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# Cultural Diversification and Decimation in the Prehistoric Record<sup>1</sup>

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by William C. Prentiss and  
James C. Chatters

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The history of human cultures is frequently marked by a distinctive pattern of evolution that paleobiologists term "diversification and decimation." Under this process, fundamentally new socioeconomic systems appear during periods of dramatic cultural diversification, typically through cultural cladogenesis. Significant diversification episodes come about under conditions that favor group economic success under effective or geographic isolation. Typically short-lived, they are often followed by abrupt decimation under more competitive economic conditions. Regional archaeological sequences, viewed from this perspective, suggest that (1) cultural evolutionary trends are strongly conditioned by historical contingency, though general evolutionary processes are continuously active; (2) the emergence of new systems may be contingent on economic opportunities associated with niche reorganization; and (3) severe competition such as that associated with demographic stress will generally favor decimation.

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The present paper was submitted 5 II 01 and accepted 1 V 02.

1. We are grateful to Richard Brolly, Aubrey Cannon, Brian Hayden, and Heather Pratt for sharing excavation reports and unpublished manuscripts with us. We thank Ken Ames, Meredith Chesson,

Although the problem of cultural origins and transformations remains central to archaeology (Ames 1985; Arnold 1993; Binford 1968; Flannery 1973; Hayden 1981, 1990, 1995a), a number of researchers have sought to expand the scale of our inquiry to longer-term trends in cultural evolution (Ames 1981, 1983; O'Brien and Lyman 2000; Rosenberg 1994; Schiffer 1996; Spencer 1997). Most critical has been the recognition that cultural evolutionary process operates on a variety of scales. Long-term differential persistence of variation is recognized on the microevolutionary scale of artifact and attribute (O'Brien and Lyman 2000) and the macroevolutionary scale of state and empire (Spencer 1997). In this paper we argue that the study of long-term trends in cultural evolution is fundamental for expanding our understanding of the evolutionary process. Toward this end, we outline and demonstrate a macroevolutionary hypothesis that cladogenesis or splitting has been responsible for the emergence of often highly diversified cultural *Baupläne* (structural designs) (Rosenberg 1994, Spencer 1997) during relatively short periods in the prehistoric past. Such high diversity appears to persist only under conditions of significant economic opportunity as expressed through reorganization of the human niche (see Binford 2001). When more economically stressful and competitive conditions return, diversification gives way to decimation. Therefore, this pattern of cultural change is similar to that described by Gould (1989) for biological macroevolution. Support for it is found in the Holocene paleoenvironmental and archaeological sequences from the Pacific Northwest, Great Basin, and Great Plains regions of North America. We suggest that the model adds to our understanding of cultural evolution through its explicit consideration of cultural cladogenesis, selection on the scale of cultural *Baupläne*, and linkage to paleoecological contexts. A major implication of this model is that demographic pressure does not generally promote human creativity and, consequently, new *Baupläne*.

## An Evolutionary Hypothesis: Diversification and Decimation

Gould's (1989) diversification-and-decimation hypothesis of biological evolution has generated intense debate over a variety of paleobiological issues including the very nature of the evolutionary process (Briggs, Fortey, and Wills 1992, Foote and Gould 1992, Gould 1993, McShea 1993, Ridley 1993). Whatever the outcome of the debate in paleobiology, the hypothesis has important implications for an understanding of cultural evolution.

Evolutionists have defined culture as a complex system of information transmission and associated human behavior (Boyd and Richerson 1985, Cavalli-Sforza and

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Junko Habu, Brian Hayden, Benjamin Orlove, Michael Rosenberg, Charles Spencer, and several anonymous reviewers for their comments on earlier drafts of the paper.

Feldman 1981, Dunnell 1980, Durham 1991, O'Brien and Lyman 2000). They have demonstrated that sorting processes such as drift and natural selection operate on cultural variation and, when combined with the effects of the transmission process, produce changing patterns of culture (e.g., Neiman 1995). However, Spencer (1997) posits that the simple microevolutionary model of unidirectional trait variation and selection cannot explain the rise of complex societies such as the Monte Alban state, which evolved through conscious or directed decisions favoring conquest and socioeconomic subjugation at the level of state government. He argues that "selection on the interlocality level was evidently suppressed or overridden by relatively stronger selection on the regional and multilocality level" (Spencer 1997:245). Actions at higher hierarchical levels of complex cultures will have far-reaching effects, potentially down to the level of the smallest traits favored for study by microevolutionists. Rosenberg (1994) argues that the most critical changes will occur in the ideational component or *Bauplan* of the socioeconomic infrastructure. This is cultural evolution on a macroevolutionary scale, similar to the model described by paleobiologists (e.g., Stanley 1979, 1998; see also Simpson 1944). This model implies that the evolution of complex systems may feature dynamics that differ from those of simple microevolution (Kauffman 1993).

Our hypothesis is that cultural evolution on the grandest scale proceeds through the differential emergence and survival of new *Baupläne*, as expressed behaviorally in resource management systems, forming an evolutionary pattern of punctuated equilibrium (per Eldredge and Gould 1972). Although behavioral expressions or systems will vary enormously with local conditions (Rosenberg 1994), significant change in *Baupläne* can occur only under circumstances that favor the implementation of new integrated forms of socioeconomic behavior. Two basic conditions are required: productive environments that encourage experimentation with new tactics and isolation from control and/or swamping by dominant cultural forces. Some periods of extraordinary environmental change may provide the optimal conditions for short-term diversification of socioeconomic systems. The emergence of Holocene environments and subsequent cultural diversification is a global example of this (Bar-Yosef and Meadow 1995, Hayden 1981, Richerson, Boyd, and Bettinger 2001). Variation on this scale is rarely long-lived; either more competitive social conditions emerge or continuing environmental changes make some early forms maladaptive. The result of this latter process is decimation, whereby the number of *Baupläne* that can operate within a given landscape is drastically reduced by competition and/or environmental inequity. This process of diversification and decimation marks many of the major transitions to new forms of human culture.

For substantial changes of this nature to occur, altered conditions must have the effect of freeing a closed system (Rosenberg 1994) to vary in critical ways. The writings of Spencer (1997) and Crumley (1995) suggest that

the emergence of new sociopolitical systems will be derived from alterations in the forms of cultural control hierarchies; for example, as autonomous villages become integrated within a centrally controlled hierarchy, they in essence produce a new system. The scale of selection then shifts up to that of the new system. When considering the emergence of smaller-scale systems such as those of hunter-gatherers, we can also recognize alterations in the locus of selection, but the extrapolation model described above will not be adequate to explain new socioeconomic systems that are not associated with drastically altered political organization.

Binford (2001:460) proposes a solution to this problem, suggesting that hunter-gatherer and small-scale horticulturalist groups have periodically filled relatively empty niche space, resulting in new "organizational collectivities" with substantial internal homogeneity and increased freedom of access to resources due to removal from previous competitive conditions. On the surface, Binford's concept of niche filling seems appropriate for understanding human socioeconomic diversification. However, we are concerned that it could also imply human diversification into multiple niches within the same habitat, a practice rarely if ever found among human groups. We suggest that the idea of niche reorganization better describes the process by which people change their resource choices or emphases, their scheduling and geographic positioning of resource use, and, sometimes, their patterns of resource distribution. Niche reorganization will have the effect of reducing the degree and form of contact between offspring and parent groups, and it is well known that alteration of communication in itself can have severe effects on rates of culture change (Arnold 1993; Cashdan 1980; Hayden 1981, 1994, 1995b; Hitchcock and Ebert 1984). Niche reorganization can come about as a consequence of human population movements into contexts of geographic isolation, as has occurred with the establishment of permanent occupations on remote islands and coastlines (Kirch 2000). Effective isolation, which is largely social and may occur under conditions of band/community fissioning, can also result in reorganization of scheduling, mobility, communication, and mating networks.

Under either the geographic or the effective-isolation model, microevolutionary forces (e.g., Boyd and Richerson 1985, 1992) may play a major role in quickly generating cultural variation. When these processes act on ideologies structuring or affecting economic organization or infrastructure—the cultural equivalents of regulatory genes (cf. Rosenberg 1994)—we can expect archaeologically visible change. Schiffer (1996:655) has called rise of cultural variants under altered conditions "stimulated variation," and Rosenberg (1994) resurrects Foster's (1960) concept of "cultural crystallization" to label this process.

Decimation of cultural *Baupläne* is associated with incompatibilities between human behavior and ecological conditions and/or intensely competitive relationships between human populations (Rosenberg 1994). Whatever the cause, this extinction process may be ev-

ident in declining human health, population reduction, and various markers of failing economic systems, including resource depression among hunter-gatherers and severe currency devaluation, political instability, and warfare in more complex societies (Broughton 1994, Chatters 1995, Tainter 1988).

### Tracking the Persistence of Cultural Variation on a Macroevolutionary Scale

If cultural *Baupläne* persist, the challenge for archaeologists is to devise a means for recognizing individuals at the macroevolutionary scale and measuring variation in their form. This is the same difficulty that is faced by paleobiologists in their attempts to identify species in the paleontological record: many of the criteria used to distinguish among living cultures—like the soft-tissue and behavioral characteristics, not to mention reproductive barriers, that are used to distinguish among living species—are not available to us. We can only directly observe what are in effect the skeletons of human behavior in patterns of artifact distribution (using “artifact” in its broadest sense [Dunnell 1973]).

As is argued by Rosenberg (1994), the *Bauplan* is the heritable or genealogical component of a given cultural pattern. In reference to resource management systems, it provides the basic design and ideological justification for fundamental resource procurement and distribution operations. It follows, then, that a *Bauplan* for a given resource management system could be expressed behaviorally in multiple ways depending upon the ecological context. Therefore, in order to recognize cultural macroevolutionary process, it becomes important to be able to distinguish between variations within a resource management system and the emergence of new *Baupläne*.

The fundamental issue for the identification of a new *Bauplan* is determining the degree to which a given system can extend itself to fit ecological variation without going beyond its indigenous knowledge base. Thus we ask at what point resource-management-system variation ceases and a new *Bauplan* emerges. We suggest that the answer lies in the fundamentally important realms of subsistence scheduling, processing, distribution, and consumption. As Bettinger and Baumhoff (1982) have argued for hunter-gatherers, some systems are simply antithetical to one another. In other words, the scheduling of mobility, subsistence pursuits, and consumption tactics are so different that no group could switch from one system to another without risking severe deprivation. Variation in some forager tactics may be so fundamental as to imply different *Baupläne*.

Following Binford (1980) and others (e.g., Bettinger and Baumhoff 1982), archaeologists have learned to recognize a variety of hunter-gatherer strategies, depending on (among other things) the extent to which they exhibit immediate or delayed food consumption, limited versus extensive task-group or logistical mobility, and varying degrees of resource intensification. Archaeologists can

also recognize wide variation in horticulturalist tactics depending upon such things as degree of mobility, crop types and cropping frequency, and complementary employment of hunting and gathering (Kent 1989, Morrison 1994). Using what Binford (1977) calls middle-range theory, we can measure patterns of subsistence (including modes and diversity of predation and production), consumption, mobility, technology (e.g., Binford 1980; Chatters 1987, 1995), exchange (e.g., Renfrew 1969, Torrence 1986), and, to a lesser degree, social ranking as it affects the distribution of food and goods within a population (e.g., Ames 1995, Hayden 1995a). When a particular constellation of these patterns appears that is fundamentally incongruent with ancestral practices, we infer the origin of a new *Bauplan*; when the pattern can no longer be perceived, the *Bauplan* has become extinct.

When seeking to elucidate universal processes of cultural development, we tend to compare the material signatures of similar *Baupläne* from multiple historical sequences and geographic areas, but to understand the evolution of specific resource management systems we must confine ourselves to genetically related historical sequences of *Baupläne*. This requires that we be able to demonstrate “heritable continuity” (O’Brien and Lyman 2000) across potentially large geographic regions and time spans. This is important, first, because it allows us to address the tempo of evolution (e.g., Simpson 1944). For example, by directly tracking inheritance of cultural patterns through ancestor-descendent relationships, we can ask whether evolution takes the form of punctuated equilibrium or phyletic gradualism (per Eldredge and Gould 1972; see also O’Brien and Lyman 2000). Second, it allows us to address the mode of evolution. Do new resource management systems emerge through an anagenetic process, essentially one cultural pattern being transformed in situ into the next, or does change take the form of cladogenesis—the splitting of cultural lineages? If cladogenesis has been important in affecting the diversity of resource management systems, how many episodes are responsible?

