,000	
2.0	7000	35,000	49,000	
	5000	25,000	35,000	
	3000	15,000	21,000	R
3.0	2000	10,000	14,000	C
	7000	21,000	28,000	
	5000	15,000	20,000	R
	3000	9000	12,000	C

TABLE 9. Calculated ages for Proto-‘Amerind’. Proto-‘Amerind’ is assumed to consist of 140 stocks; Proto-Northern ‘Amerind’, 50.

R = figure consistent with received chronology  
C = figure consistent with Clovis chronology

This measure gives an estimated absolute age for groups of languages assumed to represent one lineage. It indicates that either the received and Clovis chronologies are too shallow or ‘Amerind’ is not a single lineage, or both.

4.6. COMPARISON OF ‘AMERIND’ AND ‘NOSTRATIC’. ‘Nostratic’ is the putative ancestor to stocks including Indo-European (which emerged 6000 or more years

ago in western Asia), Uralic (6000 or more years ago in the south central Urals), Tungusic (perhaps 4000 years ago in eastern Siberia), possibly Afroasiatic (8000 years ago in North Africa), and others. To account for the geographical spread of its daughter stocks and their own chronologies, 'Nostratic' would presumably have to be given an age of at least 12,000 years and probably well over that. This places it in the same general time frame as 'Amerind' on either the Clovis or the received chronology. It is therefore worthwhile to compare these two superstocks as constructs, to see whether their differentiation also appears to be in the same ballpark. In fact, they turn out not to be in the same ballpark in a number of respects that should bear heavily on their age.

One salient difference between the two is their different receptions by specialists in their composite subgroups. The typical reaction of Indo-Europeanists, Uralicists, Altaicists, etc., to 'Nostratic' is that it is a plausible grouping but simply not demonstrable by the comparative method. (This reaction applies only to 'Nostratic' proper or to its north Eurasian core, not to Macro-'Nostratic'.) By contrast, comparative-historical stock specialists in American languages generally do not regard 'Amerind' as plausible. The difference in reactions is particularly telling in view of the fact that the Americanist tradition is considerably more inclined toward lumping than are the Eurasian traditions.

Another difference is the genetic elaboration of the two groups. 'Nostratic' consists of half a dozen stocks, Macro-'Nostratic' of a dozen. These first-order branches are all solid stocks, well established by comparative work. 'Amerind', on the other hand, has its first-order split into branches which are themselves hotly controversial superstocks; only at the third- or fourth-order split of these superstocks do we get to orthodox stocks (see again Table 7). 'Amerind' contains some 140 of these orthodox stocks—one or two orders of magnitude more than 'Nostratic'.

The degree of typological diversity of the two groups is also quite different. Table 10 shows diversity in head/dependent-marking within 'Nostratic' (minus Dravidian and Afroasiatic; the 'Nostratic' figures are based on the Indo-European, Uralic, Tungusic, Turkic, and Mongolian languages in the sample shown in the Appendix and described in note 2) and within three subparts of 'Amerind': North America (less Na-Dene), California only, and Mesoamerica. Diversity is reflected in the number of different types in an area and the percentage of the modal type (a higher percentage means a stronger mode, hence less diversity). For a rough and ready grasp of the extent of diversity I also give what I call an INDEX, calculated by dividing the mode (i.e. the percent

	FREQUENCY OF TYPES:			MODE AS %	No. OF TYPES	INDEX (%/NO. OF TYPES)
	HEAD MARKING	2/SPLIT	DEPENDENT MARKING			
'Nostratic'	0	7	10	59%	2	29
North America	27	8	9	61%	3	20
California	6	4	5	40%	3	13
Mesoamerica	6	1	0	86%	2	43

TABLE 10. Typological diversity: head/dependent marking.

figure) by the number of types present; the higher the index, the greater the consistency. Prose assessments of levels of diversity are based on considering all three entries—mode as percentage, number of types, and index. ‘Nostratic’ is lower in diversity than North America or California, hence lower than ‘Amerind’ as a whole. It is comparable only to Mesoamerica, but Mesoamerica is a classic example of a language area (Campbell et al. 1986). Thus within ‘Amerind’ we find homogeneity equivalent to that of ‘Nostratic’ only in a small and well-defined subpart, under strong areal influence.

Table 11 shows the same kind of count for alignment. ‘Nostratic’ is strongly consistent in clause alignment; ‘Amerind’ shows much more diversity, except for California.

	FREQUENCY:			MODE AS %	NO. OF TYPES	INDEX (%/TYPES)
	ACC.	ERG.	ST.-ACT.			
‘Nostratic’	14	1	2	82%	3	27
North America	25	4	12	57%	3	19
California	13	0	2	87%	2	44
Mesoamerica	3	1	1	60%	3	20

TABLE 11. Typological diversity: clause alignment.

Table 12 shows frequencies of inclusive/exclusive oppositions expressed as the percentage of families in the area having the opposition. (Dravidian and Afroasiatic are included in ‘Nostratic’ for this table only, since inclusive/exclusive oppositions are frequent in Dravidian.) Recall (from §2.3) that percentages close to 50 indicate great diversity, while those close to 0 or 100 indicate great consistency. The New World shows the greatest diversity of any area, reflecting great diversity within ‘Amerind’, while ‘Nostratic’ is quite consistent. Even when the frequency of inclusive/exclusive pronouns in ‘Nostratic’ is increased by including Dravidian and manipulating the Tungusic sample, ‘Nostratic’ is much more homogeneous than ‘Amerind’.

GROUP	% OF SAMPLE LANGUAGES HAVING INCLUSIVE/EXCLUSIVE OPPOSITION
‘Nostratic’	18%*
North America	36%
California	31%
Mesoamerica	43%
South America**	71%
New World total	50%

TABLE 12. Frequencies of inclusive/exclusive pronouns.

\* The Tungusic language in the sample, Nanai, is unusual in lacking inclusive/exclusive. Choice of another Tungusic language would raise this figure to 23%.  
\*\* Very thinly sampled.

