Direct Evolutionary Links with Food from Domesticated Animals

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ABSTRACT

In a world sample of 186 diverse societies, associations between two cultural variables are usually measured by correlation coefficients applied to the scores of both variables for the individual societies. Direct evolutionary links between two variables may be revealed by applying correlation coefficients to differences between the members of 93 pairs of societies with adjacent serial numbers. The members of the same pair are relatively close in geographical location and therefore in environmental conditions. Amount of food was compared from six sources: domesticated animals, agriculture, hunting, gathering, fishing, and intercommunity trade. Agriculture and domesticated animals both are techniques for food production. Food from domesticated animals is associated with more frequent migration and with fewer government levels above the community. Direct evolutionary links with more food obtained from domesticated animals appear to include less food from agriculture, less cultural complexity, absence of bilateral kinship, occurrence of matrilineal kinship and of bride-price, and more permissiveness of premarital sexual behavior.

INTRODUCTION

The earliest society of *Homo sapiens* members was probably a single small community in Africa, approximately 200,000 years ago (Tishkoff *et al.* 2009). Each subsequent society therefore shares a common origin. Important differences between societies include how long ago they became differentiated from each other and how different is the geographical environment. Diamond (1997) emphasized the influence of the extensive Eurasian land mass.

Social Evolution & History, Vol. 10 No. 2, September 2011 49–66

Murdock and White (1969) selected a world sample of 186 diverse societies. The information on each society includes the year it was described and identification of a focal community for societies that contain multiple communities. White (1989) contributed further information on each society. Measures of cultural variables were reported in subsequent articles in *Ethnology*. Most of these articles were reproduced in a book (Barry and Schlegel 1980).

Relationships between two cultural variables have usually been measured by correlation coefficients. A limitation is that a high correlation does not necessarily reveal a direct evolutionary link between the two variables. Two cultural variables may be correlated because both of them are more strongly associated with one or more other variables. An example is that the amount of food obtained from domesticated animals is positively correlated with the amount of food obtained from agriculture. This correlation is not a direct evolutionary link. Murdock (1967) divided the world into six regions: sub-Sahara Africa, circum-Mediterranean, East Eurasia, Insular Pacific, North America, and South America. Many circum-Mediterranean societies obtain a substantial amount of their food from both domesticated animals and agriculture. Many North American societies obtain no food from either domesticated animals or agriculture. Food from domesticated animals and food from agriculture tend to share presence or absence in the same world regions without a direct evolutionary link with each other.

Domesticated animals and agriculture are alternative sources of food. Domesticated animals contribute wealth that is mobile. Pastoral societies are usually nomadic. Agriculture enables large amounts of food to be grown in a small area, requiring minimal labor between planting and harvesting. The difference between these two sources of food has sometimes resulted in antagonistic behavior. In Genesis, the first book of the Bible, the first two sons of Adam and Eve were Cain, a farmer, and Abel, who kept sheep. Jealous rage impelled Cain to kill Abel because God preferred Abel's offerings of lambs to Cain's offerings of vegetables. The ancestor of the Hebrews was Seth, the third son. Mongolia, a large territory of nomadic pastoral societies in eastern Asia, was the source of invasions into Europe by the Huns in the 4th century AD and subsequently by Jenghiz Khan and the Tatars in the 13th century.

PAIRS OF SIMILAR SOCIETIES

The 186 societies selected by Murdock and White (1969) were divided by Barry (2009) into 93 pairs. The members of each pair have adjacent serial numbers, beginning with 1 and 2, ending with 185 and 186. Numbers 1 and 2 are in southern Africa. Numbers 185 and 186 are in southern South America. The members of the same pair are relatively close to each other in geographical location. Seven pairs (7.5 %) contain members in two of the six world regions. Both members of these seven pairs are close to the border between adjacent regions.

The two members of the same pair are usually similar in important cultural variables, including sources of food and type of kinship. Correlations between two variables are applied to the difference between the members of the same pair in both variables. Using this application, a correlation that differs reliably from zero, either in the positive or negative direction, indicates the likelihood of a direct evolutionary link between the two variables. Analysis of the difference between members of the same pair resembles the procedure of matched pairs of individuals, such as homozygous twins.

