Room Size, Organization of Construction, and Archaeological Interpretation in the Puebloan Southwest

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The size of architectural space (floor area) is a variable that is readily preserved in the archaeological record, is easy to measure, and has been used in a variety of types of archaeological interpretations, from determinations of room function to reconstructions of social organization. The use of room size in the interpretation of Southwestern pueblos is reviewed here. Assumptions about the meaning of room sizes are explored using data on rooms, houses, and households from the historic Hopi Pueblo of Orayvi. Finally, room size is used, along with other variables, to examine the organization of construction at large, late prehistoric pueblos. Planning and coordination of construction identified at some of these sites suggest a more centralized social system like those of the historic and modern Eastern Pueblos.

Architecture communicates an abundance of cultural information to archaeologists reconstructing prehistoric social systems. Room size (floor area) is the architectural variable that is most likely to survive in the archaeological record and is most easily measured. A basic assumption that underlies the use of domestic floor area in archaeological interpretation is that people create architectural spaces of an appropriate size for specific activities and for the numbers of people who will use those spaces. Technological factors affecting room size and culture specific attitudes toward the use of space are important but often are not considered.

The size of architectural space has been used as an index of population (Naroll 1962), as one of a suite of variables that inform on the function of prehistoric architectural space (Hill 1970), as an indicator of changes in social organization (Crown and Kohler 1994; Martin and Rinaldo 1950), as a measure of social status (Wilk 1983), and, rarely, as an ethnic group marker (Baldwin 1987). Using data from the American Southwest, this paper evaluates the use of architectural space in archaeological interpretation and demonstrates that the size of architectural space can be dependent on technological and cultural factors, including group specific approaches to the organization of construction.

In the northern part of the American Southwest (Fig. 1) pueblian structures built of stone or mud represent a crucial part of the archaeological record after A.D. 700. Archaeological interpretation of these structures has been based largely on ethno graphic models developed from the study of historic and modern Western Pueblos, especially the work of Victor Mindeleff (1989) at Hopi and Zuni during the 19th century (see Ciolek-Torrello 1985 for a discussion of the ethnographic model of Puebloan room function). In this study, historic data from the Hopi (Western) Pueblo of Orayvi* (Fig. 2) are presented in order to examine archaeological expectations about

* See Notes section at end of paper for all footnotes.
the meaning of differential room and house size. Surprisingly, the Orayvi data do not closely fit the ethnographically based expectations commonly used by Southwestern archaeologists. Room size and function are only generally correlated. Families of different sizes and organization occupy houses of similar sizes, and the average number of square meters of space occupied by individuals is quite different from that reported in cross-cultural studies. A number of reasons for these deviations from expected patterns are suggested, both technological and social, including the developmental cycle of the domestic group, the aggregated and terraced nature of pueblo buildings, the status of the homeowner, and the availability of building materials and labor.

When room sizes at Orayvi are compared with those of large, late prehistoric pueblos an intriguing contrast is apparent: room sizes at some pueblos, especially Eastern Pueblos, are very standard in size, while others, especially Western Pueblos, are variable. Underlying the differences in room size among prehistoric pueblos is an apparent fundamental difference in how construction (and presumably other aspects of society) is organized. Standard sized rooms are apparently the result of construction techniques that allow many rooms to be built as a single event (ladder-type construction). A distinctive site layout is produced: rows of rooms outlining plazas of similar size. Construction of these sites was apparently undertaken by a large number of people.

**FIG. 1.** The northern Southwest showing the locations of archaeological sites and regions, modern pueblos, and modern towns mentioned in the text.
and coordinated at a level above the household. Such large-scale, coordinated construction of houses has not been documented at historic Western Pueblos where home building was accomplished at the household level by women. In modern and historic Eastern Pueblos, house construction undertaken as a group project by men has been documented and supports suggestions (Ware and Blinman, in preparation) that these groups have a more highly integrated and centralized social system than the Western Pueblos.

The paper begins with discussion of the technology of pueblo construction, especially technological constraints on room and house size, and a review of the use of architectural space in archaeological interpretation in the Southwest. The Orayvi data set is introduced and the causes of variability in room and house sizes at Orayvi are examined within the framework of archaeological expectations. Room size patterns found at Orayvi are then compared to a sample of prehistoric Eastern and Western Pueblos. Differences in the organization of construction among prehistoric pueblos are discussed. The coordinated construction of a large number of houses in a single construction event suggests that during the unsettled last centuries of the prehistoric period (A.D. 1250–1500) when abandonment and population aggregation are common patterns, people were able to move in relatively large, coherent communities. Finally, suggestions about the historic connections among prehistoric and modern social and ethnic groups are made.