Establishment of heritable continuity requires the construction of lineages. O’Brien and Lyman (2000) suggest that archaeologists seeking to construct lineages need to make use of homologous and analogous traits as indicators of degrees of relatedness. They recommend application of a variety of updated seriation techniques including the use of clade-diversity diagrams. Resource-management-system *Baupläne* represent complex but heritable information packages. No two will be exactly alike, but from a structural standpoint there will be significant resemblances among them. Collectors in the Rocky Mountains emphasizing sheep and bison may be structurally similar in the use of logistical mobility and delayed consumption strategies to those of the Plateau, whose primary resources are salmon, roots, and deer. Because they embody similar characteristics resulting from independent (for the sake of argument) evolutionary histories, they are analogous. Presumably, collector-like systems have come into being many times in many places. Yet, resource-management-system *Baupläne*

could, like other heritable functional traits, evolve, forming lineages that could be tracked in part by virtue of the persistence of unique characteristics. If this were the case, then, looking to the details beyond simple resource-management-system structure, archaeologists could view the similar *Baupläne* as homologues.

### Cultural Diversification and Decimation in the Archaeological Record

The process of cultural diversification and decimation can be seen in the archaeological records of the northern Great Plains, the Great Basin, and the Pacific Northwest (including the Plateau [Chatters 1995] and the Northwest Coast [Matson and Coupland 1995]). In presenting portions of the records for each of these regions, we review the paleoecological context and indicators of variation in hunter-gatherer and horticulturalist *Baupläne*.

To infer resource management systems, we look for indicators of variation in subsistence and mobility scheduling and strategies of resource processing and consumption. To classify this variation we rely in particular on Binford's "forager-collector" continuum and Bettinger and Baumhoff's (1982) distinction between "travelers" and "processors." We assume, for purposes of this study, that travelers and processors, respectively, represent low- and high-energy investment forager strategies. Thus, foragers who move greater distances between residential sites, emphasizing, when possible, higher-ranked resources, are using a traveler-like strategy. Foragers whose residential mobility emphasizes short moves in order to invest higher processing time in lower-ranked resources are more processor-like. It is more difficult to match Binford's collectors with the processor/traveler modes, since collectors tend to be less residentially mobile but typically emphasize the harvest of high-ranked resources such as caribou in the Nunamiut case (Binford 1968) or aggregate-harvested fish and sea mammals in many Northwest Coast and Plateau examples (Binford 2001, Chatters 1995). Beyond resource characteristics, however, collectors tend to have a greater resemblance to processors (Bettinger 1991).

We posit genealogical relationships between resource management systems on the basis of culture-historical research, and in doing so we use traditional culture-historical terminology as a heuristic for describing segments of the archaeological record. There is no intent to equate elements of the record described at unequal scales. We acknowledge that more rigorous testing, using, for example, the methods proposed by O'Brien and Lyman (2000), will help to clarify many current ambiguities. Recognition of hypothetical genealogical relationships helps us to define the tempo and mode of change within each region. We argue in each case that (1) major cultural changes occurred within short-term *Bauplan* diversification events resulting from cladogenesis associated with niche reorganization and (2) most cultural variants

were short-lived, declining as competitive conditions returned.

#### PATTERNS OF EVOLUTION

*The Pacific Northwest.* The pattern of Holocene culture change in the Pacific Northwest is characterized by a lengthy Early Holocene (ca. 9,000–5,000 cal. B.P.<sup>2</sup>) period of limited change (at least as perceived under current formulations from limited data) followed by a Middle Holocene burst of cultural variation (fig. 1). Briefly, this early period is dominated by hunter-gatherer traditions known archaeologically as the Old Cordilleran, North Coast Microblade, and Nesikep traditions. The archaeological record for this time frame in the interior and on the coast exhibits some variation (Carlson 1998) but generally appears to have featured relatively frequent residential mobility, use of a relatively diversified subsistence base, little significant storage, and (therefore) immediate food consumption (Ames and Maschner 1999, Chatters and Pokotylo 1998, Coupland 1998, Matson and Coupland 1995, Prentiss and Chatters 2002, Stryd and Rousseau 1996). This is clearly a classic forager-like pattern and may have been quite similar to that of Bettinger and Baumhoff's (1982) travelers. Low stylistic diversity in artifacts probably indicates extensive social interaction across the region (e.g., Jefferies 1997). While there is evidence for variation in resource management systems in the form of specific resource use and aggregation patterns, there is no sign of sustained *Bauplan* divergence. Variation in sea level (Fladmark 1975) and climate under generally warm conditions (e.g., Chatters 1998) may have been sufficient to preclude sustained intensification (see Richerson, Boyd, and Bettinger 2001).

Diversification in *Baupläne*, including the persistence of some Early Holocene resource-management-system variants, occurred between 5,600 and 4,200 cal. B.P. Canadian Plateau archaeologists have argued for the overlapping of two systems known as the Lehman and Lochnore phases (Pokotylo and Mitchell 1998, Stryd and Rousseau 1996). These populations appear to have been residentially mobile, employing very little formal storage as might be reflected in either storage features or faunal remains. Further, lithic artifacts reflect a highly portable technology designed more typically for mammal harvesting and processing than for either fishing or long-term shelter construction. Prentiss and Kuijt (2001) argue that Lehman and Lochnore represent terminal manifestations of the Nesikep tradition and thus may not contribute substantially to the heritage of later peoples in this region.

During this time frame we recognize several distinctive designs whose scheduling, processing, and resource distribution requirements extend beyond simple varia-

2. All dates are based upon <sup>14</sup>C assays, calibrated at 2 sigmas and presented in the form "cal. B.P." with the present as A.D. 1950. Any discrepancy between the dates presented here and in previous papers (e.g., Chatters 1995) is due to the use of calibrations in the current work but not previously.

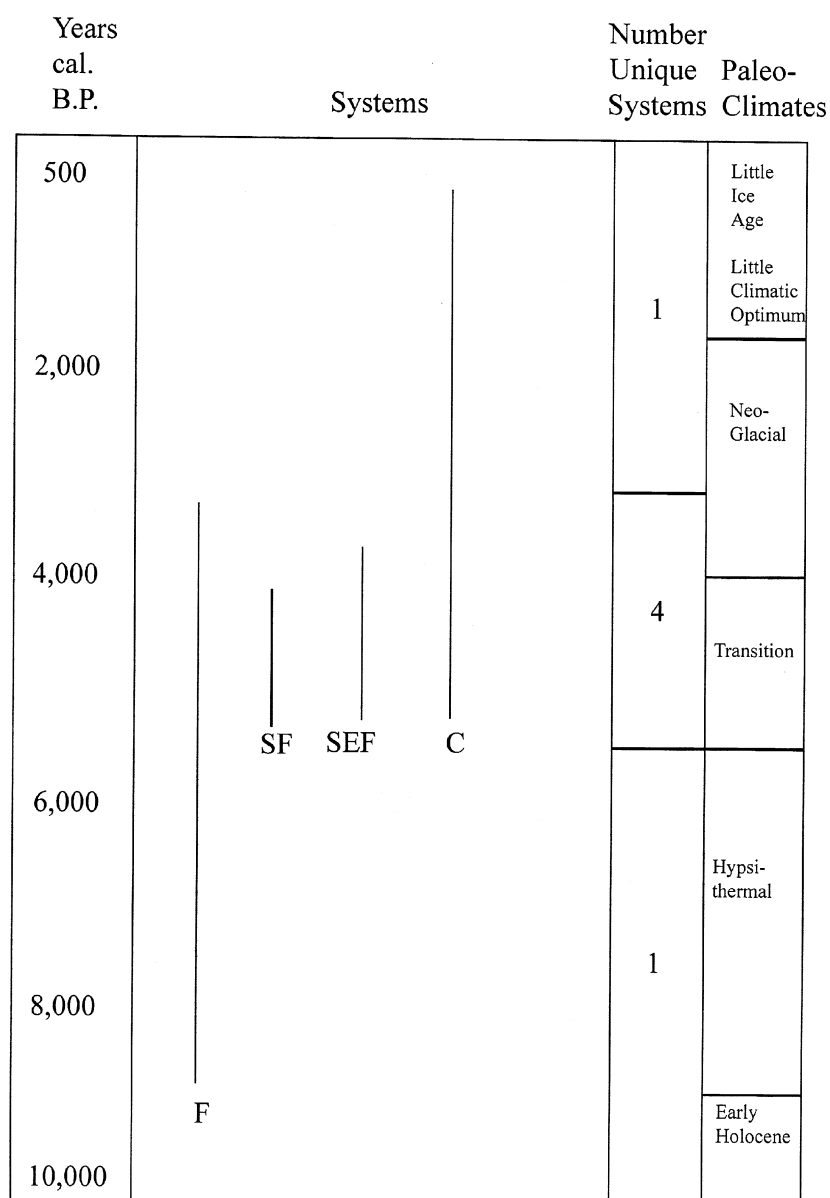


FIG. 1. *Pacific Northwest cultural and paleoenvironmental sequence illustrating cultural diversification and decimation between approximately 6,000 and 3,000 cal. B.P.* F, mobile foragers; SF, sedentary foragers; SEF, serial foragers; C, collectors.

tion in resource management systems and therefore probably reflect new *Baupläne*. The Columbia Plateau featured a short-lived system termed Pithouse I by Chatters (1989, 1995) with a pattern of annual to semiannual sedentism, an extremely diversified subsistence strategy, and a near total lack of food storage made possible in part by the placement of residential sites in ecotones (Chatters 1989, 1995). A similar archaeological signature is recognizable in the Lower Fraser Valley of British Columbia, where it is known as the Eayam phase of the Charles culture. Residential sites of the Eayam phase

feature the use of large rectangular houses suggesting a high degree of sedentism. These sites are located in ecotones, evidence for storage is lacking, and technology is similar to that of Pithouse I (Mason 1994, Prentiss and Kuijt 2001, Schaepe 1998). The Middle Holocene occupants of the Middle Columbia system and the Lower Fraser Valley seem to have possessed variant resource management systems with a single new *Bauplan*. The sudden replacement of Old Cordilleran high mobility and ephemeral house construction with subannual to annual sedentism, formal house construction, and use

of ecotones in settlement positioning in lieu of storage is sufficient to warrant this distinction.

The mainland and inshore islands of the central and northern Northwest Coast appear to have been occupied by populations possessing variants of another distinctive system. The Gulf of Georgia witnessed the sudden emergence of the Charles culture, with Mayne and St. Mungo phases. Intensification of salmon fishing supported by the rapidly increasing use of ground-slate tools appears in an otherwise "broad" subsistence strategy (Coupland 1998:41) but one with little evidence for storage or sedentism (Carlson and Hobler 1993, Matson 1989, Moss and Erlandson 1995, Pratt 1992). The Obsidian culture, defined by Mitchell (1988) in the Queen Charlotte Strait area, is technologically similar to the Charles culture, with a lithic-raw-material emphasis on obsidian and an immediate-return subsistence strategy focused on terrestrial mammalian resources (Coupland 1998). From an economic standpoint, the Obsidian culture may not be very different from the Charles culture despite its stronger emphasis on mammalian resources, but its intense use of obsidian for stone tool production could reflect the effects of some degree of geographic isolation. Data from Prince Rupert Harbor (Period III), British Columbia, and Hidden Falls and other nearby sites in southeastern Alaska suggest increased sedentism with a narrowing subsistence strategy that emphasized deer and salmon but little evidence for food storage. A single house structure is documented at Hidden Falls II, and artifact assemblages are somewhat similar to those of the Charles culture, including ground-slate points, abrading stones, wedges, harpoons, and labrets (Lightfoot 1989, MacDonald and Inglis 1981, Matson and Coupland 1995, Moss 1998).

On the southern Northwest Coast, the immediate-return foraging system called the Early Littoral presents similarities to the Charles culture (Lyman and Bennett 1991, Lyman and Ross 1988, Matson and Coupland 1995, Minor and Toepel 1986). It should be recognized that data on the Middle Holocene in this region remain exceptionally sparse (Erlandson, Tveskov, and Byram 1998), thus precluding any firm conclusions on adaptive variability.