The members of the same pair of societies are not identical. Each of the 186 societies differs from the 185 others in geographical location and in language. The members of the same pair therefore differ from each other in some cultural variables.

For a cultural variable, the difference between the members of the same pair is plus if the society with the odd serial number, such as 1 or 3, has a higher score and minus if the society with the even serial number, such as 2 or 4, has a higher score. If the score has two categories, such as present or absent, present is the higher score. If the score is an ordinal number with three or more levels, the plus or minus score includes the difference between the two ordinal numbers.

When a correlation between two variables is applied to the difference between members of the same pair, the maximum correlation is 1.00 if all the differences are the maximum plus or minus score for both members of all the pairs. The maximum correlation is –1.00 if one member has the maximum plus score and the other member has the maximum minus score in all the pairs. The correlation is zero if the scores are equally divided between plus or minus for both members of the same pair and plus for one member and minus for the other member of the same pair. The correlation applied

to the difference between members of the same pair omits pairs whose members have the same score because a zero difference does not contribute to the direction of the difference. Also omitted are pairs in which either member has no score because of insufficient information about either of the two variables.

STATISTICAL METHODS

The association between two cultural variables was measured by the Pearsonian correlation coefficient, also called the product-moment correlation. The maximum possible correlation is 1.00 or –1.00, depending on whether high scores of one variable correspond perfectly with high or low scores of the other variable. The minimum possible correlation is zero if the positive and negative relationships between the two variables are equal in frequency and magnitude. The correlation coefficients between two selected variables were applied to two different measures. One measure consists of the difference between the members of the same pair on both variables. The other measure consists of the scores of the individual societies on both variables.

Statistical significance of the difference of each correlation from zero was tested by the more stringent two-tailed criterion, estimating the probability that a difference from zero correlation is larger than can be attributed to random variation in either the positive or negative direction. A probability of less than 5 % ($p < .05$) is generally regarded as statistically significant.

The statistical programs (Norusis 2009) are adapted to personal computers. They were developed by the SPSS Company, which was recently purchased by International Business Machines Corporation.

NUMERICAL SCALE FOR SIX FOOD SOURCES

Source of food is a basic cultural variable. Barry, Child and Bacon (1959) distinguished between high and low food accumulation. Domesticated animals and agriculture enable high accumulation. The food from these sources can be consumed as needed for multiple days. Fishing and hunting are limited to low accumulation. The food needs to be obtained almost every day. Societies with high food accumulation usually train children to be compliant, measured by emphasis on obedience, responsibility, and nurturance. Societies with low food accumulation usually train children to be assertive, measured by emphasis on achievement, self reliance, and general independence.

Amount of food from domesticated animals has special importance as a cultural variable. It is an important food source in the United States of America, in the Russian Federation, and in other industrialized nations although some individuals refuse to eat meat and some of them also refuse to eat eggs and to drink milk obtained from animals. More than half of the total food is obtained from domesticated animals in a substantial number of pastoral societies.

In the *Ethnographic Atlas* (Murdock 1967), five sources of food are the first of several dozen cultural variables, applied to more than a thousand societies. They are agriculture, domesticated animals, fishing, hunting, and gathering. A total number of 10 constitutes the sum of the numerical score for each source. An article on subsistence economy (Murdock and Morrow 1970) improved the measures of each source and added a sixth source, intercommunity trade. The authors estimated separately the amount of food obtained from each of the six sources, on a scale from 0 to 7. The six variables were applied to the sample of 186 societies (Murdock and White 1969).

The present author devised an ordinal scale from 0 to 4 for amount of food. Some of the seven categories are combined because they contribute the same amount of food. 0: None. 1: Less than 10 % of the total. 2: More than 10 % of the total. 3: More food than any other single source but less than 50 % of the total. 4: More than 50 % of the total.

For each food source, Table 1 shows the number of societies with each score, 0 to 4. The number of societies (N) is slightly less than 186 for four of the six sources because of insufficient information for a score.