THE TECHNOLOGY OF PUEBLO CONSTRUCTION

An understanding of the parameters conditioning puebloan room size requires
a review of construction methods. Puebloan buildings typically consist of a set of attached, dwellings called a roomblock. Dwellings, which are occupied by a single household (a task-oriented residence group; Netting et al. 1984:xx), usually include several rooms, are often multi-storied, and built in a terraced fashion. Pueblos are made of stone, earth, and wood and are the product of many centuries of architectural development. In most parts of the northern Southwest, the move to above-ground dwellings from pit structures occurred after A.D. 700. Large, contiguous, multi-storied domestic buildings, like those that the Spanish encountered when they first entered the Southwest in the 16th century, become common after A.D. 1200. It is these large, late pueblos that this paper addresses.

Walls

Pueblo walls are of stone mortared with mud or of earth built up in courses by hand ("coursed adobe"); the prehistoric use of adobe brick has also been noted. Wall strength and sturdiness can determine room size because walls usually bear the weight of heavy roofs—the larger the room, the heavier the roof. With multi-storied construction, lower story walls must also support upper story walls. Upper story walls are built directly on top of lower story walls, even when the upper story is a later addition. Room size for upper and lower stories will, therefore, almost always be identical, even though they were typically (based on ethno-graphic information) used for different purposes (Ciolek-Torrello 1985). Stone construction is the most common wall fabric in the northern Southwest. The strength and stability of stone walls depends on a number of factors including the ratio of stone to mortar, wall width, footings, and exposure to the elements. The apogee of stone wall construction in the prehistoric northern Southwest were the 10–12th century Chacoan Great Houses where wide core-and-veneer walls were built with closely fit stones. The spaces between the stones were often filled with small sandstone spalls ("chinking stones") leaving almost no exposed mortar, producing remarkably stable, long-lasting walls (Lekson 1986). Chacoan Great Houses are an unusual case, however. At other sites in the northern Southwest, stone walls lack the elaborate masonry techniques practiced by Chacoan builders. Walls may be only one or two stones wide, although the compound masonry of the Mesa Verde area is wider (c.f. Rohn 1977:241) At Hopi and Zuni in the late 19th century, Mindeleff (1989:140) comments that masonry walls had "...been pushed to the limit of thinness" and were sometimes only barely capable of holding the weight of several stories.

Coursed adobe walls are found extensively in the northern Rio Grande and also in the Little Colorado region of the northern Southwest but are rare in the Four-Corners area. The construction method uses stiff mud that is built up in courses; each course is allowed to dry before the next course is added (Stubbs and Stallings [1953:26] provide an excellent description of the technique). This process can produce a very sturdy wall that is functionally equivalent to stone construction for load-bearing walls. Like masonry buildings, coursed adobe structures can be multi-storied and terraced (Cameron 1998). E. Charles Adams (personal communication, 1997) suggests, however, that differences in load-bearing strength between adobe and masonry walls may result in smaller adobe rooms. Recently, the use of adobe brick has been recognized at a few prehistoric sites in the northern Southwest (Johnson 1992, Gann 1996).

Adobe walls, whether coursed adobe or adobe brick, were thin. At Arroyo Hondo Pueblo and other northern Rio Grande sites, walls ranged from 20 to 35 cm in
width. At Arroyo Hondo, lower courses were widest and width decreased with upper courses (Creamer et al. 1993:16). At Homol’ovi III in the Little Colorado region, Gann (1996:95) found that adobe bricks were about 31 cm wide but decreased in height in upper portions of walls. Thin adobe walls were apparently still the norm in late 19th century Zuni. Mindeleff (1989:140) noted that “The adobe walls are built only as thick as is absolutely necessary, few of them being more than a foot in thickness.” He observed several collapsed rooms and commented on “…the insufficiency of the thin walls to sustain the weight of several stories.”

**Roofs**

Puebloan roofs are constructed of large beams (*vigas*), generally laid parallel to the long axis of the room and socketed into the walls (Ahlstrom, Dean, and Robinson 1991:629–630; Lange et al. 1993). Smaller secondary beams are laid perpendicular to the primaries. This lattice is covered with brush, twig, or reed “closing material” and then covered with a thick cap of earth. The size of timbers available for roofing may have been an important factor imposing a limit on room size (Adams, personal communication, 1997; Ciolek-Torrelo 1985). At many historic and prehistoric pueblos, Douglas fir and ponderosa pine were preferred because these trees produce long, relatively straight timbers useful for large roof beams (Ahlstrom, Dean, and Robinson 1978:29; Creamer et al. 1993). Pinyon pine and juniper produce shorter, smaller, more crooked beams, although the decay-resistant properties of these species may have led to their use at some sites. Sullivan (1974) has suggested that juniper may have been preferred for roof construction in storage rooms at Grasshopper Pueblo in east-central Arizona because it is a species of cedar whose odor and dense morphology tends to retard decay.