A final point of comparison is personal pronouns. Greenberg (1987:49ff.) regards first-person *n*- and second-person *m*- as diagnostic ‘Amerind’ features, and finds one or both in every major ‘Amerind’ branch. Personal pronouns in

detectable genetic groupings can be expected to show obvious, even transparent, paradigmaticity in stock after stock and language after language. In 'Nostratic', and especially in its northern Eurasian core, we find exactly such regular surface paradigmaticity. Table 13 shows forms from representative languages; Indo-European forms are omitted from this table because they are so well known (but see Table 14 below for I-E reconstructions).

In most of these languages there is both a first-person form *mi* and a second-person form (\*)*ti* or *si*, with *-n-* in many singular forms and vowel ablaut and/or consonantal suffixes in the plural forms. (Precisely this picture, with singular-

STOCK; LANGUAGE		SINGULAR	PLURAL
URALIC			
Finnish	1ST PERS.	<i>minä</i>	<i>me</i>
	2ND PERS.	<i>sinä</i> < * <i>tinä</i>	<i>te</i>
Komi		<i>me</i>	<i>m'i</i>
		<i>te</i>	<i>ti</i>
Cheremis		<i>myj</i>	<i>me</i>
		<i>tyj</i>	<i>te</i>
Vogul		<i>am, a:n-</i>	<i>ma:n</i>
		<i>nan</i>	<i>na:n</i>
Hungarian		<i>e:n, eng-</i>	<i>mi</i>
		<i>te</i>	<i>ti</i>
Yurak		<i>man'</i>	<i>man'a?</i>
		<i>pydar</i>	<i>pydara?</i>
Nganasan		<i>mənə</i>	<i>myŋ</i>
		<i>tənə</i>	<i>tyŋ</i>
TURKIC			
Turkish		<i>ben</i>	<i>biz</i>
		<i>sen</i>	<i>siz</i>
Yakut		<i>min, mii-</i>	<i>bihigi</i>
		<i>en, eji-</i>	<i>ehigi</i>
Kazakh		<i>men</i>	<i>biz/bizder</i>
		<i>sen</i>	<i>siz/sizder</i>
Chuvash		<i>epě, man-</i>	<i>epir, pir-</i>
		<i>esě, san-</i>	<i>esir, sir-</i>
MONGOLIAN			
Khalkha		<i>bi, min-, nad- či, čin-, čam-</i>	<i>bid-, bidn-; EXCL.. man- ta-nar</i>
Buryat		<i>bi, min-, nam- ši, šin-, šam-</i>	<i>bide, biden-, man- ta, tan-</i>
Kalmyk		<i>bi, min-, nam- či, čin-, čam-</i>	<i>bidn/madn, man- tadn, tan-</i>
TUNGUSIC			
Evenki		<i>bi, min- si, sin-</i>	<i>mit (EXCL. bu:, mun-)</i>
Negidal		<i>bi, min- si:, sin-</i>	<i>su:, sun- bitta, butta</i>
			<i>su:, sun-</i>
Nanai		<i>mi</i>	<i>bue</i>
		<i>si</i>	<i>sue</i>
Manchu		<i>bi, min-</i>	<i>muse (GEN. musej)</i>
		<i>si, sin-</i>	<i>suwe (GEN. suwen)</i>

TABLE 13. First and second person pronouns in 'Nostratic' languages (minus I-E). A comma separates nominative and oblique stem forms.

plural ablaut and the abstract possibility of suffixation, can be reconstructed for Proto-Finno-Ugric and Proto-Uralic; see Majtinskaja 1974:284ff. and Rédei & Erdélyi 1974:398–9.) What is convincing to the comparativist is the fact that we can recover not simply the forms of the pronouns, but an actual person/number paradigm. Some of the paradigmaticity is lessened when we compare protolanguages, but some of it remains. Table 14 shows reconstructed forms.<sup>7</sup>

		SINGULAR	PLURAL
Indo-European	1st pers.	*ego: / *m-	*wey- // *mes / *no(s) / *n̥(s)-
	2nd pers.	*tu: / *tew-, *tw-, *t-	*wo:s, *yu:s
Kartvelian	1st	*me(n)-	*čwen-
	2nd	*sen-	*(s <sub>1</sub> )tkwen-
Uralic		*mi-nä, *me-nä	*mV [V = front vowel]
		*ti-nä, *te-nä	*ti, *te
Turkic		*bi- // *bän-	*bi-z
		*si- // *sän-	*si-z
Tungusic	1st	*bi // *min- < **bi-n	*büä (EXCL.) *mün-ti (INCL.)
	2nd	*si // *sin-	*süä
Mongolian	1st	*bi // *min- // *na(ma)	*ba // *man- (EXCL.) *bide // *bidan- (INCL.)
	2nd	*či < **ti // *čín- < **tin-	*ta

TABLE 14. Personal pronouns in ‘Nostratic’ protolanguages.

Sources: Meillet (1964:332ff.), Gamkrelidze & Ivanov (1984:292), Klimov 1964, Rédei & Erdélyi (1974:398–9), Tenišev (1988:202ff.), Serebrennikov & Gadžieva (1986:137), Cincius et al. 1975, Poppe (1965:194, 1955:209ff.), Benzing (1955:108). A slash separates nominative and oblique stem forms, two slashes separate distinct roots (typically, nominative and oblique), a comma separates alternate reconstructions, and parentheses indicate dialectal or other variants.

This kind of transparency and paradigmaticity are missing in ‘Amerind’, whether as a whole or in a core set of stocks like the Uralic and ‘Altaic’ languages or as a set of protolanguages. Greenberg refers to the recurrence of first person *n-* and second person *m-* throughout ‘Amerind’, but in fact these forms, although indeed widely encountered, are far from being pan-‘Amerind’ (Goddard & Campbell 1990). Furthermore, to the extent that they recur, it is as simple consonants without consistent vowels, ablaut, affixation slots, or number derivation paradigms, so that their diagnostic value is much reduced in ‘Amerind’. It must be concluded that, if both ‘Nostratic’ and ‘Amerind’ represent groupings of some kind, ‘Amerind’ is substantially older than ‘Nostratic’.