Table 1

For each of six food sources, the number of societies is shown with each score 0–4 on the amount of total food, followed by the number (N) of societies with each score

Food Source	Scores on Amount of Food					N
	0	1	2	3	4	
Domesticated Animals	50	66	54	0	16	186
Agriculture	38	17	12	42	77	186
Hunting	21	85	61	8	7	182
Gathering	15	116	40	7	3	181
Fishing	28	78	55	10	13	184
Intercommunity Trade	62	81	38	0	2	183

For food from agriculture, the maximum score of 4 contains 77 societies. For food from domesticated animals, the score of 4 contains the much smaller number of 16 societies, but they are more than for any of the other four food sources. Food from domesticated animals contains 50 societies with the score of zero. They are exceeded only by 62 for food from intercommunity trade.

In Table 2, amount of food from domesticated animals is correlated with amount from each of the other five sources. The correlation with food from agriculture is –.43 when applied to differences between the members of the same pair. This negative correlation has a statistically significant difference from zero in spite of the small number of 34 pairs in which the two members have a different score on both food sources. A direct negative evolutionary link may be inferred between the two food sources. The member of the same pair that obtains more food from domesticated animals usually obtains less food from agriculture.

Table 2

Amount of food from domesticated animals is correlated with amount of food from five other food sources. The correlations, with the number of cases for the correlations, are applied to the difference between the members of the same pair and to the scores of individual societies

Food Source	Correlation		Number	
	Pairs	Scores	Pairs	Scores
Agriculture	–.43*	.11	34	186
Hunting	–.22	–.38***	31	182
Gathering	–.15	–.31***	34	181
Fishing	–.45**	–.48***	37	184
Trade	.06	.27***	33	183

Note: * $p < .05$; ** $p < .01$; *** $p < .001$.

The correlation of food from domesticated animals with food from agriculture, when applied to the scores of individual societies, is .11. This low correlation indicates a positive instead of negative relationship between the two food sources. The maximum possible positive correlation is less than 1.00 because a society with the highest scores of 3 and 4 on one source must have lower scores on the other sources.

The positive correlation of food from domesticated animals with food from agriculture, applied to the scores of individual societies, is attributable to a link of both food sources with one or more

other variables. Geographical location is associated with both food sources. The circum-Mediterranean region contains many societies with a score of 2 or higher on both food sources. North America contains many societies with a score of 0 on both food sources. Degree of technological development also contributes to the positive association. A high degree of technological development is necessary for food production from domesticated animals and also from agriculture. Less technological development is sufficient for food collection from gathering, fishing, and hunting.

Table 2 shows negative correlations of food from domesticated animals with food from hunting, gathering, and fishing. The negative correlations with hunting and gathering are much closer to zero when applied to the differences between members of the same pair than when applied to the scores of individual societies. The negative correlations therefore are largely attributable to opposite correlations with one or more other variables. Food from domesticated animals is positively correlated with technological development. An increase in technological development enables food from domesticated animals to substitute for food from hunting. Similarly, food from agriculture substitutes for food from gathering.

The negative correlation of food from domesticated animals with food from fishing is similar, whether the correlation is applied to the differences between members of the same pair or to the scores of individual societies. A negative evolutionary link is that food from domesticated animals might decrease the need to obtain food from fishing. A link with a different variable is that a favourable environment for food from domestic animals might usually be unfavourable for food from fishing.

The correlation of food from domesticated animals with food from intercommunity trade, shown in Table 2, is close to zero when applied to differences between members of the same pair. A fairly high positive correlation, when applied to the scores of individual societies, is probably attributable to correlations of domesticated animals and intercommunity trade with one or more other variables. An example is that many societies in one world region, South America, obtain no food from domesticated animals and also no food from intercommunity trade.

CORRELATIONS WITH CULTURAL COMPLEXITY

Murdock and Provost (1973) reported for each society a score between 0 and 4 on ten measures of cultural complexity and

the total score between 0 and 40. Table 3 omits agriculture from the measures of complexity because it is similar to agriculture as a source of food. All the correlations are negative when applied to the differences between members of the same pair. More food from domesticated animals therefore appears to have a direct evolutionary link with less cultural complexity. The highest negative correlations are with sedentary residence, government levels, writing, and social stratification. These four negative correlations, and total cultural complexity, differ reliably from zero in spite of the reduced number of pairs with a different score on both variables. The member of the same pair that obtains more food from domesticated animals develops less cultural complexity.