Methods of roof support are important determinants of room size as demonstrated in James’ (1997) recent study of historic Hopi and Zuni houses. He suggests that new methods of roof support were developed after Euroamerican contact that allowed larger rooms to be built. Most descriptions of historic or prehistoric puebloan architecture report that walls support the heavy roofs. At Hopi, however, James found historic illustrations and documents showing the use of interior posts and masonry “buttresses” or piers that supported major roof beams across the width of a room. This technique took some of the weight of the roof off the walls and allowed two adjoining rooms to be combined into a single large room. At Zuni, larger rooms could be constructed by placing massive roof beams across the length of a room and supporting them on very thick walls. Although a number of scholars have documented room size increases (among other architectural changes) at Hopi and Zuni beginning in the last two decades of the 19th century and the early 20th century (Adams 1982; Ahlstrom et al. 1978; Cameron 1999; Ferguson and Mills 1987) James believes that room sizes increased much earlier. He dates the use of both interior posts and larger roof beams to at least the mid-19th century.

Interestingly, prehistoric builders probably had knowledge of the techniques James (1997) describes. Interior posts roof supports were found prehistorically in Basketmaker pit structures (Cordell 1997), at Great Houses in Chaco Canyon (Windes 1987:288), in rooms at Pot Creek Pueblo the Taos area (Wetherington 1968:26–33), and at Pe- cios Pueblo (Kidder 1958:81; Fig. 29, 32). Wetherington (1968:32) lists other archaeological examples and suggests that upright post roof supports usually occur in late period pueblos in the Northern Rio Grande, but also reports their occurrence at Pueblo I
sites in the Mesa Verde region. These archaeological examples suggest that Puebloan builders had the technology to build larger rooms, but chose not to. James (1997) suggests that the introduction of Euroamerican tools, domestic animals, transportation methods, and Spanish-introduced concepts of the use of space combined to make larger rooms appealing to residents of Hopi and Zuni.

Materials and Labor

The availability of building materials for construction was almost certainly a factor conditioning room size in the prehistoric Southwest. Good quality stone and mud for mortar or coursed adobe construction were necessary for sturdy walls. At Zuni, Mindeleff (1989:139) noted that usable outcrops of stone were some distance away and masons used stone sparingly. At both Hopi and Zuni, stone was frequently recycled from earlier buildings (Cameron 1999; Ferguson and Mills 1987:253; Ferguson et al. 1990:110; Krober 1917:195). At prehistoric Arroyo Hondo pueblo, Creamer and her colleagues (1993:14–15) suspect that available outcrops of stone were exhausted after the first rooms were built, so later rooms were constructed of coursed adobe. The construction of coursed adobe walls requires quantities of good quality mud and abundant water. Abundant water is also necessary for mortar in stone walls and house-building was typically undertaken when rainwater was likely to be available.

Perhaps most costly to procure were roof timbers, especially the large vigas which had to be cut, seasoned, and hauled to the building site. Access to stands of timber may have an important factor conditioning room size. At prehistoric Grasshopper Pueblo in northeastern Arizona (discussed below) Ciolek-Torrello (1985) believes that rooms are large partly because of the ready availability of large trees. At Arroyo Hondo Pueblo, a 14th century site in the northern Rio Grande region, Creamer and her colleagues (1993:139) suggest that the large Component I occupation may have depleted surrounding timber forcing the later Component II occupants to cut younger, smaller trees and in some cases to forgo vigas altogether. Upper stories were common in Component I but absent in Component II, possibly because adequate roof supports could not be found. At the Hopi village of Walpi different species of trees were used for different parts of the roof. Primary beams are of pine, fir, or cottonwood, secondary beams are of juniper and closing material is generally willow or reed (Adams 1982:51; Ahlstrom, Dean, and Robinson 1978). Pine and fir were the most difficult to procure. At Orayvi, the University of Arizona's Laboratory of Tree-Ring Research found that sources of preferred timber near the village—pine or Douglas fir—were apparently exhausted by the late 1700s (Douglass 1929:754). By the late 19th and early 20th centuries, however, wagons and draft animals had become common at Hopi. As a result, larger beams from greater distances could be procured and the size of rooms increased (Cameron, in press). Like stone and adobe, roof beams were frequently reused (e.g., Ahlstrom, Dean, and Robinson 1978:37–39).