Taken together, the Charles culture, Obsidian culture, and North Coast data appear to indicate mobility and subsistence pursuits rather different from those of recent or earlier times. Given the substantially increased interassemblage variability in faunal remains and the absence of signs of sedentism or storage, we suggest that serial foraging (Binford 1980) could explain localized intensification of specific resources. This probably represented an adaptation close to the traveler mode but organizationally different from the more resource-diversified and mobile foraging systems of earlier times.

The Baker site, from the interior Canadian Plateau, remains enigmatic. This is a small house-pit site dating between 4,400 and 5,400 cal. B.P. with indicators of multiple seasons of occupation, small storage pits, and a large assemblage of salmon bone (Chatters and Pokotylo 1998, Wilson Consultants 1992). It does not appear to reflect

the pattern of winter sedentism and intensive logistical organization common in this area after 3,500 cal. B.P. (Chatters and Pokotylo 1998), although some form of special-task-group mobility may have been employed to access certain resources (Prentiss and Chatters 2002). Prentiss and Kuijt (2001) argue that Baker appears to reflect exploration of the Fraser-Thompson area by one or more small groups originating either on the coast or in the central Columbia area (see also Wilson Consultants 1992).

Two other sites may reflect systemic variation on the coast during this time frame. Subsistence data from the Namu site, from the central coast of British Columbia (Cannon 1991, 1998, 1999; Carlson 1998), are significantly at variance with patterns seen elsewhere on the Northwest Coast in the Middle Holocene, with an overwhelming emphasis on salmon and shellfish. The general absence of salmon head parts suggests the possibility of a delayed-return subsistence strategy. To some (Cannon 1998, Coupland 1998) this suggests an early collector system featuring intensification of salmon fishing and winter storage. Others posit that salmon consumption at a single site such as Namu could reflect not an early winter-village pattern but periodic aggregation of mobile groups (Ames 1998). If the latter is the case, then this could represent an interesting aspect of the serial forager *Bauplan* discussed above. Artifact assemblages from the Yuquot I site, from the west coast of Vancouver Island, suggest differentiation from the Charles culture and Namu patterns, particularly in the abundance of shell and bone artifacts and the near complete lack of lithic artifacts (Coupland 1998, Dewhirst 1980). The subsistence remains from Yuquot have not been adequately studied, precluding conclusions about the resource management system in place in this context.

Fladmark, Ames, and Sutherland (1990; see also Severs 1974) document an early archaeological complex from the Queen Charlotte Islands known as the Graham tradition. Although much more study of these data is necessary (Ames 1998), the Graham tradition exhibits strong resemblances to the collector *Bauplan* that becomes common throughout the region after about cal. 3,500 B.P. Dated from approximately 5,000 to 2,000 cal. B.P., with the most intense occupation at 4,500 cal. B.P., the Graham tradition component of the Blue Jackets Creek site is characterized by deep shell middens containing well-developed shell, bone, antler, and ground-stone tool industries emphasizing harpoons, fishhooks, and ground-stone knives, clubs, and labrets. House structures are suggested by the coassociation of fire-cracked rock, hearths, living floors, and pits. Faunal assemblages feature high diversity with an emphasis on sea mammals and shellfish. Both warm- and cold-season fauna are present. Looking beyond Blue Jackets Creek, special-activity sites such as Skogland's Landing (Fladmark 1970) may reflect operation of logistical task groups.

Cultural evolution in the Pacific Northwest during the Middle Holocene is clearly not a matter of gradual change from one entire pattern to another (anagenesis) but a consequence of splitting or cladogenesis (Coupland

1998, Erlandson, Tveskov, and Byram 1998, Matson and Coupland 1995, Moss 1998). An early split from the Old Cordilleran resource-management-system variant may have occurred on the Oregon coast as early as 6,000 cal. B.P. (Lyman and Ross 1988). The unique subsistence pattern at Namu appeared shortly after 5,600 cal. B.P. (Carlson 1991). The Pithouse I, Charles culture, Obsidian culture, and some North Coast patterns (Hidden Falls, Prince Rupert Harbor) appear to have diverged simultaneously (from an archaeological standpoint) at approximately 5,300 cal. B.P. from a common origin in the Old Cordilleran culture. Finally, the unique cultural pattern reflected at Yuquot is dated to approximately 5,000 cal. B.P. (Coupland 1998). Yuquot's ancestral culture is still unclear, but it is most likely the Old Cordilleran as well. Meanwhile the resource-management-system variant associated with the North Coast Microblade tradition appears to have split, forming first the Nesikep tradition and much later the Graham tradition. Thus cultural change in the Middle Holocene in the Pacific Northwest appears to have been a consequence of at least two processes of cladogenesis. Cultural diversity, at least as measured from the perspective of variation in *Bauplan*, peaked between 4,200 and 5,300 cal. B.P., with the contemporaneity of residentially highly mobile foragers or travelers, serial foragers, sedentary foragers, and early collectors. Nearly all of these systems became extinct between 4,200 and 3,500 cal. B.P. and were replaced by the winter-village collector *Bauplan*, with its probable origin on the Queen Charlotte Islands or the central coast of British Columbia. The spread of the collector system may mark movement of not just ideas but, in some areas, populations.

*The Great Basin.* Late Holocene archaeology in the Great Basin features the appearance of a variety of horticulturalist and hunter-gatherer *Baupläne* (fig. 2). For at least 3,000 years prior to 1,700 cal. B.P., the Great Basin appears to have been dominated by mobile foraging systems with highly diversified subsistence economies, described as "travelers" by Bettinger and Baumhoff (1982). Even where larger-scale settlements featuring house pits such as those associated with the Chewaucanian and Lovelock cultures of the western margin of the basin (Aikens 1994, Elston 1982, Oetting 1990) are known, subsistence strategies appear to have focused on diversified foraging and (primarily) immediate-return consumption. The emergent diversification included several Fremont variants, including sedentary horticulturalists, sedentary collectors, and more mobile collectors. To complicate things more, it would appear that some populations fluctuated in their employment of horticulture, switching between full-time collecting and farming on an inter-annual basis (Madsen and Simms 1998; Marwitt 1970, 1986; Simms 1986; Talbot and Richens 1996). Fremont systems appear to have varied so widely that archaeologists debate the usefulness of the concept as a taxonomic unit (Madsen and Simms 1998, Marwitt 1986). Central Great Basin populations remained committed to mobile foraging strategies, while additional diversity is recognizable in the western Great Basin with the emer-

gence of semisedentary collecting systems in the Owens Valley and in high-altitude contexts of the White Mountains, the Toquima Range (Bettinger 1977, Grayson 1993, Thomas 1982), and the Mojave Desert (Sutton 1996). Meanwhile, at the southern margins of the basin, relatively sedentary Anasazi horticultural systems existed between 1,700 and 700 cal. B.P. (Fowler and Madsen 1986). Beginning around 1,000 cal. B.P., Fremont and Anasazi systems began to fail in the face of economic pressure due to increasing aridity (Jones et al. 1999, Marwitt 1986, Stine 2000), reduction in the length of growing seasons (Petersen 1988), and intergroup competition (Madsen and Simms 1998). This competition was exacerbated by the expansion of Numic-speakers from the Mojave Desert, who brought with them the new hunter-gatherer resource management system that Bettinger and Baumhoff (1982) call the "processor." Simultaneously, semisedentary hunter-gatherer systems in the northern and western basin also disappeared (Aikens 1994). By 600 cal. B.P., the Great Basin was characterized primarily by variants of the processor *Bauplan*.

The emergence of variation in Great Basin systems after 1,700 cal. B.P. is the result of splitting by the earlier foraging systems and the expansion and divergence of horticultural and hunter-gatherer systems of the American Southwest (Aikens 1972; Grayson 1993, 1994; Madsen and Simms 1998; Marwitt 1986). Anasazi and Fremont variants likely have their origin in early horticultural systems of the Southwest and northern Mexico (Parr, Carlisle, and O'Rourke 1996), although Madsen and Simms (1998) argue that population movement appears only partially responsible for the Fremont phenomenon. Given their cultural and biological similarities, we suggest that this reflects common origin and thus cladogenesis. The diversity seen in the western Great Basin is also most likely the result of splitting associated with increasing territoriality and somewhat reduced mobility after 2,000 cal. B.P. (Gilbreath and Hildebrandt 1999). Maximum diversity in *Baupläne* between 1,700 and 1,000 cal. B.P. included high-mobility travelers with limited use of storage, more residentially sedentary collectors using storage, desert processors, semisedentary horticulturalists, and, in the Anasazi and some Fremont cases, sedentary horticulturalists. The later failure of horticultural systems (Jones et al. 1999, Madsen and Simms 1998, Marwitt 1986) and their replacement by processors originating in the Mojave Desert (Bettinger and Baumhoff 1982, Kaestle 1997) is now well established.

*The Great Plains.* The late Holocene prehistoric chronology of the northern Great Plains (including the northwestern Plains [e.g., Frison 1991]) provides a third example of diversification and decimation (fig. 3). The cultural systems of the Late Archaic period (ca. 3,500–1,600 cal. B.P.) were relatively homogeneous in their emphasis on small bands, relatively high mobility, communal bison hunting (when possible), and reliance on winter food storage in the form of pemmican and frozen meat caches (Frison 1991, Reeves 1990). The focus on geographically extensive residential mobility, low



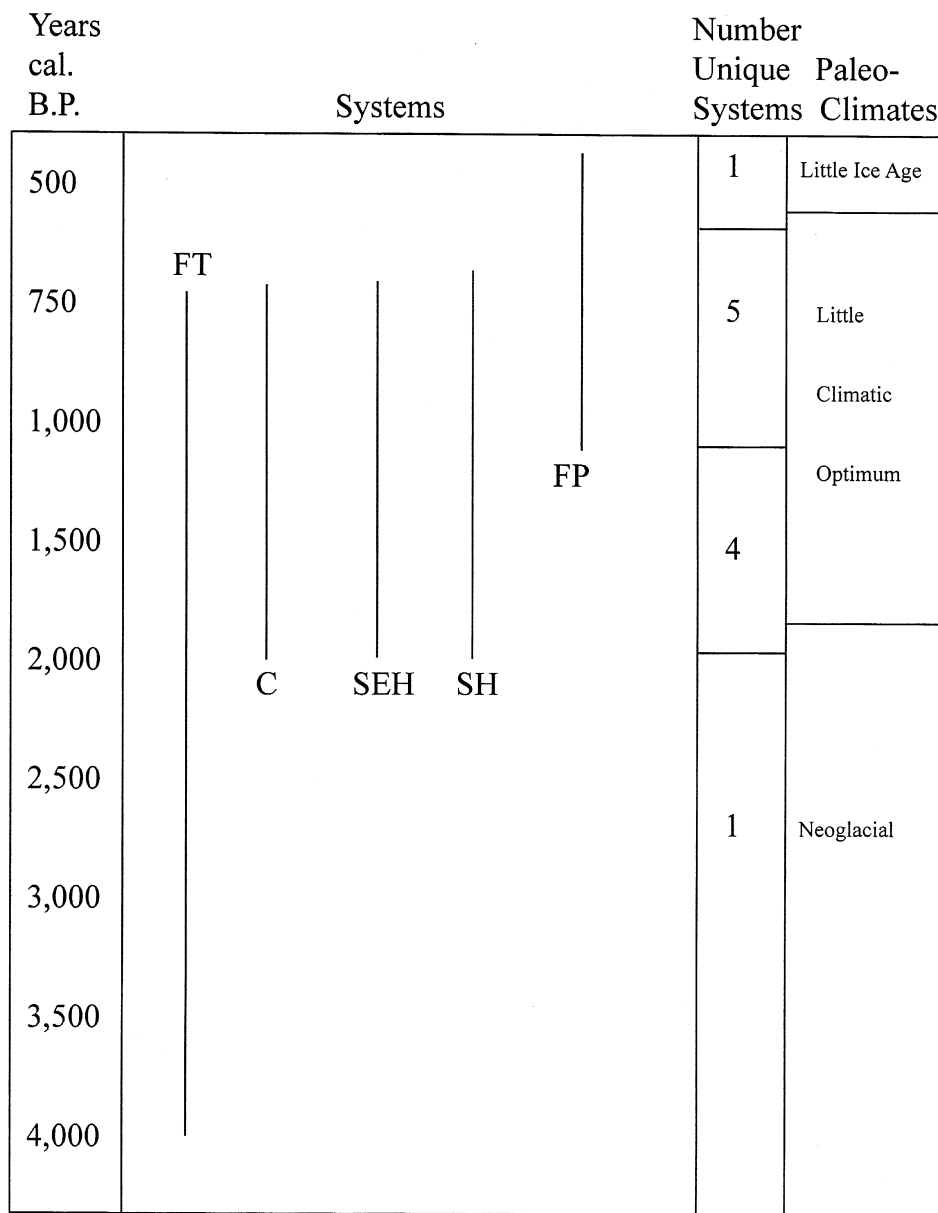


FIG. 2. Great Basin cultural and paleoenvironmental sequence illustrating cultural diversification and decimation between approximately 2,000 and 500 cal. B.P. FT, mobile foragers/travelers; C, collectors; SEH, semisedentary horticulturalists; SH, sedentary horticulturalists; FP, mobile foragers/processors.

population density, and resource emphasis on larger game suggests a traveler orientation. The role of logistical mobility has not been adequately assessed, but Bamforth (1997) has argued that bison-oriented Plains hunter-gatherers were more forager-like in that they "mapped-on" (Binford 1980) to resource patches through residential mobility. By 2,000 cal. B.P., however, a number of new cultural entities had begun to appear. *Bauplan* diversification in the late period on the Plains appears to have occurred in two major phases following an early expansion of the range of resource management systems

operating in the region. Beginning around 2,000 cal. B.P. the traveler *Bauplan*, represented by the Pelican Lake complex, began to vary to an increasing degree. Two major techno-complexes, Avonlea and Besant, overlapping with late Pelican Lake, emerged at this time. Economically there were only subtle differences between these, and thus we consider them variants on a single *Bauplan*. Significantly, populations associated with the early Avonlea complex may have been the first on the Great Plains to employ the bow and arrow in bison hunting (Reeves 1990).