Table 3

Amount of food from domesticated animals is correlated with nine measures of cultural complexity and the total of the ten measures. The correlations, with the number of cases for the correlations, are applied to the difference between the members of the same pair and to the scores of individual societies

Complexity	Correlation		Number	
	Pairs	Scores	Pairs	Scores
Sedentary	–.45*	.01	29	186
Government Levels	–.40*	.30***	35	186
Writing	–.39*	.28***	29	186
Stratification	–.36*	.29***	34	186
Money	–.34	.22**	29	186
Population Density	–.26	.22**	38	186
Urbanization	–.26	.13	40	186
Land Transport	–.12	.22**	17	186
Specialization	–.09	.39***	35	186
Total Complexity	–.36*	.30***	49	186

Note: * $p < .05$; ** $p < .01$; *** $p < .001$

When applied to the scores of the individual societies, Table 3 shows that food from domesticated animals has a positive correlation with each measure of cultural complexity. The positive correlations are not attributable to a direct evolutionary link between more food from domesticated animals and more cultural complexity. Food from domesticated animals and the measures of cultural complexity both require a high degree of technological development. Specialization

is the measure of cultural complexity that is most associated with technological development. Accordingly, the correlation between amount of food from domesticated animals and specialization is the highest positive number (r = .39) when applied to scores of individual societies and is the negative number (r = –.09) closest to zero when applied to the differences between members of the same pair.

In the world sample of 186 diverse societies, agriculture is dominant over the other food sources. Agriculture in a small area can feed a large population. Agriculture thereby is associated with sedentary residence and hierarchical government levels. The highest government level can develop military forces to conquer the neighbors and build empires that control large portions of the Earth's surface.

Food from domesticated animals is an alternative to agriculture as a technique of food production. In comparison with agriculture, an advantage of food from domesticated animals is more protein in the diet. The families that own and tend the valuable domesticated animals resist the development of hierarchical government levels.

Table 4

Amount of food from domesticated animals is correlated with several other cultural variables. The correlations, with the number of cases for the correlations, are applied to the difference between the members of the same pair and to the scores of individual societies

Complexity	Correlation		Number	
	Pairs	Scores	Pairs	Scores
Bilateral kinship	–.90***	–.30***	15	186
Matrileal kinship	.73**	–.02	12	186
Patrileal kinship	.15	.33***	23	186
Bride-price	.51*	–.06	20	186
Sex. Permiss. Girls	.43**	.03	25	144
Sexual freedom	.50**	.02	32	144
High Gods	–.10	.49***	25	167

Note: * p < .05; ** p < .01; *** p < .001

CORRELATIONS WITH OTHER CULTURAL VARIABLES

Murdock and Wilson (1972) reported on five kinship types: patrilineal (P), matrilineal (M), bilateral (B), double (D), and ambilin-

eal (A). In Table 4, food from domesticated animals is correlated with the three kinship types that occur in the largest numbers of societies. Kinship is patrilineal in 75 societies, bilateral in 69, and matrilineal in 26.

When applied to differences between members of the same pair, the negative correlation of food from domesticated animals with bilateral kinship is extraordinarily high (–.90). The difference from zero is statistically significant in spite of the small number of 15 pairs in which the members have a different score on both correlated customs.

Table 5

In all except one of 14 pairs of societies, the member with less food from domesticated animals (DA), shown on the left, had bilateral descent (B) instead of patrilineal (P), matrilineal (M), or double (D) descent

Society	Name	DA	Desc.	Society	Name	DA	Desc.
2	Kung Bush-men	0	B	1	Nama Hottentot	2	P
9	Hadza	0	B	10	Luguru	1	M
13	Mbuti	0	B	14	Nkundo Mongo	1	P
37	Amhara	2	B	38	Bogo	4	P
45	Babylonians	2	B	46	Rwala Bedouin	4	P
54	Russians	2	B	53	Yurak Samoyed	4	P
71	Burmese	1	B	72	Lamet	2	P
83	Javanese	1	B	84	Balinese	2	P
93	Kimam	1	B	94	Kapauku	2	P
118	Ainu	0	D	117	Japanese	1	B
135	Pomo	0	B	136	Yokuts	1	P
150	Havasupai	0	B	149	Zuni	2	M
160	Haitians	2	B	159	Goajiro	4	M
171	Inca	1	B	172	Aymara	2	P
175	Trumai	0	B	176	Timbira	1	M