The organization of housebuilding activities (procuring timbers and stone, procuring and mixing adobe or mortar, constructing walls and roofs) may have been an important determinant of puebloan room size. Most ethnographic accounts report Pueblo housebuilding was undertaken at the household level by male kin (Jorgenson 1980:152, Cu-104/V-229). This was apparently not the case among the matrilineal Hopi where women owned the houses. Mindeleff (1989:101) reported that Hopi men said they built the houses while women only plastered them. However, he observed that a woman and her female
kin actually accomplished much of the house-building with only occasional male assistance. Cameron (1999) shows a house under construction at Orayvi with two women laying stones and four to six women mixing mortar. Only one figure may be male—an individual bent over the roof. James (1997:435) also presents evidence that women at both Hopi and Zuni built and owned their homes.

Among modern Eastern Pueblos, where residence is generally patrilocal or neolocal, men often own the houses (Hill 1982:20; Ortiz 1979:290) although in some cases either sex may own and inherit a dwelling (Hoebel 1979:411; White 1942:196). Where housebuilding is discussed, construction is often reported to be by male relatives or is a cooperative project assigned to males. For example, at Santa Clara Pueblo, Hill (1982:73–74) notes that houses are built by a father and his sons, a group of brothers, or the affinal relatives of a husband and wife (see also Ortiz 1979:191). Parsons (1936:52) reports that Northern Tiwa house construction is a cooperative project of male family members. House building was not exclusively a household activity however. Adolph Bandelier reported that house construction was organized at the village level (Lang and Rilley 1966:97). At Santo Domingo he was told that “When a house is built, the Pueblo details ten men to build the walls and also ten to construct the roof (Lang and Rilley 1966:97).” At Santa Clara Pueblo, Hill (1982:73) reports that a cacique might assign a house-building task (in hardship cases) to the male membership of a moiety or a governor might ask the village to cooperate in such a project. The rebuilding of Acoma in the 17th century seemed to have been a planned endeavor in which much of the village probably took part (Robinson 1990).

The Organization of Settlements

Settlement layout is important to an examination of puebloan room sizes because particular patterns seem to be associated with certain room size characteristics. Adams (1991) proposes that settlement layout for large, late pueblos is of two main types: enclosed plaza and street oriented (see also Reed 1956). In enclosed plaza pueblos, roomblocks are built up around one or more plazas which were used for domestic activities and religious ceremonies. In street-oriented pueblos, like Orayvi, plazas are the areas (“streets”) between linear roomblocks, and were also used for domestic and ceremonial purposes. Roomblocks in street-oriented pueblos tend to face southeast, a direction that ensures maximum solar efficiency and is an important ritual direction for many Pueblo people. Terracing in both types of settlements allowed upper story living rooms to receive maximum light and ventilation, while occupying a defensive position atop a platform of lower story rooms.

In this paper, a dichotomy is recognized within prehistoric enclosed plaza pueblos. “Linear plaza” pueblos are characterized by a few rows of rooms which define several, relatively large, generally enclosed plazas. “Agglomerative” layouts (Mills 1998) consist of dense clusters of rooms surrounding small plazas. Some linear plaza pueblos were built using a technique that has been called “ladder type” construction (Cordell 1996; also “aggregate construction,” Creamer et al. 1993:16). At Arroyo Hondo Pueblo near Santa Fe, this method was used to build many rooms at the same time by constructing two long walls first and then subdividing the space between them with cross walls (Creamer et al. 1993:16). This technique creates a number of rooms in one construction episode and rooms tend to be very similar in size because at least one dimension (width) will be the same for each room. Rooms constructed in pueblos with agglomerative layouts seem to have been individually built, although, of course,
many rooms could have been under construction at the same time.

Ladder type construction suggests that house building was an activity undertaken by a large group of people, rather than an individual family. Ladder type construction creates a single row of rooms and linear plaza pueblos generally consist of several rows of rooms surrounding a plaza. Ample archaeological evidence suggests that dwellings cross-cut these rows, so that families have a plaza facing room(s), as well as interior and rear rooms. Like the construction of a modern apartment building, ladder type construction can create many houses through the coordinated construction of many cells. Agglomerative construction does not require a similar level of coordination in room construction; construction can be accomplished room by room.