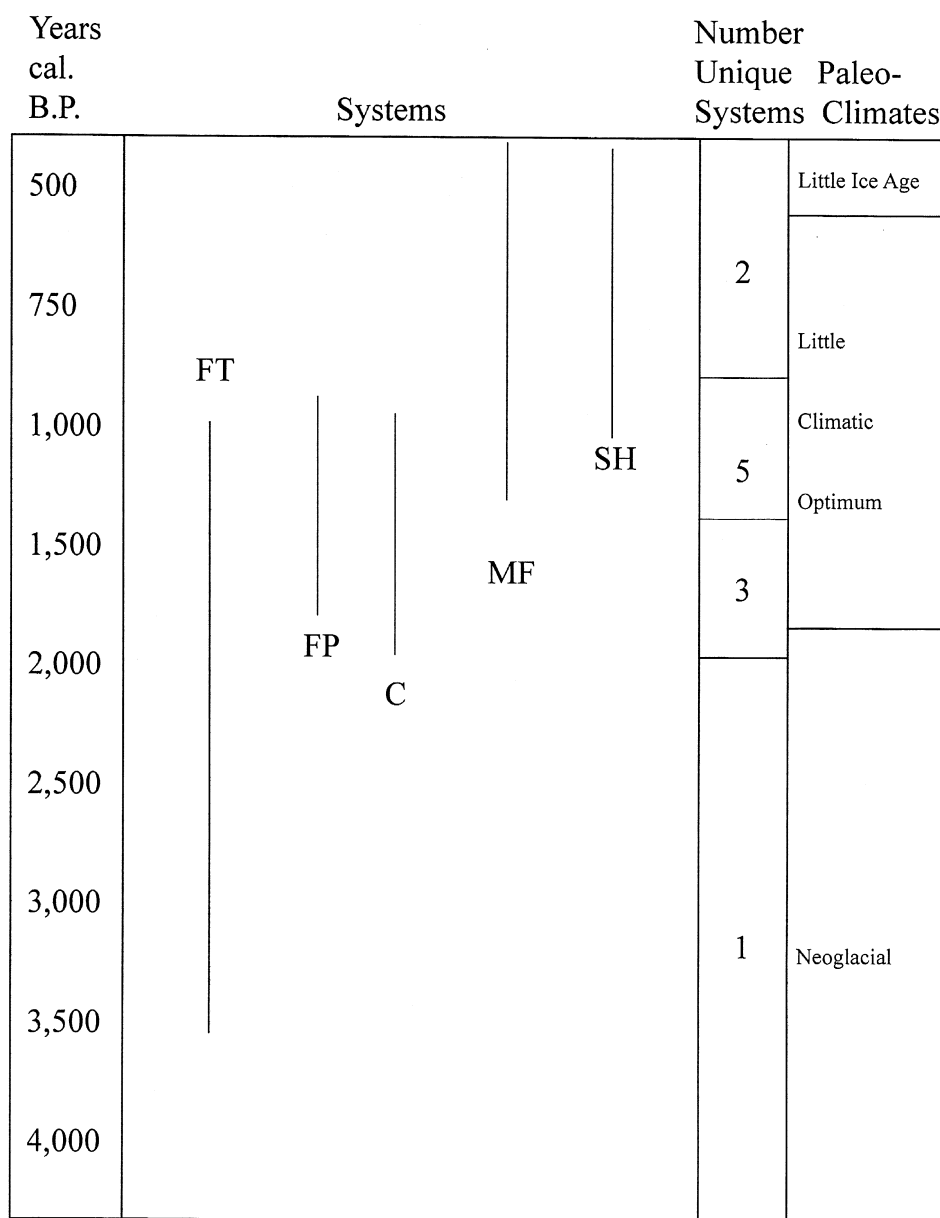


FIG. 3. Great Plains cultural and paleoenvironmental sequence illustrating cultural diversification and decimation between approximately 2,000 and 500 cal. B.P. FT, mobile foragers/travelers; FP, mobile foragers/processors; C, collectors; MF, mutualist foragers; SH, sedentary horticulturalists.

Between 1,900 and 1,500 cal. B.P. we recognize the first of two phases of *Bauplan* divergence within this region. The intermontane basins of southern Montana and western Wyoming witnessed the emergence of a system of high-mobility foraging at about 1,700 cal. B.P. In this context, people emphasized plant resources and lower-ranking fauna but apparently did not employ any significant storage strategies (Prentiss 2000). They appear to have spent very little time in montane contexts, confining their site occupations almost entirely to the open desert-shrub terrain of the interior basins (Prentiss 2000,

Prentiss, Romanski, and Douthit 1988). This resource management system bears some resemblance to that of processors, since the primary resources appear to have been plants with high processing costs, populations were larger (Frison 1991), and distances between settlements were apparently short. It differs from the classic processor model (Bettinger 1991) in that residential moves appear to have been relatively frequent. Further, although evidence is currently lacking for the array of specialized harvesting and processing tools used by the processors of the late prehistoric Great Basin, the emphasis of lithic

technological organization also shifted from direct quarrying of stone from high-quality sources and production of curated tools to the production of expedient tools from low-grade secondary sources (Prentiss 2000, Prentiss, Romanski, and Douthit 1988). Overall, this change appears to have been substantial, with a major reorganization of resource emphases, scheduling, patterns of technological organization, and demography.

The same period saw the emergence of a set of hunter-gatherer resource-management-system variants reflecting at least one new *Bauplan* in the Middle Missouri area (and elsewhere to the south and east). The Plains Woodland period is still not well understood from a socioeconomic standpoint. Excavation data, however, indicate a combination of ephemeral and more extensive camps featuring small house structures and storage pits, subsistence emphases on seeds, roots, and a diverse fauna ranging from bison to fish, and some indicators of localized variation in artifact style that may reflect group membership and possibly territories (Benn 1983; Bozell and Winfrey 1994; Toom 1992a, 1996; Winham and Lueck 1994). These data appear to imply collector-like behavior with increasing energy expenditures on resource processing. Steadily increasing site densities also suggest that population was on the rise and that some degree of localized packing was occurring (Benn 1983). Late Plains Woodland complexes (Truman Mounds, Loseke Creek, and Cross Ranch) featured a continuation of hunting and gathering, combined in some places with the possible practice of horticulture (Benn 1990, Johnson and Johnson 1998). We suggest that the late appearance of horticulture was not a substantial reorganization of Woodland society but a small-scale exploration of new subsistence options and thus a variant resource management system.

The second phase of *Bauplan* divergence features the emergence of the terminal Late Prehistoric bison-hunter and Plains Village cultural patterns. With the appearance of the Old Women's phase by about 1,300 cal. B.P., foraging on the northwestern Plains was transformed from a traveler-based subsistence focus to what was in essence a form of mutualism; bison products were exchanged for horticultural items from the Middle Missouri area and prestige goods originating as far away as the Gulf Coast (Frison 1991, Reeves 1990, Speth and Spielmann 1983). Thus, while mobility strategies probably did not change substantially, resource harvesting, processing, and distribution pathways were distinctly altered. As described by Reeves (1990), tribal integration of the form known from the Historic period made its appearance by this time. The final new *Bauplan* is the abrupt emergence of the Plains Village pattern in the Middle Missouri area, featuring large earth-lodge villages, maize horticulture, intensive storage, and extensive trade networks (Toom 1992a). After 1,200 cal. B.P. the number of systems in the region precipitously declined, only the communal bison-hunting systems and those of the Plains Village horticulturalists surviving.

Late Prehistoric diversification on the northern Great Plains is probably the result of the splitting of existing

systems combined with immigration of new ones. The "classic" bison-hunting systems of the far northern Plains appear to have largely emerged from local traditions extending back in time to the Late Archaic (Reeves 1990), as does the foraging system of the Wyoming intermontane basins during this era (Greiser 1994). Some have suggested that extraregional population movement could explain the emergence of the Avonlea and Besant complexes (e.g., Greiser 1994), but there is little evidence to support either a Subarctic origin for Avonlea or a clear Upper Midwest or Great Lakes source for Besant (Benn 1983, Johnson and Johnson 1998, Winham and Lueck 1994). There is good reason, however, to suggest that some Late Woodland and, particularly, Early Plains Village patterns derive from immigration of populations from the eastern margins of the Plains (Bamforth 1993; Toom 1992a, b). Thus, we view much of the northern Plains diversification process as cladogenetic, with its origin in the wide-ranging peoples associated with the Late Archaic Pelican Lake complex. Late variability in the Middle Missouri area is, however, a consequence of the arrival of new populations bringing new systems from the eastern Plains and the upper Midwest. Peak diversity in *Baupläne* on the northern Great Plains emerged between approximately 1,700 and 1,000 cal. B.P., minimally including traveler-like foragers, processor-like high-mobility foragers, mutualist communal bison hunters, possible collectors (Plains Woodland), and village-based horticulturalists. With the collapse of this diversity only the mutualist bison specialists and the village-based horticulturalists remained.

#### CULTURAL DIVERSIFICATION

If the pattern of cultural change is indeed cladogenetic, then the emergence of new cultural forms should tend to be associated with short-term periods of significant cultural diversification. Earlier systems do not have to be slowly transformed in their entirety but rather bud off new smaller-scale systems as local populations break from old models and "experiment" (Stanley 1979) with new adaptive patterns. Evolutionary experimentation of this nature may occur regularly, but under special conditions it is likely to intensify, producing large-scale diversification events. We have argued that the critical pathways toward this sort of diversification come from opportunities that promote group isolation, typically by niche reorganization.