<sup>7</sup> These reconstructions are taken from standard comparative works for the individual stocks, not from the ‘Nostratic’ literature, since the table is intended to show the evidence for grouping the language stocks together rather than the result of doing so. For the same reasons, the discussions accompanying Tables 13 and 14 are based on the attested forms and the stock-level reconstructions, not on the ‘Nostratic’ literature. For the Tungusic, Turkic, and Mongolian pronouns there are appreciable differences in the reconstructions offered by those who reconstruct ‘Altaic’ and those who do not. For example, the Altaicist Poppe (1965:194) reconstructs for Turkic a first-person oblique stem \*män, while stock-internal reconstructions posit \*bän.

There is another consideration that lengthens the evident age of 'Amerind'. The standard explanation for rapid differentiation in language families is foreign contact or substratum. But if 'Amerind' entered the New World as a single language or dialect cluster, there would have been no possibility for foreign contact by definition: for the first few millennia, all contacts would have been between closely related languages. Therefore we should expect for 'Amerind' a lower degree of differentiation than in any other grouping of comparable age.

The measure proposed in this subsection provides an approximate relative chronology for groups presumed to represent genetic lineages. 'Nostratic', whatever one may think of its reality, is based on stocks which are well described, have extensive philological traditions, are well reconstructed, and can be dated with some precision. It can therefore serve as a reference point in assessing ages (as well as plausibilities) of other presumed early groupings; and it is often so used. This section has added to that vernacular, qualitative use of 'Nostratic' only the quantified measures of diversity and the insistence on paradigmaticity, rather than mere perceptual similarity, in personal pronoun systems. On either the Clovis or the received chronology one would expect 'Amerind' to look approximately as plausible and approximately as old as 'Nostratic', when in fact it looks substantially less plausible and substantially older.

**4.7. SUMMARY AND DISCUSSION.** The measures proposed here show that the Clovis and received chronologies in Americanist studies are inconsistent with the linguistic facts. The measures of relative age (diversity and its distribution; typological profile; comparison to 'Nostratic') indicate that the New World population is older than either chronology.<sup>8</sup>

In estimates of absolute chronology, there are three variables to be dealt

<sup>8</sup> The appearance of agriculture gives another measure of relative age. White & O'Connell (1982:216–17) argue that the Clovis chronology is insufficient to account for the cultural evolution that lay behind the rise of agriculture in Mesoamerica. Rindos (1984:194ff., 246ff., et pass.) shows that agriculture is not a sudden innovation but a gradually reached statistical threshold in the relative contribution of domesticates to the diet, and that domestication is a gradual process of natural selection and the result of an extremely long period of gradual coevolution of human society and plants. By 9000 years ago in Mesoamerica this extremely long period had led to the stage where the proportion of domesticates in the diet was detectable and began a sharp rise culminating in full-blown agriculture a few millennia later (251ff.). The domesticates in question are, of course, indigenous Mesoamerican plants. Thus prior to 9000 years ago there was an indeterminately long period of utilization of Mesoamerican plants by humans. I calculate that the comparable phase in Anatolia, Southeast Asia, and New Guinea lasted approximately 30,000–40,000 years (from first settlement to first clear domesticates or agriculture, with some rounding and extrapolating), and it is difficult to believe that the same coevolutionary ground could have been covered in Mesoamerica in the mere 3000–5000 years allowed by the Clovis chronology, or even the 10,000 years consistent with the received chronology. (Rindos's model, based on natural selection and processes of unconscious incipient domestication ethnographically observed in pre-agricultural peoples, precludes absolutely a scenario whereby, say, Proto-'Amerind' speakers in Beringia at ca. 13,000 years ago learn to propagate tundra berries and then move rapidly to Mesoamerica to apply the same technology to ancestral maize.) Since agriculture appears to require a very long period of close familiarity with an environment, the fact that it arose independently and roughly simultaneously in Africa, southwest Asia, the Pacific, and the New World suggests that all these areas have been inhabited for roughly comparable periods of time since the rapid expansion of our species about 40,000 years ago.



with: the colonization rate, the time frame, and the rate of internal differentiation of languages (itself based on average stock age and rate of elaboration). Both the Clovis and the received chronology require gross distortion of either the colonization rate or the rate of internal ('Amerind') differentiation. The colonization rates and rates of internal differentiation proposed here are offered as provisional, but only because more research on them is needed; once refined, they will offer less flexibility (and almost no arbitrary flexibility), as they have the nature of general principles rather than historical contingencies. Even in their present state, there is no reason to doubt their approximate accuracy. Thus manipulating these rates is, in principle, not the way to resolve the inconsistencies in the standard frameworks.

The time frame offers more inherent flexibility, however, as it is a matter of history. The Clovis chronology for settlement of the New World became standard at a time when our species was believed to be only 40,000 years old and the colonization of the Pacific substantially more recent than that. Now, however, the age of our species is known to be at least 100,000 years; the settlement of New Guinea and hence the development of seaworthy watercraft is set at over 40,000 years ago; central Siberian sites go back to 35,000 years ago, and interior northeastern Siberian sites to 18,000 years ago (Abramova 1984:314)—a figure unlikely to represent the earliest actual settlement, since northern Siberia has been little excavated.<sup>9</sup> Dates in the vicinity of 30,000 years ago have been proposed for a few New World sites (e.g. Monte Verde in Chile: Dillehay & Collins 1988; for a survey of early proposed dates, see Gruhn 1992). Thus there is no obstacle to pushing back the time frame for settlement of the New World to at least 20,000 years and perhaps up to 40,000.

Let us combine the various measures for absolute chronology and use the other information presented here to make realistic assumptions for the variables. A reasonable set of assumptions would appear to be the following: a colonization rate of one lineage per 3500 years; 10 entering lineages (with, on the average, 14 daughter stocks as descendants; the relatedness of the sets of modern daughter stocks will generally not be revealed by the standard comparative method); a rate of elaboration of 1.6; and an average stock age of 5000 years. The following calculations do not assume genetic unity for 'Amerind', and they treat the ancestor of Na-Dene as just one of the ten entering lineages. Only Eskimo-Aleut is excluded from the calculation.