Table 5 lists the 15 pairs of societies in which one member has bilateral kinship and the other member has a different type of kinship. Only one of the 15 bilateral societies, 117 Japanese, obtains more food

from domesticated animals than the other member of its pair, 118 Ainu. When applied to the scores of individual societies, the correlation of –.30 is also negative and reliably different from zero. In comparison with –.90, the correlation of –.30 is much closer to zero.

A direct evolutionary link appears to connect more food from domesticated animals with kinship that is not bilateral. The principal alternative to bilateral kinship is either patrilineal or matrilineal. Domesticated animals that provide food constitute important resources for the families that own them. Patrilineal or matrilineal kinship strengthens the ability of the family to manage domesticated animals and to transmit them to the next generation.

Table 6 shows a comparison between matrilineal descent and other types of descent that are not bilateral. Six of the eight matrilineal societies obtain more food from domesticated animals than the other member of their pair. In Table 5, four of the 15 societies that obtain more food from domesticated animals than the other member of their pair have matrilineal kinship. If the four matrilineal societies in the same pair as a bilateral society in Table 5 are added to the eight matrilineal societies in Table 6, matrilineal descent occurs in ten of the 12 societies that obtain more food from domesticated animals than the other member of their pair.

Table 6

In all except two of eight pairs of societies, the member with more food from domesticated animals (DA), shown on the right, had matrilineal descent (M) instead of patrilineal (P), ambilineal (A), or double (D) descent

Society	Name	DA	Desc.	Society	Name	DA	Desc.
6	Suku	1	M	5	Mbundu	2	D
7	Bemba	1	M	8	Nyakyusa	2	P
42	Riffans	2	P	41	Ahaggaran	4	M
73	Vietnamese	1	P	74	Rhade	2	M
100	Tikopia	0	P	99	Siuai	2	M
107	Gilbertese	0	A	108	Marshallese	1	M
143	Omaha	0	P	144	Huron	1	M
166	Mundurucu	0	P	165	Saramacca	1	M

Table 4 shows that when applied to differences between members of the same pair, the positive correlation of .73 between food from domesticated animals and matrilineal kinship is high enough to be a statistically significant difference from zero in spite of the small number of 12 pairs. This difference is also statistically significant ($p = .038$) when tested by the difference from an equal number of matrilineal societies obtaining more food and less food from domesticated animals than the other member of the same pair. When applied to the scores of individual societies, the correlation of –.02 is close to zero and in the opposite direction.

A direct evolutionary link appears to connect more food from domesticated animals with matrilineal kinship. The domesticated animals that are sources of food are generally owned by family members. This family ownership of an important source of wealth is compatible with matrilineal kinship, which emphasizes and broadens family affiliation. Matrilineal kinship counteracts the development of higher government levels, which are associated with bilateral kinship more often than with matrilineal or patrilineal kinship.

Table 4 shows that for the difference between members of the same pair, food from domesticated animals has a low positive correlation with patrilineal kinship ($r = .15$), which is not reliably different from zero. In contrast with bilateral and matrilineal kinship, scores of individual societies show that patrilineal kinship has a statistically significant positive correlation ($r = .33$) with amount of food from domesticated animals. High frequency of food from domesticated animals and occurrence of patrilinal kinship in the world regions of circum-Mediterranean and East Eurasia might account for this correlation between food from domesticated animals and patrilineal kinship.

More food from domesticated animals than from all other sources combined, indicted by the highest score of 4, occurs in Table 5 for three societies and in Table 6 for one society. Table 7 lists the other 12 societies with the highest score of 4 on food from domesticated animals. Type of kinship, shown for each society in Table 7, is patrilineal except for bilateral in two societies and double in one society.

Murdock (1967) coded the 186 societies on seven modes of obtaining a wife. The first is bride-price, transfer of a substantial

consideration in the form of livestock, goods, or money from the groom or his relatives to the kinsmen of the bride.