Cultural diversification in the Pacific Northwest occurs in the range of 5,600–4,200 cal. B.P.—a time of significant global culture change that included the emergence of the Harappan, Egyptian, and Sumerian states. A global commonality associated with this time of change appears to be a significant climatic shift marking the beginnings of the Neoglacial (Pielou 1991). Multiple independent investigations suggest the occurrence of a transition period of approximately 1,000 to 1,500 years prior to the full onset of the Neoglacial period at about 4,200 cal. B.P. On the Plateau, pollen data indicate that before approximately 6,000 cal. B.P. landscapes were

dominated by vegetation adapted to warm and drier conditions. Highlands that are now significantly forested, such as the floodplain of the lower Clark Fork River, the Blue Mountains, and the Okanogan Highlands, were dominated by sagebrush steppe communities (Chatters and Leavell 1994, Mehringer 1985a). Between 6,000 and 4,400 cal. B.P., increased moisture is indicated by significantly higher frequencies of arboreal pollen and the establishment of paleosols (Chatters 1986, Hammatt 1977, Mehringer 1985b). The moisture increase after about 6,000 cal. B.P. is also recognizable in the expansion of western red cedar on the southern and central Northwest Coast (Hebda and Mathewes 1984, Heusser 1985). Mann et al. (1998) argue for an increase in moisture in the Gulf of Alaska between 6,000 and 3,500 cal. B.P. Temperatures, however, appear to have remained relatively warm up to about 4,200 cal. B.P. Columbia River fluvial paleohydrology reflects early snowmelt, warm waters, and low discharge prior to around 5,600 cal. B.P., warm conditions and frequent floods between 5,600 and 4,200 cal. B.P., and late snowmelts, cooling, and stable flows after 4,200 cal. B.P. (Chatters 1992, 1995; Chatters et al. 1995; Chatters and Hoover 1992). Except for a minor advance in the Cascades and Coast ranges between about 5,000 and 6,000 cal. B.P. (Burke and Birkeland 1983, Davis 1988, Mann et al. 1998), glacial activity does not significantly expand until after approximately 4,400 cal. B.P. Likewise, in cave and rock-shelter deposits, sedimentation, associated with cold conditions, becomes prominent only after 4,200 cal. B.P. (e.g., Thompson 1985).

Overall, these data suggest increased primary productivity without a major alteration in seasonality during the transition from Hypsithermal to Neoglacial, 5,600 to 4,200 cal. B.P. Initially, increased primary productivity would have improved people's access to many terrestrial faunal and floral resources. Sea levels moved to within several meters of their current levels between 6,000 and 4,200 cal. B.P. (Cannon 2000, Fedje and Christiansen 1999, Fedje et al. 1996, Mann et al. 1998) in most parts of the coast, and the available archaeological evidence suggests full establishment of productive shellfish beds and inshore fisheries (Imamoto 1976, Matson, Pratt, and Rankin 1991). However, relatively warm temperatures and frequent riverine flooding and aggradation would have prevented significant increase in anadromous fish populations.

Increased productivity reduced subsistence uncertainty. Expanded steppe-forest ecotones in many areas provided access to a wide variety of resources, thereby reducing pressure for frequent residential moves. Declining residential mobility could have reduced the frequency of intergroup interaction. Populations could have moved into or persisted permanently in environments that had previously been considered too remote, impoverished, or otherwise risky for longer-term habitation. Significantly reduced or otherwise altered interaction rates could have rapidly bred cultural variation on the scale of new *Baupläne* as foragers implemented new subsistence and mobility strategies and altered past social commitments. Some of the most distinct Middle Holo-

cene cultural variants can indeed be linked to direct geographic separation through the establishment of permanent residential sites in remote locations. Examples include the relatively intensive residential occupations indicated in the Queen Charlotte Islands (Fladmark, Ames, and Sutherland 1990), Namu, and Yuquot (Coupland 1998) and the establishment of distinctive residential sites on the remote islands of southeastern Alaska (e.g., Lightfoot 1989, Moss 1989).

Reduction of the geographic scale of systems and change in the organization of intergroup communication is often evident in the development of local style systems across a region (see Jefferies 1997, Neiman 1995). Matson and Coupland (1995:142) comment that there is "great regional technological variability during this stage," noting major differences in the use of ground stone, chipped stone, and bone/antler technology throughout the Northwest Coast. Chatters (1989) also recognized stylistic variation particularly in ornamentation, on the Plateau, suggesting reduced networking between social groups.

Diversification on the Great Plains and in the Great Basin occurred at approximately the same time as the onset of the warmer conditions during the early Little Climatic Optimum (Jones et al. 1999, Madsen et al. 2001, Pielou 1991). A variety of data reflect increasing aridity and warmth after 2,400 cal. B.P. and significant drought after 1,000 cal. B.P. Increased aridity in the Great Basin and the northwestern Plains beginning at approximately 1,700 cal. B.P. is indicated by eolian deposition (Ahlbrandt, Swinehart, and Maroney 1983), recession of Lake Bonneville (Currey 1990, Currey and James 1982), calcium carbonate accumulations in soils, higher rates of slope erosion and accumulation of sediments in basins (Eckerle 1997), and pollen cores reflecting increased frequencies of plants adapted to xeric conditions (Bieswenger 1991, Mehringer 1985a). Madsen et al. (2001) provide a variety of data suggesting wide swings in northeastern Great Basin moisture regimes from a trend toward xeric conditions after 2,400 cal. B.P. to slightly wetter conditions around 1,200 cal. B.P., followed by strong droughts at ca. 700 cal. B.P.

We suggest that the Late Archaic foraging systems of the northwestern Plains, which emphasized the hunting of high-ranking resources, became ineffective in the intermontane basins because of the significantly increased search costs of large-game hunting. Substantial opportunities for plant foraging were developing, however, as the desert-shrub biome expanded. Subsequently, large-game-focused strategies were replaced by processor-like foraging, which placed less emphasis on storage and larger game species (Eckerle 1997, Prentiss 2000). Judging from the population increase in this area (Frison 1991), this system appears to have been very successful, at least for a short time. Climate change in the short-grass regions of the northwestern Plains appears to have had little effect on grassland productivity (Markgraf and Lennon 1986, Toom 1992b). Whereas optimal range conditions will favor larger and more frequently aggregated bison herds (Bamforth 1988), data from the Vore site in northeastern Wyoming suggest that even minor shifts in

local rainfall regimes could have had serious impacts on bison populations and the associated potential for communal hunting (Reher and Frison 1980). Despite these concerns, archaeological evidence supports substantial intensification of bison hunting on the northern Plains of Montana and Alberta after about 1,500 cal. B.P. (Reeves 1990). Longer growing seasons in the central Plains and Middle Missouri areas provided opportunities for new forager and horticulturalist systems during the Little Climatic Optimum (e.g., Bozell and Winfrey 1994). In each case, niches were reorganized, resulting in diversity in *Baupläne*.

A similar process occurred in the Great Basin during the final 2,500 years of prehistory. The arrival of warmer conditions as early as 2,400 cal. B.P. and certainly after 1,700 cal. B.P. brought reduced moisture but longer growing seasons. The drying of lakes to marshes, increasing high-elevation productivity, and warm seasons long enough to grow tropical cultigens allowed foraging and mobility strategies to vary widely and opened the door to the expansion of agricultural traits and agriculturalists out of the Southwest (Madsen and Simms 1998).

#### CULTURAL DECIMATION

Cultural decimation occurs under conditions of incongruity between ecological context and a resource management system or severe economic competition or conflict. Historically contingent factors such as stochastic environmental change may provide a "roll of the dice" favoring some systems but not others, despite the fact that all were highly adapted to the previous environmental context (cf. Gould 1989). Under these conditions, behaviors that once were adaptive become maladaptive or at least selectively disadvantageous. If the system of preexisting beliefs and social dynamics forces the continued expression of these behaviors despite their deleterious consequences, the inevitable result is, in Rosenberg's (1994:328) terms, "rapid disintegration of the full range of socio-economic and political structures."

Environmental change may reduce landscape productivity, thereby increasing demographic stress and, often, the intensity of intersystem competition (Jones et al. 1999). Decimation followed diversification in the Pacific Northwest after 4,200 cal. B.P. and in the northern Great Plains and the Great Basin after 1,000 cal. B.P., and in each case it was associated with significant environmental changes and, in a number of contexts, intensified competition between human groups.

Evidence from the Pacific Northwest suggests that by about 3,300 cal. B.P. almost all of the cultural variation recognizable during the prior 1,500 years had vanished, having been replaced by the semisedentary collector system that typifies the latter 3,000 years of the region's prehistory. It is highly unlikely that each unique system that appeared during the earlier diversification event gradually evolved into the latter system or that a pan-regional "mega-system" evolved anagenetically into this form. Rather, it would appear that at least some of the

earlier entities suffered abrupt economic failure well before the collector system spread into their environments.

The catastrophe that led to this economic failure appears to have been precipitated by a sharp decline in temperature shortly after approximately 4,200 cal. B.P. (Chatters 1998). Conifer pollen significantly increases and fire frequency decreases on the Plateau from 4,200 to 3,000 cal. B.P. (Chatters 1995, Mack, Rutter, and Valastro 1978, Mack et al. 1978, Mack, Bryant, and Valastro 1978, Smith 1983). Significant increases in cedar and hemlock are recognized in southeastern Alaska (Mann et al. 1998). Mollusc shell growth rates indicate that Columbia River temperature dropped significantly beginning in 4,200 cal. B.P. (Chatters et al. 1995). Glacial expansion was under way in most mountain ranges soon after 4,200 cal. B.P. (Burke and Birkeland 1983, Mann et al. 1998). This onset of full Neoglacial conditions after 4,200 cal. B.P. had severe effects on the distribution of resources that were critical to the foragers of the Middle Holocene. Cold and moist climates favored maximum forest extent and density. Unless aggregations of prey species could be effectively located and exploited in this increasingly closed environment, search times for ungulates would have increased significantly, particularly during the cold season. Stable riverine flows and cold temperatures increased the quantity of available anadromous fish but significantly reduced their period of availability (Chatters 1995, Chatters et al. 1995, Mann et al. 1998). Indeed, sustained colder air and water temperatures may have had the effect of increasing overall marine productivity while increasing seasonal and annual variance in total production, depending upon the annual strength of the Aleutian Low pressure index (Mann et al. 1998). Populations dependent on broad-spectrum foraging without significant investment in storage would have experienced severe hardship during the cold season because of the inaccessibility of critical fish and game.

The Columbia Plateau Pithouse I system, with its immediate-return subsistence strategy, appears to have been poorly equipped for the drop in water and air temperatures and associated restructuring of resource distributions. Thus, Pithouse I/Eayam variants disappeared shortly after 4,200 cal. B.P., and populations at least on the Plateau (Chatters 1995) and possibly in the Fraser Valley declined precipitously. The other interior Plateau system that exhibits little evidence for significant storage, known archaeologically as the Lochnore phase, likely suffered the same fate (Prentiss and Chatters 2002, Prentiss and Kuijt 2001). Coastal systems, including the Charles culture, the Obsidian culture, and those of the North Coast, that lacked a storage-based subsistence strategy also appear to have vanished by approximately 3,500–3,400 cal. B.P. (Coupland 1988, Matson 1976, Moss 1998). The unique adaptation represented at Yuquot disappeared by 3,000 cal. B.P. (Coupland 1998). The foraging system of the Oregon coast may have declined between 3,500 and 3,000 cal. B.P. (Draper 1988).

Systems with the collector *Bauplan*, possibly descended from the salmon-focused system glimpsed at

Namu and in the Graham tradition of the Queen Charlotte Islands, weathered the sharp temperature decline. Data from these contexts suggest that their adaptive strategies were characterized by semisedentism, resource storage, and complex hunting and fishing technologies (Fladmark, Ames, and Sutherland 1990). Ultimately, as more forager-like systems failed, this collector system spread. It came to dominate the region, eventually becoming what some call the "Developed Northwest Coast Pattern" (Matson and Coupland 1995), which features, among other things, winter sedentism in large permanent villages, intensive salmon exploitation, and storage.

The cultural extinctions that occurred between 4,200 and 3,000 cal. B.P. were followed by the florescence of this collector *Bauplan*, which expanded first after 3,800 cal. B.P. throughout the coast and interior regions as marked by the Locarno Beach phase of the Gulf Islands and Lower Mainland in British Columbia (Matson and Coupland 1995), the Paul Mason site of Kitselas Canyon (Coupland 1988), the Period II middens of Prince Rupert Harbor (MacDonald and Inglis 1981), and the Shuswap horizon on the Canadian Plateau (Richards and Rousseau 1987, Stryd and Rousseau 1996). It expanded soon after onto the Columbia Plateau, with the Pithouse II system (Chatters 1995), into southeastern Alaska, where it is recognized at Hidden Falls III (Davis 1989, Moss 1998) and various specialized fishing sites (Moss, Erlandson, and Stuckenrath 1990), and finally onto the south coast (Draper 1988) and even into northern California (Chatters and Cleland 1998), all by 3,000 cal. B.P. In some cases, this expansion appears to have been accompanied by population replacement, in others by in situ adoption of new practices. For example, the expansion of collector systems across the Plateau after 3,800 cal. B.P. may mark the actual spread of Interior Salish-speakers through this region as originally hypothesized by Elmendorf (1965). Conversely, despite apparently abrupt cultural change, there are no indicators of population flux in the transition from the Charles culture to the collector-based Locarno Beach phase in the Gulf of Georgia region, which suggests that at least some populations adopted the innovations of their neighbors as a means of gaining competitive advantage or at least parity.