The age of an individual 14-stock lineage would be 25,000 years at this rate. This is only an average age; the actual lineages can range from 50,000 years in age (such a lineage would have many more than 14 daughter stocks) to zero (such a lineage would have one stock). 50,000 years is probably too great, and zero is demonstrably too young (even Eskimo-Aleut, the latest immigrant, entered at least two millennia ago); thus both extremes of the possible range can

<sup>9</sup> Dates of 30,000 years and more have been obtained in northeastern Siberia, but not from the cultural remains themselves, and the stratigraphic argument connecting these earlier dates to the culture horizons has weak spots: see Abramova's careful assessment (1984:325–6).

be rejected. Midway between the maximum possible lineage age of 50,000 years and the average lineage age of 25,000 years is 37,500 years, a figure that can provisionally be taken as a low estimate of the age of the oldest lineage and hence the age of New World settlement yielded by this calculation. Midway between the minimum possible age of zero and the average of 25,000 is 12,500, which can provisionally be taken as a high estimate of the age of the youngest American lineage. This high estimate is too high: if the American stocks are taken to include everything except Eskimo-Aleut, the youngest stock should be only a few millennia old. If the high estimate is lowered (as is perfectly possible, since the average of zero and 25,000 was somewhat arbitrarily selected), then for symmetry the low estimate of the oldest entrant should be raised somewhat.

The actual time required to bring in 10 lineages at an average of one colonization per 3500 years is 35,000 years. This figure, plus two or more millennia for Eskimo-Aleut, represents the age of settlement of the New World. The figures of 37,500 years or somewhat more (age of oldest lineage) and 35,000 years plus two or more millennia for Eskimo-Aleut (age of settlement) are similar. Therefore the assumptions used here (colonization rate of once per 3500 years, 10 entering lineages, stock age of 5000, elaboration rate of 1.6) can be taken as consistent with one another and a settlement age of 37,500 years as consistent with reality.

Another internally consistent scenario would be the following: stock age of 5000; elaboration rate of 1.6; entry to the New World completely blocked off by glaciation most of the time; colonization rate irrelevant because of glaciation; one glacial retreat sufficient to permit entry, and one entering lineage during that glacial retreat. This is the scenario posited by Gruhn 1992, where all of 'Amerind' is traced to a single entry during the Middle Wisconsinian interval, a significant glacial retreat that occurred slightly over 50,000 years ago (there was no later comparable retreat until the end of glaciation). The age of about 50,000 years that Gruhn posits on archeological and paleoclimatological grounds is identical to the figure of 50,000 years required to derive the 140 stocks of 'Amerind' from a single ancestral lineage at the elaboration rate of 1.6 (see again Table 9).

These analyses are offered as sample plausible answers and hypotheses to be tested. Since the accuracy of any answer will depend crucially on the accuracy of such measures as average age of stocks and average rate of elaboration, the most important linguistic aspect of any testing must be close stock-internal comparative work to establish ages and internal branching structures of stocks from all parts of the world. Once the measures are refined, paleoclimatological evidence may prove decisive in choosing between competing scenarios, but ultimately the linguistic evidence may yield a more precise answer than paleoclimatology can give to the question of whether and when the New World was open to entry during the Ice Age. There is, for instance, strong linguistic evidence for multiple colonization of the New World (see Nichols 1992), which weakens the case for the single entry at 50,000 years ago.

**4.8. COASTAL COLONIZATION OF THE NEW WORLD AND ITS CHRONOLOGICAL IMPLICATIONS.** The standard view of the languages in Canada and Alaska, as discussed above, is that Eskimo and Na-Dene give us a visible stratigraphy of colonization: Eskimo was pushed or drawn into the New World and thereby displaced Na-Dene to the south, the latest instance in a regular scenario where languages were tamped down southward by new entrants. Jacobsen 1989 proposes a new interpretation of the patterning: the configuration of Na-Dene represents not a southward displacement occasioned by the arrival of Eskimo, but an eastward spread from a coastal homeland; Na-Dene happens to be the northernmost such stratum in a continent where interior languages are almost all traceable to eastward spreads from the Pacific coast. Extending Jacobsen's reasoning, consider what would happen if the Chukchi crossed the Bering Strait and colonized the Alaska coast. It is unlikely that this would cause the Eskimo to abandon their maritime culture and migrate inland in a neat band; rather, Chukchi would split up Eskimoan unity and absorb some Eskimo speakers, and the result would be two coastal lineages. Eventually one of them would occupy most of the present Eskimo territory (an area of low lineage density) and the other would be confined to southern coastal Alaska (where lineage density begins to rise). The southern one might drift southward, and a later branch of it might spread eastward as Athabascan has done.

This scenario can provide a rough model for coastal colonization of the New World. New languages would be brought in by coastally adapted people entering in groups no smaller than the minimal arctic tribe. Immigrants would coexist with previous inhabitants, perhaps displacing them (usually southward) and perhaps absorbing some of their speakers. Whenever a group ventured inward from the coast, the result was elongation and an extended eastward spread. If another group later made the same move, the result would be absorption of the new group by the previous settlers or vice versa: the geographical conditions that trigger elongation inland also preclude high lineage density, so any group spreading to the interior must by definition make a substantial spread. The spreading families we now see in the interior of North America are the latest stratum of elongated interior languages and have presumably replaced previous, also elongated, interior languages. Additional interior spreads might have been generated by internal colonizations whenever there was a passable ice-free area. Like all interior spreads, such entries would have increased the rate of language succession in the interior, not the density of lineages; that would increase around the periphery, where the former interior language could survive in refuges and enclaves.