Table 7

Twelve societies with a score of 4 on food from domesticated animals are listed in addition to four in Tables 5 and 6. Kinship type is patrilineal (P) in 9 of the 12 societies

Society	Name	Kinship
25	Wodaabe Fulani	P
34	Masai	P
36	Somali	P
38	Bogo	P
40	Teda	P
52	Lapps	B
55	Abkhaz	P
58	Basseri	P
61	Toda	D
65	Kazak	P
66	Khalka Mongols	P
121	Chukchee	B

The other six modes are grouped together as a different category. They are bride-service by the groom for the bride's family, token bride-price (a small or symbolic payment only), dowry (a gift by the bride's family to the groom's family), gift exchange, exchange of a sister or other female relative, and absence of any significant consideration except bridal gifts.

In Table 4, a positive correlation of food from domesticated animals with bride-price is high and is reliably different from zero when applied to differences between members of the same pair. The correlation is close to zero and in the opposite direction when applied to scores of individual societies. Food from domesticated animals appears to have a direct evolutionary link with substantial gifts from the groom's family to the bride's family. Domesticated animals that contribute food are valuable, mobile, and easily transmittable forms of wealth. Livestock is included in Murdock's definition of bride-price. The custom of bride-price strengthens affiliation of the individual with the matrilineal or patrilineal kinship, counteracting affiliation with a higher level of government.

Table 4 contains a measure of premarital sexual permissiveness for girls and a measure of premarital sexual freedom for both boys and girls. Sexual permissiveness for girls is one of the several

dozen codes in the *Ethnographic Atlas* (Murdock 1967). Seven categories of premarital sex relations for females are redefined into an ordinal scale with four levels. 1: Prohibited, strongly sanctioned, and in fact rare or precluded by a very early age of marriage for females. 2: Prohibited but weakly censured and not infrequent in fact. 3: Allowed and not sanctioned unless pregnancy results. 4: Trial marriage or freely permitted. Sexual freedom for boys and girls is derived from ordinal scales of sexual expression and sexual restraint by adolescent boys and girls (Barry and Schlegel 1984). The scores for restraint are subtracted from the scores for expression. The scores for boys and girls are added. The scores for the societies ranged from –16 to +16. Barry (2007) corrected a few errors in the article by Barry and Schlegel (1984).

In Table 4, the positive correlations of food from domesticated animals with both measures of sexual permissiveness are high and differ reliably from zero, measured by differences between members of the same pair. The correlations are close to zero measured by scores of the individual societies. Barry (2007), using partial correlations and a regression analysis, reported evidence for a functional link of premarital sexual freedom for boys and girls with fewer government levels above the community and with matrilineal kinship. Fewer government levels usually minimize restrictions on premarital behavior by adolescents. Matrilineal kinship minimizes the need to identify or involve the father of a baby born to an unmarried adolescent girl. These functional relationships probably contribute to a direct evolutionary link of food from domesticated animals with premarital sexual permissiveness. Food from domesticated animals appears to have a direct evolutionary link with fewer government levels above the community (Table 3) and with matrilineal kinship (Table 4).

The last variable in Table 4 measures belief in a high god (Swanson 1980). Murdock (1967) included this variable in the *Ethnographic Atlas.* A high god is defined as a spiritual being who is believed to have created all reality and/or to be its ultimate governor. The four categories form an ordinal scale. 1: Absent or not reported in substantial descriptions of religious beliefs. 2: Present but otiose or not concerned with human affairs. 3: Present and active in human affairs but not offering positive support to human morality. 4: Present, active, and specifically supportive of human morality. Most of the societies with category 4 have a predominantly Christian or Muslim population. Societies with

these and other religious adherents were identified by Schlegel and Barry (1991).

Food from domesticated animals has a low negative correlation with the ordinal scale for belief in a high god ($r = -.10$) when applied to differences between members of the same pair. Food from domesticated animals has a high positive correlation ($r = .49$) when applied to scores of individual societies. The correlated variables do not appear to have a direct evolutionary link. Both variables have a link with geographical region. Many societies in the circum-Mediterranean region have a high score on amount of food from domesticated animals and on belief in a high god. Many societies in the Insular Pacific region have a low score on both variables.