Decimation of similar scale occurred in the Late Prehistoric Great Basin. The significant drought conditions indicated by sedimentary, hydrological, faunal, and floral evidence appear to have persisted at various times between 1,000 and 550 cal. B.P. throughout much of the Great Basin (Jones et al. 1999, Madsen et al. 2001; see also Stine 1994, 1998, 2000). Midway through that period, the onset of the Little Ice Age reduced the length of growing seasons. By 600 cal. B.P. the Great Basin was dominated by the processor *Bauplan*, which had expanded rapidly out of the Mojave Desert on the southwestern edge of the Great Basin. Most of the variant systems of the preceding centuries, which appear to have been temporary "experiments" with ecological specialization in an environment favoring adaptive flexibility, had become extinct. The exception to this pattern was

the emergence of an almost entirely sedentary system dependent upon irrigation of wild crops in the Owens Valley after 700 cal. B.P. (Elston 1986).

Cultural decimation on the northern Great Plains during the Late Prehistoric period may have been a consequence of an increasingly competitive environment associated with the appearance and expansion of complex forager and horticulturalist societies (e.g., Hayden 1995b) and the drought conditions of the Little Climatic Optimum. Dry conditions are documented for this time in many Plains and Rocky Mountains contexts, including the Colorado Front Range, where alpine glaciers were in recession after 950 cal. B.P. (Benedict 1973), and in the Middle Missouri area, where soils indicate droughts after 950 cal. B.P. (Toom 1992b). By 1,000 cal. B.P. Plains Village horticulturalists appeared on the northern Plains and began a complex interaction with communal bison-hunting groups to the north and west. If, as is argued by Bamforth (1993) and Toom (1992a, b), the earliest Plains Village peoples were immigrants from the highly developed horticultural Mississippian system, immediate economic pressure would have been placed on the less aggregated and politically integrated Plains Woodland peoples. The best land may have been appropriated by the more powerful groups. The Great Oasis aspect of the Initial Middle Missouri tradition may represent the settlement of the earliest Mississippian peoples in the Middle Missouri area and their adoption of some indigenous practices, although some suggest that it primarily reflects the persistence of Woodland lifeways with some influence from Mississippian contexts to the east (Tiffany 1983, Winham and Calabrese 1998). After 800 cal. B.P., climates shifted toward even greater aridity and slightly cooler temperatures (Baerreis and Bryson 1965, Bryson, Baerreis, and Wendland 1970, Toom 1992c). Competition for horticultural land increased severely, resulting in new population movements and overt warfare in the Middle Missouri region (Bamforth 1993).

The emergence of the regionally dominant Plains Village systems offered new economic opportunity for the communal bison hunters of the northern plains of Montana, Alberta, Saskatchewan, and western North Dakota. Exchange between mobile carbohydrate-poor hunting groups and sedentary protein-depleted horticulturalists produced a greater flow of not only basic commodities such as foods but also prestige items (e.g., Hayden 1998), including exotic lithic materials and shell, leather, and bone/horn crafts (Boyd 1998, Wood 1980). The benefits of these interactions, which would have been evident to the region's occupants, would have fueled increased competition between sedentary and mobile groups for power and status (Boyd 1998). Competition among mobile groups for the most productive grasslands and, thus, hunting territories may have been increasingly severe, particularly as climatic conditions became more xeric and human populations increased (Bamforth 1988).

It was in the range of 1,200–900 cal. B.P. that the mobile foraging systems of the northwestern plains of Wyoming and southern Montana declined. The reasons for this are not yet clear, but current data suggest decline

in desert-shrub foraging after 1,200 cal. B.P. and, ultimately, large-scale depopulation of the intermontane basins of Wyoming by approximately 900 cal. B.P. (Frison 1988, 1991; Prentiss 2000). One cause could have been excessive pressure from temporarily expanded local populations on the desert-shrub resource base. It is also quite possible that competition or even direct predation by more organized forces to the north and east helped bring the end of the intermontane basin foragers. The Benson's Butte-Beehive complex of southern Montana and northern Wyoming, a manifestation of the widespread Avonlea pattern of the larger northern Plains that dates to approximately 2,000–800 cal. B.P., has been interpreted to represent an incursion of populations originating in Montana, Alberta, and Saskatchewan (Fredlund 1988, Frison 1988, Greiser 1994). The frequency of Avonlea-related sites in natural or constructed fortifications increases in this region at approximately 1,150 to 950 cal. B.P. (Frison 1988, 1991). Other fortifications are known from various sites along the eastern Wyoming border from the Black Hills to Pine Bluffs, suggesting the possibility of violent interactions between northwestern Plains peoples and those of the Middle Missouri and the central Plains (Frison 1991). Indeed, Scheiber and Gill (1996) document significantly increased interpersonal conflict after 1,200 cal. B.P. in human remains from the northwestern Plains, particularly compared with the Late Archaic period.

## Discussion

We have argued that the concept of diversification and decimation has significant applicability to the processes of cultural evolution, particularly in the emergence of new resource management systems. Culture change can be understood as a process of the emergence, history, and death of these structural entities, seen archaeologically in patterns of predation, consumption, mobility, and exchange. Natural selection of entities at higher levels may be the most critical force in cultural evolution, although change may also come about as a consequence of driftlike processes set in motion by unpredictable events. Dramatically new patterns of culture commonly appear to emerge through cladogenesis during cultural diversification events wherein multiple *Baupläne* appear but only one or a few succeed in the longer term. Examples of this process include the emergence of semi-sedentary collectors in the Pacific Northwest and of various foraging and horticulturalist systems in the Great Basin and Great Plains regions of North America. We suggest that similar patterns have been documented elsewhere. For example, the emergence of Neolithic societies in the eastern Mediterranean region appears to have occurred during a period of significant cultural diversification (Bar-Yosef and Meadow 1995, Rosenberg 1994). This pattern implies that in the history of cultural systems, most emergent entities have been successful only in the short term, eventually succumbing to competition, environmental catastrophe, and maladaptation.

The archaeological record chronicles primarily the more successful systems, but even those eventually suffer the same fate.

Although our arguments have many points in common with those of Rosenberg (1994, 1998) and Diener (1980), we differ somewhat with regard to the role of stress (particularly in its demographic form) in generating new cultural variants. Rosenberg and Diener consider stressful conditions necessary for cultural collapse and reintegration. We have countered that high-pressure contexts will not favor innovation and therefore where populations have operated under stable conditions of high uncertainty the emergence of new cultural *Baupläne* has been rare. The risk that experimentation will lead to failure is simply too high. One consequence is that rates of cultural change have been comparatively low in marginal environments such as the arctic, the subarctic, and many temperate deserts. We find it difficult to imagine how the competitive environment generated by catastrophically increasing population could result in anything other than cultural bottlenecks, with a net change in cultural diversity of zero if not cultural collapse and loss of cultural diversity (e.g., Kirch 1997). We suggest that more productive avenues for diversification would be the conditions favoring isolation described above. Opportunities for marginal groups to vary successfully (cf. Diener 1980) could potentially come from contexts of limited competition. One can imagine scenarios in which disease, ecological change, or selective competition/predation between human groups could rearrange competitive relationships within and between groups, resulting in opportunities for the evolution of new cultural entities. For hunter-gatherers, however, the most powerful and diverse social rearrangements would be a consequence of ecological change that offered new resource opportunities—in essence, new niches.

Severe stress and collapse have more commonly been associated with subsequent invasions by more powerful and economically successful neighbors than with in situ reorganization and emergence of dramatically new systems. The archaeological record is rife with examples, including the demise of Pithouse I and replacement by Pithouse II collectors, Fremont collapse and replacement by Numic-speaking processors, the fall of the major Mayan polities and subsequent domination by the Toltecs (Davies 1977, Weaver 1991), and the collapse of the Roman empire and conquest by Germanic groups (Tainter 1988). Invasion and empire building can result in evolutionary change, as in the case of the emergence of the Monte Alban state (Spencer 1997), but it will not result in greater cultural diversity. Thus, outside of special bottleneck situations, stress has been more commonly associated with decimation than with diversification.

Our research does not support the ecological concept of competitive exclusion (Hardin 1960) as an appropriate model for the evolution of new cultural variants. The competitive-exclusion principle suggests (among other things) that competition could favor strong selection for differences between populations that are competing with each other within a habitat, resulting in speciation into

forms with divergent niches and thus much lowered levels of competition. This principle will rarely be found to apply to human beings, because we have almost never developed distinct systems occupying different niches in the same habitat. The diversification we speak of, unlike that seen in biological diversification events, is not ordinarily sympatric. As noted above, when competition increases it generally has the effect of *reducing* the number of systems in a given region.

## Conclusion

Macroevolutionary-scale cultural trends appear to follow a pattern of diversification and decimation like that seen in the evolutionary history of biological species. Radically new *Baupläne* often emerge during short-lived diversification events associated with economic opportunity and isolation. Diversification is typically followed by equally rapid decimation under more stressful and competitive conditions. With its base in neo-Darwinian evolutionary theory, macroevolutionary theory does not prevent us from studying cultural process at the microevolutionary level as has been enthusiastically recommended by many of our colleagues. What it does is open us to a wider range of research questions about culture change on a scale that is highly amenable to archaeological analysis.

## Comments

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This is a stimulating paper, with its arguments supported by both theoretical framework and archaeological data. Because of space shortage my comments will refer only to what I consider the heart of the matter, the general approach reflected herein as regards cultural diversification and decimation.

I fully agree that stress cannot be considered as a trigger for cultural diversification; on the contrary, it has been more commonly associated with cultural decimation. Prentiss and Chatters are right in saying that demographic pressure in and of itself does not generally promote human creativity and, consequently, new *Baupläne* or resource management systems.

Comparing biological and cultural processes has become common practice. I myself have been unable to resist using Gould's argumentation (Bar-Yosef and Belfer-Cohen 1991, Belfer-Cohen and Goren-Inbar 1994), but sometimes it seems that we are overdoing it in our struggle to be recognized as real scientists. In the present case, the similarity is on such a large scale (and see the classic general systems theory [Bertalanffy 1968]) that it be-

comes meaningless; the mechanism described at this level is constantly "on." Thus, after rejoicing in recognizing its regularity, the next stage of research should be to identify the differences within this regularity, for example, how and why agriculture (one of many resource management systems) won the day or the implications of a socioeconomic structure based on exchange. As archaeologists we strive to understand the *next* level of complexity, and I believe that we can manage very well without looking for support from biological evolution, especially since there is no consensus among biologists (see Conway Morris 1998).

It is safe to assume that "diversity" is always replaced by "uniformity" as the former is constantly tested not only against the climatic conditions, which can be stable for a while, but also against the varying conditions of social existence, both internal and external. Competition, whether direct or indirect, brings about the demise of some of the new socioeconomic systems. This stage of decimation can come about in tandem with climatic deterioration but also because of social mechanisms that, although triggered by deterministic stimuli (climatic oscillations), are acting independently of the climatic shifts.

Prentiss and Chatters say that most cultural variants were short-lived, declining when competitive, stressful conditions reappeared, but in their case studies these competitive conditions are always tied in directly and specifically with climatic deterioration. Though they state that "cultural evolutionary trends are strongly conditioned by historical contingency though general evolutionary processes are continuously active" and that "natural selection of entities at higher levels may be the most critical force in cultural evolution, although change may also come about as a consequence of driftlike processes set in motion by unpredictable events," this interplay is ignored and the arguments focus on the general evolutionary processes which are directed by the ultimate deterministic mechanism of climate change and its ramifications. I find it hard to accept that historical contingency is not taken into consideration. Climatic determinism is undoubtedly a very powerful source of changes in human societies, but the story is always much more complicated, and the one *Bauplan* that comes to be the dominant or only one differs in various places under different circumstances, not only climatic but cultural.