The linear plaza settlement form also suggests coordination above the level of the household (see Cordell 1998:27 and Kidder 1958:63). Unlike agglomerative pueblos, the closely packed dwellings of this enclosed plaza design limit the easy addition of individual houses. Instead, expansion consisted of using roomblocks to create a new plaza or, occasionally, adding another row of rooms on the interior (plaza-facing) side of the roomblock (e.g., Creamer et al. 1993, Figs. 7.5–7.7). This pattern of growth suggests that communities that build these sites share an understanding about the size of plaza space that would be surrounded by roomblocks (Cameron 1999). A coordinated building effort using the ladder construction technique would be a likely approach to construction.

Rooms and Houses

A final technological consideration involves house size. In the Southwest and elsewhere, house size is reported either as numbers of rooms or the combined floor area of rooms. House size is especially important for determining household size. Although house size might seem to be directly related to social needs (the addition of a room to accommodate a growing family), there are technological limits on Puebloan house size. As noted above, the closely built houses typical of both enclosed plaza and street-oriented pueblos limit a homeowner's ability to add rooms horizontally. Additional rooms could be added vertically, but there are limits to the number of stories that can be accommodated using puebloan construction technology (Cameron 1999). Of course, the construction of a new roomblock avoids these difficulties. Throughout this paper both room size and house size are discussed. Both are important, related parameters of puebloan use of space.

ROOM SIZE AND ARCHAEOLOGICAL INTERPRETATION IN THE SOUTHWEST

Even though there are clear technological constraints on puebloan room size, technology has generally been given little consideration in archaeological studies of room size (but see Ciolek-Torrello 1985). Instead, the size (floor area) of Pueblo rooms has been assumed to reflect social requirements. As a result, room size has been used in two basic, but intertwined types of archaeological interpretation: estimates of prehistoric population and reconstruction of prehistoric social groups. For both, the identification of room function—with room size usually an important variable—is a first step.

Once rooms are assigned to a functional type (generally using other indicators as well, such as floor features and artifacts) rooms of different types can be combined into houses. The identification of houses permits population estimates because the number of houses can be multiplied by an average household size. Population can also be estimated directly, dividing house
size by a constant number of square meters per person (Naroll 1962; Brown 1987). House size has been used to study of the make-up of the household, changes in household composition over time, and differences in household wealth and/or status (although seldom in the South-west). Room size has also been used, rarely, in the identification of prehistoric ethnic groups. Each of these uses of room size are discussed below.

Room Size and Room Function

Early scholars noted that very small rooms were appropriate for only a limited number of activities (primarily storage) and room size eventually became one of a group of attributes, including floor features and artifacts, that were used by archaeologists to define room function. Drawing heavily on Cosmos and Victor Mindeleff’s architectural studies among the Hopi (Mindeleff 1900; Mindeleff 1989), most archaeologists, especially those studying Western Pueblos, have assumed a close relationship between room size and room function. At least one study of room function at a prehistoric Western pueblo has questioned this relationship, however (Ciolek-Torrello 1985).

Hill’s (1968, 1970) study of Broken K Pueblo, a 12th–13th century site in east-central Arizona was the first archaeological study to test the assumption that floor area (among other variables) was an indicator of room function. He articulated the commonly held archaeological assumption that “... a large room containing a firepit and mealing bin is called a living room or habitation room, while a small room without a firepit is called a storage room (Hill 1970:37).” The largest rooms at Broken K Pueblo were assumed to have been used for ceremonial purposes. Hill assigned rooms to different types based on their size and the presence certain distinctive floor or wall features, then confirmed the architecturally assigned function through an analysis of artifacts and ecofacts present in rooms. The methods used in Hill’s study have been heavily criticized (especially his lack of consideration for the processes that result in the deposition of artifacts on floors), but not his equation of room size with room function (except Ciolek-Torrello 1985).

E. Charles Adams (1978, 1983) also tested the ethnographic model relating room size to room function. He determined room function for abandoned rooms at the Hopi Pueblo of Walpi through interviews with informants and then collected architectural and artifactual data from these same rooms. These data were used to define several categories of room use. Rooms of different uses at Walpi were found to differ significantly in size. Rooms from two prehistoric sites, in the Kayenta area (Betatakin) and on Mesa Verde (Badger House), were categorized by room function using the architectural attributes developed at Walpi (room story location, number of interior wall doors, presence or absence of doors in exterior walls). Adams found significant differences in size between rooms of different functions. Other archaeologists working in the Western Pueblo area have continued to find room size an important indicator of room function (Jorgensen 1975; Lowell 1991; Hansen and Schiffer 1975; Sullivan 1974), often identifying a bi- or tri-modal distribution of room sizes with the largest rooms assumed to have been used for ceremonial activities and the smallest for storage.