The possibility of coastal colonization is important to an early chronology of settlement, since much of the interior New World was impassable during the Ice Age. Fladmark (1979, 1986), arguing for coastal colonization of America, points out that people with marine technology including watercraft could have settled coastal areas regardless of continental glaciation, and that even at the height of the Cordilleran glaciation there were coastal refugia in Alaska and Canada that could have supported human populations. Thus coastal colonization imposes few chronological limits and is fully compatible with the time

frame needed to provide for the genetic and typological diversity of the New World. Coastal colonization of the New World is favored by a number of archaeologists (see Gruhn 1992), and draws support from the fact that coastal colonization and earlier settlement of coast than interior is increasingly favored as a model for the settlement of Australia (see Bowdler 1977 for the original proposal). It is important to emphasize once again that the distribution of lineage density is not the result of coastal colonization but is rather due to geographical conditions.

#### CONCLUSIONS

5. Genetic relatedness is the only kind of affinity having theoretical status in historical linguistics. (Other kinds of affinity find their theoretical status in the fields of typology, language universals, sociolinguistics, etc., rather than in historical linguistics). It is therefore inevitable that linguists seeking to extend our view of language history back in time have pursued ever deeper genetic connections: genetic affinity is the only model we have. This paper has attempted to treat diversity, a statistical property of populations, as an object of description in its own right and a construct deserving of theoretical status in historical linguistics. The result is an analytic framework which has almost nothing to say about deep genetic connections (although of course this paper presupposes orthodox genetic connections, e.g. in basing its sample design, the rates of elaboration, the rates of colonization, etc., on accepted genetic stocks) but lends itself naturally to approximate chronological calculations.

This paper began by assuming several of the elements of Greenberg's model: the recent chronology of first settlement, 'Amerind' and its macrostocks, the stratification of Na-Dene and Eskimo-Aleut, and the age of Na-Dene based on associating it with a particular archaeological culture of Beringia. These elements have been shown to be in conflict with each other and/or with reality. If 'Amerind' is a single genetic lineage, it is at least 50,000 years old. If it is not a genetic group, then over 20,000 years would have been required to move even a few lineages through and out of northeastern Siberia to seed the New World. Thus either stance on the 'Amerind' question requires a deep chronology.

'Amerind' presents us with a chronological paradox. A single pre-Na-Dene entry fits well with the Clovis chronology, where the few millennia between the Clovis culture and the Na-Dene entry allow just one colonization at the rates established here; on a deeper chronology more entries would be expected (three or four on the received chronology). But genetic unity requires an extremely deep chronology of 50,000 years or more to derive the 140 'Amerind' stocks from a single ancestor. On this very deep chronology, to assume genetic unity of 'Amerind' is to assume only one successful colonization (that by 'Amerind') in the over 40,000 years before the Na-Dene entry. Now, a colonization rate of only one entry per 40,000 years, for an area that may have been continuously open to entry during most of this time (see Fladmark 1979), is as implausible as one every 50 years. Thus the very genetic unity proposed for 'Amerind' precludes the deeper chronology required by genetic unity.

The linguistic facts require a chronology that is sufficient to bring a large

number of stocks from and to high-latitude areas, and/or to allow for internal differentiation, both genetic and typological, to a level indistinguishable from that of long-inhabited areas like New Guinea. The linguistic evidence is not fully precise as to dates, but it is absolutely unambiguous in regard to ballparks: the New World has been inhabited for tens of millennia.<sup>10</sup>

APPENDIX

Below is a list of stocks and families, by area. ISOLATE identifies single languages without families; SAME identifies small families with branches below the family level ('stock-level families'). The 'Sample language' column shows the languages used to obtain the areal profiles of Tables 3–5. Areas are listed in the following order: Africa, Near East, Northern Eurasia, New Guinea, Australia, North America, Mesoamerica, South America.

AFRICA		
STOCKS	FAMILIES	SAMPLE LANGUAGE
Afroasiatic	Semitic	Amharic
	Berber	
	Chadic	
	Cushitic	
	Omotic	
Niger-Kordofanian	Kordofanian	Orig
	Niger-Congo: 5 families	
	Mande	
	West Atlantic	
	North Central	
Nilo-Saharan	South Central: Bantu	Luganda
	South Central	
	East Sudanic	
	Nilotic	
	Kuljak	
	North Sudanic	
	Central Sudanic	
	Kunama	
	Songhai	
	Saharan	
	Maban	
	Fur	
Khoisan 1	Koman	Nama
	Kadugli	
	Khoisan proper	
Khoisan 2	Hadza, Sandawe (1 or 2 families)	Sandawe
TOTAL: 5	25	

(Low-density figure in Table 1 assumes Nilo-Saharan is one stock; high-density figure assumes it comprises 11 stocks.)

<sup>10</sup> After this paper had gone to press, R.G. Roberts et al. (Nature 345.153–6) announced a date of over 50,000 years for an Australian occupation site. This date considerably increases the age of settlement of Australia (from the ca. 40,000 years mentioned in §§4.1, 4.5, and Table 1 here), indirectly strengthens the case for early colonization around the northern Pacific, and makes colonization of the New World prior to 40,000 years ago more plausible than was assumed in §4.5.

## ANCIENT NEAR EAST

STOCKS	FAMILIES	SAMPLE LANGUAGE
Afroasiatic	Semitic	Akkadian
Elamite	same	Elamite
Hattic	same	
Hurrian-Urartean	same	Hurrian
Indo-European	Anatolian	Hittite
Sumerian	same	Sumerian
TOTAL: 6	6	

## NORTHERN EURASIA. '\*\*' in the final column marks languages used for the Siberia sample.

STOCKS	FAMILIES	NOTES	SAMPLE LANGUAGE	SIBERIA
Indo-European**	Balto-Slavic		Russian	
	Germanic		English	
	Celtic			
	Italic		French	
	Greek			
	Albanian			
	Armenian		Modern Armenian	
	Indo-Iranian		Waigali	
Basque	isolate		Basque	
NW Caucasian	same		Abkhaz	
NE Caucasian	Nakh		Ingush	
	Daghestanian (4 families)			
Kartveian	(2–3 branches)		Georgian	
Turkic	(2–5 branches)		Tuva	*
Tungusic	(2 branches)		Nanai	*
Mongolian	same		Modern Mongolian	*
Chukotkan	same		Chukchi	*
Gilyak	isolate		Gilyak	*
Yeniseian	same		Ket	*
Uralic	Finno-Ugric		Komi, Hungarian	*
	Samoyedic		Yurak	*
Yukagir	isolate	Uralic?	Yukagir	*
Ainu	isolate		Ainu	
Japanese	same		Japanese	
TOTAL: 15	23			9

(Low-density figure in Table 1 groups Uralic and Yukagir as one stock; high-density figure separates them.)