The Levantine prehistoric record presents cases of diversification and decimation of *Baupläne* in which it is quite obvious that there is a very complex interaction between changing conditions, the specific adaptations of the various human groups, and the outcome as regards continuity or disruption of cultural units, which is definitely influenced but not dictated by climatic conditions per se (and see Goring-Morris and Belfer-Cohen 1997, Belfer-Cohen and Bar-Yosef 2000). The transitions from the Natufian varieties of subsistence to those of the Neolithic are not in fact expressed in dramatic diversification or reduction in the number of *Baupläne*. Just before and during the Natufian (ca. 4,000 years B.P. [Bar-



Yosef 1998]) there were only a very few *Baupläne* around, and, most significant, transformations in Natufian *Baupläne* occurred linearly, within that entity, from its Early to Late stages.

What I find truly stimulating is the data that the authors employ in presenting their model. These data pertain to the origins of cultural entities, the movements of populations and ideas, how one can trace them, etc. There is great variability within each of the three regions used as case studies. The differences are significant and have serious implications for the development of the region. Did the local trend imitate the general evolutionary trend of human society? Did the population grow or decline? Were the adaptive responses in the long run damaging or not to the local ecology? Was there genetic continuity or total replacement? What is special about the “winning” local *Baupläne*? All these issues will play a crucial role in any future changes taking place in any particular region, making the story much more complex. These differences are actually the cause of the different life histories of different human groups. When all is said and done, trying to figure out this part of the game is the next challenge.

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This paper does a good job of connecting abstract theoretical concepts to real-world archaeological examples. The main point, of course, is that cultural evolution is driven by the emergence and differential persistence of cultural systems generated by underlying structures of logic termed *Baupläne*. *Bauplan* diversification under permissive conditions (e.g., climatic amelioration) occasionally leads to wholesale system restructuring and the formation of novel, fundamentally different, *Baupläne*. Extinction and competition reduce *Bauplan* diversity under worsening conditions (e.g., climatic deterioration), resulting in wholesale *Bauplan* replacement and adaptive change. I am obviously sympathetic to the basic model, which underlies much of my work on hunter-gatherer adaptive change (Bettinger 1980, 2001) and the Numic spread in particular (Bettinger 1994, Bettinger and Baumhoff 1982). As I have noted elsewhere (Bettinger 1993), the traditional objection to such models is that they make processes of cultural transmission more important than rational decision making. In this view, changing from one adaptive strategy to another cannot be accomplished by individual rational action. It is a group-level process in which cultural transmission is instrumental.

I am likewise in full agreement with the authors that adaptive innovation resulting in wholesale system change is most likely to occur—and to occur rapidly—when resources are abundant relative to population as a consequence of environmental amelioration (Richerson, Boyd, and Bettinger 2001) or breakthrough

technologies such as the bow and arrow (Bettinger 1999). It is less clear to me that the ensuing replacement of one adaptive system by another is most frequently the result of environmental deterioration as the authors seem to imply. The differences between adaptive systems, especially in the population densities they can support, will frequently result in expansion and replacement without external triggers. Indeed, the stochastic effect of rapid climatic change may slow rather than hasten the expansion of nascent adaptive systems. In the last analysis, the question is as empirical as it is theoretical.

Certainly the most problematic aspects of the model are the definition of a *Bauplan* and the recognition of its archaeological signature. As does Rosenberg (1994), Prentiss and Chatters stress the ideational basis of the *Bauplan*, and this makes me uneasy. Humans in general and hunter-gatherers in particular may transmit the *Bauplan* as ideology, but I doubt it. In the scenario I see as more likely the *Bauplan* is not transmitted at all. Without putting too fine a point on it, hunter-gatherers don't have adaptive systems—they act adaptively as part of a system. In the same way, the transmission of an adaptive system does not require transmission of its underlying logic. What is transmitted is all the various individual elements that together constitute the system; the *Bauplan* logic simply emerges when these various elements are put to work in conjunction and may or may not be apparent to individuals going about their daily business. Ideology still plays an important role, however, because the individual elements of the system will most likely be transmitted as a package through the process Boyd and Richerson (1985) term *indirect bias*, in which potential social models are chosen according to indicator traits that are culturally specific and generally connected with prestige. It is the ideology concerning these symbolic indicator traits, not *Bauplan* ideology, that matters. Indirectly biased transmission “glues” the elements of the cultural system together, guaranteeing coherence and preservation of system logic, especially in the presence of competing systems (Boyd and Richerson 1987). Because of this, it permits adaptive diversification in regions in which groups are closely juxtaposed—that is, isolated by transmission rather than geography.

Whether or not I disagree with Prentiss and Chatters about *Bauplan* ideology (and it is possible that I have misread them), we agree that the most important archaeological signatures will be in things that are familiar and comparatively easy to observe: settlement size and distribution, storage facilities, faunal remains, and procurement technologies. Seeing these as elements of adaptive strategies that differ in fundamental logic and recognizing the emergence of and competition between such strategies as the dominant force in the shaping of cultural landscapes are critical to improving our archaeological understanding of the past.

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Over the past several decades, archaeologists have proposed various hypotheses to explain the development of cultural complexity in the course of human history. In the fields of hunter-gatherer archaeology and the study of so-called middle-range societies, some case studies have focused on the analysis of subsistence, settlement, and society at the macro scale from a perspective of cultural ecology, while others have adopted models of evolutionary ecology at the micro scale. Recent theoretical shifts in anthropological archaeology toward an emphasis on historical contingency and human agency have also resulted in a flourishing of case studies in social archaeology at the micro scale (e.g., individuals and households). In contrast to these scholars, however, Prentiss and Chatters have chosen to present a macroevolutionary model to explain long-term changes in resource management systems and the resulting changes in sociopolitical organizations and then to test their model against three sets of archaeological data.

The model is intellectually stimulating and worth testing archaeologically, but the distinction between a new *Bauplan* and a variant of an existing one needs further elaboration in relation to archaeological data. In recent years many scholars working in hunter-gatherer archaeology have moved away from typological classification of resource management systems and acknowledged variability in various aspects of subsistence-settlement practice that may or may not be correlated. In particular, Binford's (1980) collector-forager model, which Prentiss and Chatters have adopted here, emphasizes the continuity of the collector-forager spectrum rather than identifying collectors and foragers as two separate systems. In this regard, the proposition that the various systems listed in figures 1–3 were associated with different cultural *Baupläne* requires further supporting arguments. These figures also give the impression that each system lasted as a static entity for 1,000 years or longer, which may not have been the case.

Furthermore, Prentiss and Chatters's characterization of new systems such as that of sedentary foragers in the Pacific Northwest needs to be further substantiated by regional settlement-pattern analysis. Identifying characteristics of a resource management system on the basis of data from a limited number of sites is not an easy task unless the function of each site is understood in the context of an overall regional system. Examination of site distribution in conjunction with the analysis of artifact assemblage variability will be critical.

As for the factors that stimulated the emergence of diversified new systems, Prentiss and Chatters suggest the importance of isolation or reduced frequency of intergroup interaction as a result of declining residential mobility. However, whether a decrease in residential mobility meant isolation needs to be tested with further lines of archaeological evidence. Ethnographically, it is known

that hunter-gatherers could communicate and interact effectively through periodic gathering at a "trading center" and/or long-distance exchange networks. It should also be noted that increasing regional variability in artifact styles does not necessarily indicate reduced interaction between groups: it may simply mean that stylistic characteristics reflect different group identities.

These comments are not intended to diminish the significance of this article. It will certainly stimulate active discussions on the utility of evolutionary theory for explaining cultural variability and on the development of cultural complexity.

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The interrelationships between evolutionary theory and social change continue to be a topic of energetic discussion in the social sciences in general and in archaeology and anthropology in particular. It is at the intersection of these issues that Prentiss and Chatters's provocative essay is directed. Building upon a number of studies over the past ten years, it simultaneously provides a valuable regional case study and actively explores and discusses the utility and complexities of evolutionary modeling in anthropology and archaeology. Indeed, modeling, conceptualizing, and explaining long-term cultural developments is one of the central goals of archaeological research. Regardless of the cultural and environmental context of the individual researcher, archaeologists working on prestate cultural contexts are forced to explore the long- and short-term processes of change and variation in cultural practice within a single geographical area. Moreover, such analysis and interpretation requires researchers to address the question of why some distinctive cultural/social/economic developments occur in one area but not in another. While there is only limited consensus within the discipline on how to undertake this work, as social scientists who deal with changing material culture and human behavior through time archaeologists have no alternative but to discuss the trajectory and mechanisms of change.

Prentiss and Chatters's paper makes several important contributions and challenges us to explore several dimensions of evolutionary archaeology further. It provides researchers with a complex comparative data set that serves as an important first step in the recognition and modeling of regional and interregional patterns of prehistoric adaptation in western North America. In addition, it tackles the complicated issue of finding historical, economic, and evolutionary significance in the spatial and temporal patterns of the distribution of material culture in a poorly known archaeological context. From this perspective, Prentiss and Chatters are to be congratulated on modeling regional and interregional commonalities through time in a way that is consistent with detailed archaeological data sets and explores the

possible evolutionary connections between them. Whether one agrees with their evolutionary approach, let alone their interpretation, or not, this attempt to bridge these different scales of research is rare in our discipline and welcome.

Several points deserve further reflection. The first is the need to consider mechanisms of isolation, diversification, and decimation. From the standpoint of both evolutionary biology and the macroevolutionary modeling of human societies, the existence of boundaries, whether reproductive or cultural, is critical for the development of variation or diversification. As noted elsewhere (Shennan 2002, O'Brien and Lyman 2000), researchers have recognized a wide range of mechanisms by which cultural practices are maintained and altered through time. From Prentiss and Chatters's perspective they appear to center upon ecological factors, with the cyclical nature of diversification and decimation in prehistoric times being closely linked to mid- and late-Holocene environmental changes. As articulated by Shennan (2002), this perspective assumes that diversity in behavior in the past is the product of different courses of action in different environments. While they are working at a larger scale than researchers looking at optimal foraging theory, Prentiss and Chatters make the same assumption: the selection of specific subsistence strategies is guided by the principle of optimality, which assumes that individuals will relate to their environment in ways that will maximize their reproductive success (see Shennan 2000). One of the concerns that I have with this assumption is that such macroevolutionary modeling runs the risk of equating environmental and subsistence changes with cultural developments in a way that is overly deterministic and risks overlooking some of the subtle regional variations in cultural systems. An additional point to consider is that unless one believes that such boundaries and forces are strictly environmental, it is necessary to explore them from the standpoint of social agency and social organization. It is important to recognize that the modes of transmission and selective pressures are likely to be different for different realms of human behavior (e.g., lithic technology versus subsistence economy). The challenge is, of course, that in this particular case the archaeological generation of culture-history sequences is based on many dimensions of the human past, not just environmental conditions. While stressing the need to understand synchronic changes in multiple environmental regions of western North America, Prentiss and Chatters devote only limited time to addressing the mechanisms of isolation, let alone the transference of such systems through time. While noting the existence of different forms of isolation (effective and geographical), their model is limited in its application by the restricted discussion of the forms of isolation. While Prentiss and Chatters argue that a range of cultural and environmental processes serve as sorting processes, this is not explored in sufficient detail. This focuses attention once again on the ongoing debate about the extent to which biological models of evolution are applicable to cultural phenomena and, more specifically

in this case, what scale ("culture" versus "species") is appropriate for archaeological units of analysis. The interrelationships of human agency, scale, time, and the transition of aspects of human culture through time will continue to be debated by researchers for a long time, and the work of Prentiss and Chatters contributes toward this fundamental dialogue.

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We welcome any effort to apply concepts developed in evolutionary biology and paleobiology to the archaeological record, but we expect that they will bear some semblance to the original formulations both theoretically and methodologically. Prentiss and Chatters apply several paleobiological concepts to their study of cultural diversification and decimation, but the results are not compelling.

First, Prentiss and Chatters misrepresent punctuated equilibrium, which is not about the "differential emergence and survival of new . . . *Baupläne*" but about a particular combination of evolutionary tempo and the mode of emergence of *taxa* of higher than species rank. The term was coined by Eldredge and Gould (1972) to refer to the view that evolution proceeds primarily through abrupt speciation events separated by long periods of evolutionary stasis. The punctuated-equilibrium model specifies that daughter species arise only by cladogenesis, originating near the periphery of the range of the parent species and sometimes spreading back into the locale still occupied by the parent population. Thus in a local geological section there should be a clear morphological difference between ancestor and descendant. Only a single kind of speciation, peripatric speciation (Mayr 1982a, b), is identified. It involves geographic isolation of a parent population from a daughter population, which eventually results in the biological reproductive isolation of the two populations, their morphological divergence, and the creation of two lineages. Except for their mention of "isolation," Prentiss and Chatters ignore all other aspects of peripatric speciation, an omission that renders their use of the term "punctuated equilibrium" metaphorical.