Not all archaeologists are convinced that room size is a good indicator of room function, however. In his comprehensive study of room function at Grasshopper Pueblo, Ciolek-Torrello (1978) did not find floor area to be useful. Rooms at Grasshopper are relatively large (16.3 sq m on average) in comparison to other sites such as Broken K Pueblo. Ciolek-Torrello attributes this to the ready availability of large trees in the Grasshopper area for use as roof beams. Instead of a bi- or tri-modal
distribution of room sizes, Ciolek-Torrello found that room floor areas at Grasshopper were normally distributed about the mean (1985: Fig. 3). While Ciolek-Torrello observes that, in general, storage rooms are smaller than habitation rooms, the difference in size is slight and range of sizes within types is great. He explains the lack of correlation between room size and room function partly as a result of constant remodeling at Grasshopper with a resulting change in room function (a conclusion also reached in Sullivan’s 1974 study). He also cites a technological consideration: Grasshopper is a multistoried pueblo where upper and lower stories were the same size even though (based on ethnographic analogy) they should have been used for different purposes (habitation and storage, respectively).

While the constant rebuilding and remodeling observable in prehistoric and historic pueblos might obscure relationships that once existed between room function and room size, ethnographic data from historic pueblos, as well as pueblo-like structures outside the Southwest, suggest that this is not always the case (Cameron 1999). These data indicate that habitation rooms tend to be modified more frequently than rooms of other types (but see Lowell 1991:36–38) because they are used more intensively and deteriorate faster. Most often they continue to be used as habitation rooms, however. In fact, change in structure function is commonly a result of structural deterioration and decisions not to rebuild (i.e., a dilapidated living room used for storage).

Room Size and Population Estimates

The most common method of estimating population at excavated prehistoric pueblos involves assigning rooms to functions and grouping them into “suites” that are assumed to have sheltered a household. The number of suites is multiplied by a constant number of individuals per household to arrive at site population. Alternatively, the number of living rooms can simply be counted, assuming each family occupies a one living room (Schlanger 1986:570). Room size is an important variable in this equation because it is so frequently used to define room function which is essential to both methods of estimating population.

In 1962, Naroll proposed a constant, cross-cultural relationship between quantity of roofed space and population. “Naroll’s Constant” resulted, in the Southwest, in the occasional use of room size as a means of calculating population (Drager 1976; Snow 1976:A224, see also Bullard 1962:123). Naroll’s original proposal was refined (Brown 1987; Leblanc 1971) and new calculations were suggested for use in the Southwest (Clarke 1974) and elsewhere (Castleberry 1974; Kolb 1985; Webel 1979) but it is still not a commonly used index of population size except as a general measure for unexcavated pueblos (e.g., Wilshusen 1995:70; see also Schlanger 1986:579 who develops a project-specific constant). At Orayvi (discussed below), pueblo house size appears to vary widely from the constants proposed by Naroll and others. This may be a result of technological rather than social factors, however. Because not all space in a pueblo house is active use, the fit may be closer than it seems.

Room Size, House Size, and Social Organization

Several studies have attempted to account for changes in room or house size at pueblos by relating these measures to economic activities, the size and organization of households, to community organization, or social interaction. In the Cochiti area near Santa Fe, New Mexico, Hunter-Anderson (1979:182) found greater variability in room sizes at larger sites (dating to the Pueblo IV period) and suggests that these sites would be used for a wider va-
variety of functions. At small sites (Pueblo III and Pueblo IV farmsteads), Hunter-Anderson suggests that smaller room sizes may be related to a decrease in the number of people or amount of time spent at farmsteads, or a lack of certainty about whether the sites would be reused.

A change in economic activities caused changes in room and house sizes at Pot Creek Pueblo, a site located near Taos New Mexico, that dates primarily to the late 13th and early 14th centuries. Crown and Kohler (1994:111) found an increase in size for both rooms and residence units at the Pot Creek through time. They attribute this to an increase in household size brought on by population aggregation (see also Holschlag 1975). Population aggregation resulted in an expanded dependence on agricultural products but an increase in distance to fields that may have caused scheduling problems related to agricultural work versus child care. This conflict could be solved by a shift to extended families. Extended families, they believe, would necessitate larger houses with larger rooms. Kulishek and others (1994) note that Crown and Kohler rely heavily on contemporaneity of construction in defining residence units. While not questioning Crown and Kohler’s postulated increase in household size, Kulishek and his colleagues point out that simply because a group of rooms were built as a unit does not mean that those rooms were occupied by a single family. In other words, they suggest that Pot Creek experienced a change in building technology, rather than (or in addition to) a change in social organization.