\*\* Only surviving branches of Indo-European are listed.

## NEW GUINEA. Stocks shown only where known.

STOCKS	FAMILIES	SAMPLE LANGUAGE
	Sepik Hill	Alamblak
	?	Amele
	Torricelli	Arapesh
	Central South Coast	Asmat



STOCKS	FAMILIES	SAMPLE LANGUAGE
Sepik-Ramu	Ram	Awtuw
	?	Barai
	?	Bo Ung
E.N.G. Highlands	Eastern Central	Hua
E.N.G. Highlands	Kalam	Kobon
	Awyu	Kombai
	Waris	Waris
	Dani	Yali
Upper Sepik	Tama	Yessan-Mayo
	Lower Sepik	Yimas
TOTAL:	>60 (Foley 1986)	14 languages

AUSTRALIA. The generic stock name 'Northern Australian' is used for 11 distinct families that may well represent distinct stocks. '\*' in the final column marks languages in the northern Australian subcontinental area.

STOCKS	FAMILIES	NOTES	SAMPLE LANGUAGE	NORTH
isolate	Tiwi		Tiwi	*
Northern Australian			Malak-Malak	*
Northern Australian			Gunwinggu	*
Northern Australian			Kuniyanti	
Northern Australian			Mangarayi	*
Northern Australian			Maung	*
Northern Australian			Nunggubuyu	*
Northern Australian			Nyigina	*
Northern Australian			Ungarinjin	*
Northern Australian			Warndarang	*
Northern Australian			Djingili	
Northern Australian			Garawa	
Pama-Nyungan			Western Desert	
Pama-Nyungan			Martuthunira	
Pama-Nyungan			Yukulta	*
Pama-Nyungan			Uradhi	
Pama-Nyungan			Dyirbal	
Pama-Nyungan			Ngiyambaa	
Southern Australian		Pama-Nyungan?	Wemba-Wemba	

NORTH AMERICA (= U.S. and Canada) (Source: Campbell & Mithun 1979:39ff., with some changes.)

'\*' in the final column marks families represented on the West Coast (the sample language is from the West Coast for all these families except Athabascan).

STOCKS	FAMILIES	NOTES	SAMPLE LANGUAGE	WEST COAST
Achomawi-Atsugewi	same		Atsugewi	*
Algonquian-Ritwan	Algonquian		Cree	
	Ritwan	2 families?	Yurok	*
Alsea	isolate			*
Atakapa	isolate		Atakapa	
(Beothuk)	isolate	affiliation unknown		
Caddoan	same		Pawnee	
Chitimacha	isolate		Chitimacha	
California Penutian	Yokuts		Yawelmani	*
	Miwok		S. Sierra Miwok	*
	Costanoan			*

STOCKS	FAMILIES	NOTES	SAMPLE LANGUAGE	WEST COAST
	Maiduan		Maidu	*
	Wintun		Wintu	*
Klamath-Modoc	Klamath	likely Penutian		*
	Modoc	" "		*
Sahaptian	Sahaptin	likely Penutian		*
	Nez Perce	" "	Nez Perce	*
Cayuse	?			*
Molala	?			*
Chinookan	same	Penutian?	Wishram	*
Chimakuan	same			*
Coos	isolate	Penutian?	Coos	*
Kalapuya	isolate	Penutian?		*
Coahuiltecan	same?			
Comecrudan	several?			
Eskimo-Aleut	Eskimo			
	Aleut			
Haida	Haida	Na-Dene?	Haida	*
Na-Dene	Tlingit		Tlingit	*
	Eyak			*
	Athabaskan		Navajo	*
Yuman	same	Hokan	Diegueño	*
Pomoan	same	Hokan	E. Pomo	*
Chimariko	same	Hokan	Chimariko	*
Salinan	isolate	Hokan		*
Chumashan	same	Hokan?	Barbareño	*
Esselen	isolate	Hokan		*
Yanan	same	Hokan		*
Karok	isolate	Hokan	Karok	*
Shasta	isolate	Hokan	Shasta	*
Washo	isolate	Hokan	Washo	*
Iroquian	same		Seneca	
Karankawa	isolate			
Keresan	same		Acoma	
Kiowa-Tanoan	same		Kiowa	
Kutenai	isolate	with Salishan?	Kutenai	
Muskogean	same		Choctaw	
Natchez	isolate		Natchez	
Siouan	same		Lakhota	
Siuslawan	same		Siuslaw	*
Salishan	Bella Coola			*
	Main body:			*
	Coast			
	Tsamosan			
	Interior		Squamish	
	Comoxan			*
Takelma	isolate		Takelma	*
Timucua	isolate			
Tonkawa	isolate		Tonkawa	
Tsimshian	same			
Tunica	isolate		Tunica	
Uto-Aztecan**	Numic		Southern Paiute	
	Tubatulabal		Tubatulabal	
	Takic		Luiseno	*

STOCKS	FAMILIES	NOTES	SAMPLE LANGUAGE	WEST COAST
	Hopi			
	Southern:		Nevome	
	Sonoran			
Wakashan	Nootkan		Nootka	*
	Kwakiutlan			
Yukian	same		Wappo	*
Yuchian	same		Yuchi	
Zuni	isolate		Zuni	
TOTAL for North America:				
Stocks	Families			West Coast:
51	69			29 stocks, 41 families

\*\* Uto-Aztecán has an additional branch in Mesoamerica.  
 (Low-density figure in Table 1 assumes the Hokan languages except for Chumashan, form one stock, and groups California Penutian, Klamath-Modoc, and Sahaptian into one stock.)