Further, Prentiss and Chatters imply that punctuated equilibrium involves only tempo, but it involves both tempo and mode. Gould and Eldredge continually pointed out that punctuated equilibrium is "a specific claim about speciation and its deployment in geological time; it should not be used as a synonym for any theory of rapid evolutionary change at any scale" (Gould 1982: 84). Gould suggested that the cladogenetic event should take place over  $\leq 1\%$  of the duration of a taxon's subsequent existence in stasis. Given the geologically rapid rate of punctuated cladogenesis and its resultant paleontological invisibility, Gould and Eldredge (1977:121) stated that "stasis," defined as nondirectional fluctua-

tion in a lineage's morphometry, was a good indication of the equilibrium part of the model. Prentiss and Chatters ignore this point.

Second, the durations of the particular instances of cultural cladogenesis and stasis depicted by Prentiss and Chatters are difficult to determine. They present no synthesis of calendrical data for any of the three regions they discuss, and without such a synthesis we cannot tell whether a particular sequence represents gradual change or stasis punctuated by abrupt cladogenesis. Their figures suggest that cladogenesis was rather rapid in each of the three areas, but that may be a function of their graphing algorithm. They do not tell us how they lumped the widely dispersed archaeological materials they mention. Thus, any time-transgressive appearance and "decimation" of, say, the serial forager *Bauplan* in the Pacific Northwest is muted to some unknown degree.

Third, it is not surprising that Prentiss and Chatters misunderstand *Baupläne*, because instead of citing the relevant biological or paleobiological literature on the concept (e.g., Hall 1996, Wray 1999) they cite other anthropologists and archaeologists who have similarly misunderstood the concept (e.g., Rosenberg 1994, Spencer 1997). This is not to say that the concept is not of use in archaeological endeavors or that it cannot be reworked in order to accommodate archaeological data (O'Brien and Lyman 2000). Biological *Baupläne* are conceptual (ideational) units rather than empirical units (actual objects) and thus can be viewed at a variety of scales. Prentiss and Chatters are unclear with respect to the scale of their cultural *Baupläne*. The problems this creates are exacerbated when they indicate that *Baupläne* are analogous to replicators or genomes and that within any particular category of *Baupläne* there can be varied empirical expressions or different phenotypes. Here they seem to be equating *Baupläne* with taxa, but the latter concept does not appear in their discussion.

Fourth, the imprecision with which Prentiss and Chatters use the term *Baupläne* has dire consequences for their use of clade-diversity diagrams. Such diagrams are built to display the multiplication and extinction of species or some higher taxonomic unit within a clade and are founded on the assumption of phylogenetic continuity, or heredity, between taxa included in the graph. But a critical data requirement for using clade-diversity diagrams is that the taxa be of the same scale and not overlap in definitive features. In other words, one's systematics must contend with both phylogenetic history and position within the taxonomic hierarchy (see Cracraft 1981:461). The names that Prentiss and Chatters have assigned to their *Baupläne* indicate that the units variously overlap and that they vary considerably in their distinctiveness. They appear to constitute taxa of different rank, and this makes them useless for studies of clade diversity (see Lyman and O'Brien 2000). It is impossible to assess how distinctive they are and thus of what taxonomic rank they might be because Prentiss and Chatters do not define them. Thus it is unclear whether what is graphed in their figures is what paleobiologists refer to as taxonomic diversity or morphological disparity

(Gould 1995). These facts render Prentiss and Chatter's results not only nonreplicable but epistemologically invalid. The construction of clade-diversity diagrams in the context of Darwinian theory is a way of exploring and explaining the history of diversity within an artifact lineage, but only so long as we pay attention to systematics.

## Reply

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We thank all of the commentators for their thoughtful insight and stimulating questions. They provide us with the opportunity to revisit and expand upon a number of points that were impossible to consider in depth in this short article. Several themes appear in the interesting comments of Belfer-Cohen, Bettinger, Kuijt, and Habu, including environmental determinism, assumptions of optimality, processes of isolation and cultural transmission, and the evidence for stasis. Lyman and O'Brien, in contrast, seek to defend their own evolutionary framework by dismissing our research on the basis of misused terminology.

Belfer-Cohen, Kuijt, and, to a lesser degree, Bettinger raise the issue of environmental determinism and simple adaptationism. While this is an important concern, we suggest that it is not relevant to our work. By basing our model upon the work of Gould (1989), with its paramount emphasis on historical contingency, we explicitly sought to avoid adaptationist and determinist assumptions. Belfer-Cohen argues that we ignore historical contingency in favor of environmental determinism. She assumes that since the environment has a major impact on change in our case studies we must be assuming that it operates as a mechanistic driver. This is a misunderstanding of our model, which actually asserts that diversification and decimation in cultural practices are associated with variability in the degree of isolation and competitive conditions affecting a given population. The environment does not dictate the form of the cultural divergence; it only helps (along with demography) to provide a selective context for evolutionary process, measured as effective human population density. Similarly, it is not environmental deterioration per se that stimulates competition between adaptive systems (as Bettinger suggests we believe) but changes in effective population density. That same competition would ultimately develop in any case as populations grew under positive environmental conditions.

Kuijt takes Belfer-Cohen's argument one step farther when he suggests that we rely upon assumptions of optimality to such a degree that we overlook potential regional variation in cultural systems. Nowhere in the paper did we say or cite anything that placed us within this adaptationist school of thought. To persist, eco-

conomic strategies do not have to be optimal, only functional. Bettinger (1998) notes that most innovative change is a consequence of modification of existing technologies and reorganization of old strategies. Thus, many elements of new evolutionary configurations will be not adaptations but exaptations (Gould and Vrba 1982), each a combination of newer and older parts "co-opted" to function as a newly integrated whole (Gould 2000:123). If these wholes act as competitive evolutionary units, then variation in their form will be necessary if evolution is going to proceed at this scale. Thus, it was vital that we identify variation. Indeed, we joined David and Sterner (1999) in arguing that cultural variation was greater in the past than archaeologists have often been willing to recognize.

Several commentators (Bettinger, Kuijt, and Habu) are concerned with *Bauplan* transmission and the impact of different forms of isolation on the emergence of new variants. Our argument used the *Bauplan* concept to denote diversification and decline in higher-order variation; we did not discuss the interesting microevolutionary problem of how new *Baupläne* emerge. Bettinger delves into this topic, noting that the *Bauplan* is not transmitted as a complete, integrated package. He argues that, rather, its logic emerges as a consequence of the operation of its various elements as a unit. From a macroevolutionary standpoint, it would be logical to expect new *Baupläne* to develop in contexts of isolation, where new and different combinations of behavioral variants could more frequently become integrated into new forms. Even if the *Bauplan* itself is not transmitted as a whole, this does not mean that ideology has no role in the emergence of cultural variation. Ideological barriers can effectively isolate human populations with much the same impact as geographic isolation. As we noted, this should be marked archaeologically by rapid and geographically distinctive coincident change in the use of symbolism and adaptive strategies.

Habu warns that although our figures give the impression that some systems persisted as static entities for more than a thousand years, this may not have been the case. This comment brings up important theoretical and empirical issues. From a theoretical standpoint, the question is whether higher-order entities can remain in stasis for extended periods. Under punctuated equilibrium this would be expected, but for stasis to persist lower-order variation would be fundamental. Evolutionary biologists have outlined a variety of ways in which stasis is maintained, including stabilizing selection on local populations (Wright 1931, Gould 2002), habitat tracking (Eldredge 1995, 1999), local adaptive plasticity (Lieberman and Dudgeon 1996), and selective culling of outer variants around a mean (Vrba 1980). It is not difficult to imagine that these processes could also impact the persistence of cultural systems, resulting in fluctuating or oscillating patterns (Bamforth 2002, Shennan and Wilkinson 2001) around a basic structural model or *Bauplan*. From an empirical standpoint, we supported our contentions regarding differential persistence of socioeconomic systems with discussion of data associated

with settlement patterns, subsistence strategies, and technological organization. We cited an extensive list of sources providing primary data supporting our contentions. We do acknowledge that archaeologists should pay more attention to processes that generate stasis, for, as Gould (2002:759) notes, "stasis is data."

Lyman and O'Brien can find little support in our work for their own views and consequently provide a variety of criticisms. First, they contend that we fail to provide details supporting our contention that evolution has followed the pattern of punctuated equilibrium. In particular, they suggest that we discuss only isolation and do not outline the processes leading to lineage divergence. In response we can only suggest that they reread our paper, because we were explicit about the impact of isolation on variation and the role of niche reorganization in the emergence of new socio-economies. Second, they accuse us of ignoring the role of stasis in punctuated equilibrium. Although the emphasis in this paper was not on stasis, an important part of our model was the explicit acknowledgment that higher-order stasis has persisted for extended periods in all the cultural sequences reviewed and that special conditions are required for significant variation to emerge. This means that the processes that prevent stasis from breaking down must be "unlocked" (Gould 2002). We argued that the most powerful means is isolation and niche reorganization, producing cladogenesis through a process similar to allopatric speciation. We backed up our theoretical contentions with archaeological data, something rarely accomplished by Lyman and O'Brien. Finally, they argue that they cannot determine the relative durations of episodes of cladogenesis and stasis because we provide no "synthesis of calendrical data" and no indication of how we "lumped the widely dispersed archaeological materials" to create our graphics. This is an odd comment, since we provided extensive discussion of radiocarbon-dated chronologies, emphasizing a wide variety of archaeological evidence for variability in integrated human behavior. Our data clearly support patterns of geologically abrupt cladogenesis and extended stasis. We are not sure how we could have made these issues clearer and can only wonder why these critics do not challenge us on any of the particulars of our case studies.

Lyman and O'Brien claim that, with Rosenberg (1994), we misunderstand the *Bauplan* concept. This is nonsense. As we said at the outset, the *Bauplan* concept is an effective tool for describing structural variation. Thus, when we speak of variability in *Bauplan* or the emergence of new *Baupläne* we are speaking of disparity in the form of socioeconomic organization. Within a given *Bauplan* we could expect a nearly infinite array of actual expressions. Some periods of cultural diversification will give rise to such substantial disparity that each new system could reflect an entirely new *Bauplan* and thus also a new cultural clade.

Lyman and O'Brien assert that our imprecision about the definition of *Bauplan* is fatal for our construction of clade-diversity diagrams, but our paper has no such diagrams. Our graphics merely illustrate our arguments,

derived from the archaeological data, that substantial disparity in socioeconomic systems has periodically occurred and has severely affected the cultural history of each region (see also David and Sterner 1999). These do not illustrate histories or phylogenetic relationships between clade members. Indeed, it is possible that more than one cultural clade is represented in each graph.

On the surface, Lyman and O'Brien reject our challenge to their self-proclaimed authority on evolutionary matters on the basis of technicalities derived from paleontological systematics. In reality, they find our model unacceptable because it avoids the reductionism and adaptationism inherent in their brand of evolutionary archaeology. Their reliance on Dawkins's (1976, 1990) notion that evolution proceeds through competition between genes via their use of extended phenotypic vehicles (including artifacts) places them in the position of defending the outmoded model of all evolutionary change except stylistic drift as adaptive and driven from the bottom up. If cultural change must also reflect this ladder of progress, then models that assert contrary iconographies must be automatically assumed to be invalid. This model has been critiqued in evolutionary biology for subverting Darwin's original emphasis upon individual organisms (Dover 2000, Gould 2002) and for avoiding consideration of evolutionary phenomena acting on higher phylogenetic levels (Eldredge 1995, Gould 2002, Wilson and Sober 1994). Further, the basic tenets of its archaeological manifestation (artifact selectionism) have been recently critiqued as empirically unwarranted and thus largely metaphorical (Bamforth 2002). We join a larger group of archaeologists asserting the empirically warranted conclusion that, while Darwinian processes act to create cultural evolution, the fundamentals of the process are not necessarily the same as those of biology (Spencer 1997). Let us celebrate the evolution of an archaeology that can embrace the genius of Charles Darwin but avoid disservice to his discipline through misappropriation of its tenets.

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