Change in household type was also identified at Grasshopper Pueblo and was associated with changes in how the pueblo was used. Here, Reid and Whittlesey (1982) identified two household types: those occupying multiple rooms and those occupying single rooms (see Lowell 1988 for a similar study at Turkey Creek Pueblo). They observed a change through time in the frequency of these household types at Grasshopper that suggested a change in both household size and use of the pueblo. Households occupying multiple-room houses were larger and more established; these houses were found in the main part of the pueblo. Families occupying only a single, multifunctional rooms were typically located in outlying roomblocks. Single room houses appear late in the history of the pueblo and may have been used only part-time during the last occupation episode. The change in household size over time is supported by a decrease in cooking hearth size that would have serviced a smaller family (Reid and Whittlesey 1982:696; see also Ciolek-Torrello and Reid 1974).

In a comprehensive study of prehistoric Pueblo households in the Southwest, James (1994) has linked room size with patterns of residence and descent. Using measurements from almost 9000 rooms at 350 sites in 11 areas of the Southwest, he associates matrilocal residence and matrilineal descent with Puebloan groups on the Colorado Plateau and adjacent regions, including the northern Rio Grande. These groups, prehistorically, tended to have rooms that were under 10 sq m in size. Below the Mogollon Rim, groups in the southern Southwest had very large rooms, more than 21 sq m, that James associates with patrilocal residence and patrilineal descent. He associates residence and descent patterns with differences in subsistence practices, especially corn storage, but also food preparation.

Two studies see changes in room or house size as reflecting changes in community organization or social interaction, rather than modal family size. Dohm (1990) proposes that the spatial proximity of houses is a determinant of house size. Using data from modern and historic Eastern and Western Pueblos, she found that with increasingly aggregated popula-
tions, house size (measured both by number of rooms and quantity of roofed area) in pueblos increases. Dohm ties this change to an increased need for privacy as people aggregate into close-packed, contiguous pueblos. Privacy is sometime achieved, she suggests, by subdividing rooms, thereby increasing the number of rooms in a house and decreasing their size.

In a more detailed study of social interactions, Ferguson (1996:132–135) compared room sizes at modern Zuni Pueblo for vernacular (user built) houses and houses built by the Federal government’s Department of Housing and Urban Development (HUD). He found that both house types were of similar size (about 120 sq. m), but that vernacular houses had fewer, larger rooms, while HUD houses had a greater number of smaller rooms. These differences reflect and contribute to a reformulation of the norms of Zuni society. For example, because kitchens in HUD houses are too small to hold the large numbers of people that traditionally gathered in these spaces, Ferguson believes that the role of women is changing in Zuni society. He observes that the small HUD kitchens “...weakens the social role of women by spatially constraining their social interaction during family gatherings... The role of women shifts from being the social interactional focus of social activity to a role more characteristic of a servant who caters to the needs of other groups of people in the house (1996:142).”

House Size and Social Status

Blanton’s (1994) recent cross-cultural study of houses and households in peasant communities found that house size was one element in a complex system of architectural communication. In cultures where large extended family households were typical, house layout and decoration was directed toward pressuring younger members to sacrifice for the good of the household. Where neolocal households predominated, homeowners were more likely to use the size and decoration of their houses to express their status within the community. Other studies show that in village-level, egalitarian societies, house size can be an indicator of differential status or wealth, even when the distinction is not consciously made. Wilk’s (1983) study of the Kekchi Maya found that individuals with greater social status had houses of larger size, although the Kekchi “...denied vehemently that the size of a house is any reflection of a household’s wealth, status, or power (1983:103).” In Iranian Kurdistan, Kramer (1980) found a positive correlation between compound size and wealth. In the Ecuadorian Amazon, Brenda Bowser’s study of the small-scale, segmental, egalitarian village of Conambo found that house size (floor area) is strongly correlated with social status (personal communication, 1997). High status households in Conambo are also beginning to roof their houses with tin, an expensive and ineffective material, but one that is an indicator of success in contact with the outside economic world.

In the Southwest only a handful of studies explore the relationship between social status and pueblo house sizes. At Grasshopper Pueblo, Reid and Whittlesey (1982:696) suggest that multiroom houses may have been occupied by older, more established, “wealthier” families. Similarly, at Turkey Creek, Lowell (1988:91) believes that families occupying only a single room might have been poorer than families with multiroom houses. In the Mogollon area, Lightfoot and Feinman (1982) suggest that large, early pit structures found in some villages, housed village leaders with greater access to exotic goods.