MESOAMERICA

STOCKS	FAMILIES	SAMPLE LANGUAGE
Uto-Aztecán	Corachol	Cora
Totonac-Tepehua		Tepehua
Otomanguean		Mixtec
Tarascan	isolate	Tarascan
Tequistlatec-Jiquaque		Chontal
Mixe-Zoque		Mixe
Mayan		Tzutujil

SOUTH AMERICA. This area does not enter into the basic sample listed above, but the following languages were surveyed to give a thin sample.

STOCKS	FAMILIES	SAMPLE LANGUAGE
Carib		Hixkaryana
Tupian	Tupi-Guarani	generic
Je		Canela-Kraho
Peba-Yaguan		Yagua
isolate	isolate	Cayuvava
Mataco-Macca		Mataco
Arawakan		Axininca Campa
Mura		Pirahã
?	?	Worani (Auca)
Nambiquara		Nambiquara
Quechuan		Huánuco Quechua
Aymaran		Jaqi
Araucanian		Mapuche
?	?	Genaken

REFERENCES

ABRAMOVA, Z. A. 1984. Pozdnij paleolit aziatskoj časti SSSR. Paleolit SSSR, ed. P. I. Borisovskij, 302–46. (Arxeologija SSSR v 20-ti tomox.) Moscow: Akademija Nauk.  
 ACKERMAN, ROBERT E. 1984. Prehistory of the Asian Eskimo zone. In Sturtevant 1984:106–18.  
 ADOVASIO, J. M.; J. DONAHUE; and R. STUCKENRATH. 1990. The Meadowcroft radio-carbon chronology: 1975: 1988: Some ruminations. American Antiquity, to appear.

- ALLEN, J. 1989. When did humans first colonize Australia? *Search* 20:5.149–54.
- ; J. GOLSON; and R. JONES (eds.) 1977. *Sunda and Sahul: Prehistoric studies in Southeast Asia, Melanesia, and Australia*. London: Academic Press.
- AUSTERLITZ, ROBERT. 1980. Language-family density in America and North Eurasia. *Ural-Altaische Jahrbücher* 52.1–10.
- BENZING, J. 1955. *Die tungusischen Sprachen: Versuch einer vergleichenden Grammatik*. (Geistes- und Sozialwissenschaftliche Klasse, Abhandlungen, 1955:11.) Mainz: Akademie der Wissenschaften und der Literatur.
- BOAS, FRANZ. [1888] 1964. *The Central Eskimo*. Lincoln: University of Nebraska Press.
- BOWDLER, S. 1977. The coastal colonisation of Australia. In Allen et al. 1977:205–46.
- BURCH, ERNEST, S., JR. 1984. Kotzebue Sound Eskimo. In Sturtevant 1984:303–19.
- CAMPBELL, LYLE. 1988. Review of Greenberg 1987. *Lg.* 64.591–615.
- ; TERRENCE KAUFMAN; and THOMAS SMITH-STARK. 1986. Mesoamerica as a linguistic area. *Lg.* 62.530–70.
- , and MARIANNE MITHUN (eds.) 1979. *The languages of Native America: Historical and comparative assessment*. Austin: University of Texas Press.
- CINCIUS, V. I., et al. (eds.) 1975. *Sravnitel'nyj slovar' tunguso-man'čžurskix jazykov: Materialy k ètimologičeskomu slovarju*. Leningrad: Nauka.
- COMRIE, BERNARD. 1981. *The languages of the Soviet Union*. Cambridge: Cambridge University Press.
- DILLEHAY, T., and M. COLLINS. 1988. Early cultural evidence from Monte Verde in Chile. *Nature* 332.150–52.
- DUMOND, DON E. 1984. Prehistory: Summary. In Sturtevant 1984:72–9.
- ÈDEL'MAN, Dž. I. 1980. K substratnomu naslediju central'noaziatskogo jazykovogo sojuza. *Voprosy jazykoznanija* 1980:5.21–32.
- FLADMARK, KNUT R. 1979. Routes: Alternate migration corridors for early man in North America. *American Antiquity* 44.55–69.
- . 1986. Getting one's Berings. *Natural History* 95:11.8–19.
- FOLEY, WILLIAM A. 1986. *The Papuan languages of New Guinea*. Cambridge: Cambridge University Press.
- GAMKRELIDZE, T. V., and V. V. IVANOV. 1984. *Indoevropskij jazyk i indoevropejcy*. Tbilisi: Tbilisi University Press.
- GODDARD, IVES, and LYLE CAMPBELL. 1990. The history and classification of American Indian languages: What are the implications for the peopling of the Americas? *Proceedings of the First World Summit Conference on the Peopling of the Americas*, ed. by Robson Bonnichsen, to appear.
- GOLSON, JACK. 1977. No room at the top: Agricultural intensification in the New Guinea highlands. In Allen et al. 1977:601–38.
- . 1989. The origins and development of New Guinea agriculture. *Foraging and farming: The evolution of plant exploitation*, ed. by David Harris and Gordon Hillman, 678–87. London: Unwin Hyman.
- GREENBERG, JOSEPH H. 1987. *Language in the Americas*. Stanford: Stanford University Press.
- GRUHN, RUTH. 1987. On the settlement of the Americas: South American evidence for an expanded time frame. *Current Anthropology* 28.363–4.
- . 1992. The Pacific coast route: An alternative model of the initial peopling of the Americas. In Taylor 1992, to appear.
- GULYA, JÁNOS. 1974. Prarodina finno-ugrov i razdelenie finno-ugorskoj ètničeskoj obščnosti. In Lytkin et al. 1974:28–42.
- HAIMAN, JOHN. 1980. *Hua: A Papuan language of the eastern highlands of New Guinea*. (Studies in language companion series, 5.) Amsterdam: Benjamins.
- HARMS, ROBERT T. 1987. Uralic languages. *Encyclopedia Britannica*, 15th edn. Macropedia, 22.701–11.
- JACOBSEN, WILLIAM H., JR. 1989. The Pacific orientation of western North American languages. Paper presented at the Circum-Pacific Prehistory Conference, Seattle.