PRIOR COMPARISONS BETWEEN PAIRS OF SOCIETIES

A recent analysis of pairs of societies was by Barry (2009). In the world sample of 186 diverse societies, government levels above the community were correlated with other customs. When correlations were applied to the differences between members of the same pair instead of to the scores of the individual societies, the member of the pair with more government levels usually had higher scores on several measures of cultural complexity, had bilateral kinship, obtained less food from domesticated animals, contained a large building in the community, and continued schooling of girls for a longer duration prior to adolescence.

An advantage of the prior report on correlations with government levels above the community is the prominence of cultural evolution from independent communities to great nations. An advantage of the present report on correlations with amount of food from domesticated animals is that most cultural variables are probably influenced more directly by the source of food than by government levels above the community.

Barry (2009) emphasized that when applying correlations to the scores of individual societies, the evolutionary link may be with other variables instead of the two correlated variables. Correlations applied to the differences between members of the same pair do not eliminate this disadvantage but they do partially counteract it. Barry (2009) also emphasized the reduction in number of cases when applying correlations to differences between members of the same pair. The 186 societies are reduced to 93 pairs. The number

of pairs is reduced further because the pair members need to have a different score on both correlated variables.

An earlier analysis of differences between members of the same pair of societies (Barry 1969) selected 12 pairs that are members of the same cluster. The members of each cluster are similar in every known respect and became separated from the same society less than 1,000 years earlier (Murdock 1967: 412). The member of the same pair that trained children to be more compliant instead of assertive also usually obtained more food from agriculture or from domesticated animals than from fishing, hunting, or gathering, treated infants more indulgently, and drunkenness was less frequent. Because of the similarity between members of the same cluster, this study was limited to a small number of pairs of societies that differed in the variables that were correlated. Subsequent attempts by Barry failed to find consistent differences between pairs of societies that were members of the same cluster.

POSSIBLE ANALYSES OF CULTURAL EVOLUTION

The consecutive serial numbers of the societies, and thereby the members of the same pair, were selected by Murdock and White (1969) on the basis of geographical closeness and general cultural similarity. A desirable modification of correlations applied to differences between members of the same pair might be to select pairs that have a small difference in the year they were described and that share the same linguistic family. This selection would minimize the duration while the members of the same pair became differentiated from their common antecedent society.

A disadvantage of language family as the criterion for pairs is that many of the members of the same pair would be greatly separated geographically because of migration by one or both pair members. Geographical proximity might be a preferable criterion for assignment to the same pair. Cultural evolution includes adaptation to the geographical environment. If pairs are assigned on the basis of both geographical proximity and the same language family, the number of pairs would be reduced and the increased similarity of the members of the same pair would further decrease the number of pairs with different scores on both of the variables that are correlated.

Analyses of differences between members of the same pair of societies can be applied to more societies than the standard sample

of 186 societies. The last book by Murdock (1981) contains information on 561 societies. The cultural customs of each society include most but not all of the variables in the *Ethnographic Atlas* (Murdock 1967).

INTERPRETATIONS FROM CORRELATIONS

Differences between members of the same pair contribute evidence that more food obtained from domesticated animals has a direct evolutionary link with several cultural variables. Evidence for an evolutionary link between two cultural variables does not determine the causal direction of the link. For example, the high negative correlation of food from domesticated animals with bilateral kinship, applied to differences between members of the same pair, does not determine whether more food from domesticated animals causes avoidance of bilateral kinship or whether bilateral kinship causes less food from domesticated animals. The causation might be concurrently in both directions. More food from domesticated animals in the member of the same pair with bilateral kinship may not originate or perpetuate because these cultural variables are not compatible. Instead, more food from domesticated animals in the member of the same pair with matrilineal kinship may originate and perpetuate because these cultural variables are highly compatible.

Knowledge about cultural variables may be more useful than correlation coefficients for determining the causal direction of a direct evolutionary link. A cultural variable that is unstable and easily modified is likely to be the cause of a change in a custom that is stable and resistant to change. Adoption of a new cultural variable that is suitable for a new environment may be followed by adoption of other compatible variables.

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