- JANHUNEN, JUHA. 1989. On the interaction of Mator with Turkic, Mongolic, and Tungusic. *Journal de la Société Finno-Ougrienne* 82:287–97.
- KAISER, MARK, and V. SHEVOROSHKIN. 1988. Nostratic. *Annual Review of Anthropology* 17:309–29.
- KAUFMAN, TERRENCE S. 1990. Language history in South America: What we know and how to know more. *Amazonian linguistics: Studies in lowland South American languages*, ed. by Doris Payne, 13–73. Austin: University of Texas Press.
- KLIMOV, G. A. 1964. *Ėtimologičeskij slovar' kartvel'skix jazykov*. Moscow: Akademija Nauk.
- KRAUSS, MICHAEL E. 1979. Na-Dene and Eskimo-Aleut. In Campbell & Mithun 1979:803–901.
- LYTKIN, V. I.; K. E. MAJTINSKAJA; and K. RÉDEI (eds.) 1974. *Osnovy finno-ugorskogo jazykoznanija: Voprosy proisxoždenija i razvitija finno-ugorskix jazykov*. Moscow: Nauka.
- MACARTHUR, ROBERT H. 1972. *Geographical ecology: Patterns in the distribution of species*. Princeton: Princeton University Press.
- MAJTINSKAJA, K. E. 1974. *Sravnitel'naja morfologija finno-ugorskix jazykov*. In Lytkin et al. 1974:214–382.
- MEIKLEJOHN, C. 1974. Biological concomitants of a model of band society. *International conference on the prehistory and paleoecology of western North American Arctic and Subarctic*, ed. by S. Raymond and P. Schledermann, 133–42. Calgary: University of Calgary Archaeological Association.
- MEILLET, ANTOINE. 1964. *Introduction à l'étude comparative des langues indo-européennes*. University, AL: University of Alabama Press.
- MELTZER, DAVID J. 1989. Why don't we know when the first people came to North America? *American Antiquity* 54:471–90.
- MULVANEY, D. J. 1975. *The prehistory of Australia*. 2nd edn. Harmondsworth: Penguin.
- NICHOLS, JOHANNA. 1986. Head-marking and dependent-marking grammar. *Lg.* 62:56–119.
- . 1992. Linguistic diversity and the origin of New World languages. In Taylor 1992, to appear.
- POPPE, NICHOLAS. 1955. *Introduction to Mongolian comparative studies*. (Mémoires de la Société Finno-Ougrienne, 110.) Helsinki: Suomalais-Ugrilainen Seura.
- . 1965. *Introduction to Altaic linguistics*. (Ural-Altaische Bibliothek, 14.) Wiesbaden: Otto Harrassowitz.
- RÉDEI, KÁROLY, and ISTVÁN ERDÉLYI. 1974. *Sravnitel'naja leksika finno-ugorskix jazykov*. In Lytkin et al. 1974:397–438.
- RILEY, I. D. 1983. Population change and distribution in Papua New Guinea: An epidemiological approach. *The biology of man in New Guinea*, ed. by R. L. Kirk and J. Golson, 125–32. (Journal of Human Evolution 12:1.) London: Academic Press.
- RINDOS, DAVID. 1984. *The origins of agriculture: An evolutionary perspective*. New York: Academic Press.
- ROGERS, R. A. 1985. Glacial geography and native North American languages. *Quaternary Research* 23:130–37.
- . 1987. Review of Greenberg 1987. *Current Anthropology* 28:662–3.
- RUHLEN, MERRITT. 1987. *A guide to the world's languages*, vol. 1: Classification. Stanford: Stanford University Press.
- SAPIR, EDWARD. [1916] 1949. Time perspective in aboriginal American culture: A study in method. *Selected writings of Edward Sapir*, ed. by David G. Mandelbaum, 389–467. Berkeley & Los Angeles: University of California Press.
- SEREBRENNIKOV, B. A., and N. Z. GADŽIEVA. 1986. *Sravnitel'no-istoričeskaja grammatika tjurkskix jazykov* (izdanie 2-e). Moscow: Nauka.
- SPENCER, ROBERT F. 1984. North Alaska coast Eskimo. In Sturtevant 1984:278–84.
- STURTEVANT, WILLIAM C. (ed.) 1984. *Handbook of North American Indians*, vol. 5: Arctic. Washington, D.C.: Smithsonian Institution.

- SUÁREZ, JORGE A. 1983. *The Mesoamerican Indian languages*. Cambridge: Cambridge University Press.
- . 1987. South American Indian languages. *Encyclopedia Britannica* (15th edn.) 22.792–9.
- SZATHMÁRY, EMŐKE. 1984. Peopling of northern North America: Clues for genetic studies. *Acta Anthropogenetica* 8.79–109.
- TAYLOR, ALLAN R. (ed.) 1992. *Proceedings of the Conference on Language and Prehistory*, Boulder, CO, March 1990. Stanford: Stanford University Press, to appear.
- TENIŠEV, E. R. (ed.) 1988. *Sravnitel'no-istoričeskaja grammatika tjurkskix jazykov: Morfologija*. Moscow: Nauka.
- TERRELL, JOHN. 1986. *Prehistory in the Pacific islands: A study of variation in language, customs, and human biology*. Cambridge: Cambridge University Press.
- TUTTLE, RUSSELL H. 1988. What's new in African paleoanthropology? *Annual Review of Anthropology* 17.391–426.
- WHITE, J. PETER, and JAMES F. O'CONNELL. 1982. *A prehistory of Australia, New Guinea, and Sahul*. Sydney: Academic Press.
- WIXMAN, RONALD. 1984. *The peoples of the USSR: An ethnographic handbook*. Armonk, NY: M. E. Sharpe.
- WOODBURY, ANTHONY C. 1984. Eskimo and Aleut languages. In Sturtevant 1984:49–63.
- WURM, STEPHEN A. 1982. *The Papuan languages of New Guinea*. Tübingen: Gunter Narr.

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[Received 22 January 1990;  
accepted 26 February 1990.]