In most Southwestern studies, however, Southwestern archaeologists link large rooms or houses with the location of ceremonial activities, not with the homes of
high status individuals—even though in most middle-range societies, social rank is closely tied to roles within a ceremonial or religious hierarchy. For example, in Puebloan society, high status individuals are usually religious leaders and at the Western Pueblos, these individuals would be clan leaders—especially the leaders of the highest ranking clans. In his study of Walpi Pueblo, Adams (1983) included clan houses—the habitation room of a clan matriarch—with “religious rooms” and observed that religious rooms were larger than rooms of other types. Adams did not associate these differences in room size with status differences however, but with religious use.

Similarly, during the Chacoan era in the northern Southwest, there is long-standing recognition that rooms in Chacoan Great Houses are much larger than rooms in contemporary unit pueblos. Many Chacoan rooms lack evidence of domestic activity, however. Great Houses have most frequently been interpreted as ceremonial or community structures or even storehouses, not primarily as the residences of high status individuals (Lekson et al. 1988). Finally, Lightfoot and Feinman’s (1982) suggestion that large early large pit structures in the Mogollon area, housed village leaders with greater access to exotic goods was heavily criticized for assuming that they had correctly identified the archaeological correlates of status (Cordell 1984:319–320). Large structures in the Mogollon area are, instead, believed to reflect the location of ceremonial activities.

Room Size and Cultural Identity

Because the types of indoor activities undertaken by village-level horticulturalists practicing corn agriculture are broadly similar (food processing, cooking, storage, tool manufacturing and maintenance, eating, sleeping) the size and shape interior space in Southwestern pueblos might be assumed to be similar. Recently, however, archaeologists have begun to recognize an association between room size and ethnic or cultural affiliation. For example, James’ (1994) pan-Southwestern study (described above) found that room sizes are associated with different patterns of residence and descent. He associates these patterns with differences in the organization of room space for corn storage and processing among communities above and below the Mogollon Rim. James believes that patterns of residence and descent, and their associated architectural correlates, become established early and are quite stable and recognizable for cultural groups in different parts of the Southwest. In fact, he questions a often-cited migration from the Kayenta area to the 13th century site of Point of Pines, Arizona (Haury 1958) because room sizes of the immigrant group are not similar to those in the Kayenta area (1994:161–162).

In a similar but less comprehensive study Baldwin (1987) also uses room size to define prehistoric Southwestern cultures. Building from classic studies of proxemics and architecture (Hall 1966, 1968) and the theory of architectural design offered by McGuire and Schiffer (1983), he suggests, with regard to pueblo buildings, that “... the largely subconscious, culture-specific proxemic system of the builder is a major determinant of some properties of rooms, particularly the size and shape of dwelling spaces (1987:166).” He uses cumulative frequency curves (ogives) of room sizes to distinguish populations with culturally specific building patterns at sites in Chaco Canyon, the Mesa Verde area, and the northern Rio Grande. Where cumulative frequency curves overlap, Baldwin (1987:169,173) postulates immigration and cultural mixing.

In the Western Pueblo area, during the Pueblo IV period (A.D. 1275–1550), archaeologists have begun to link changes in room sizes to the arrival of immigrants to the area and to internal population movements. In the Silver Creek area of
east–central Arizona, Mills (in press) finds a decrease in room size after A.D. 1325 that she associates with a population influx. At the Homolovi pueblos, located on the middle Little Colorado River near Winslow, Arizona, Adams (1998; see also Adams 1996), has found that immigrants converged on this area during the early Pueblo IV from both the north and the south. Room sizes at the pueblos occupied by each of these groups were different. Both Homolovi and the Silver Creek cases are discussed further below.

James (1994) is the only scholar to propose material causes for room size differences among groups in the Southwest: agricultural practices that result in differences in patterns of residence and descent. Nevertheless, the examples presented here indicate that a number of Southwestern scholars are beginning to explore the importance of culturally based conceptions of the use of space in determining room size and, presumably, house size.

THE ORAYVI DATA SET

Historic records from Orayvi, including maps and census materials provide an unparalleled set of data for examining the historic use and modification of pueblo structures (Cameron 1999). For the present study, the most important aspect of these data is that they provide a link between the pueblo house—a set of rooms occupied by a household—and the individuals who made up the household. The exact articulation of house and household is not, to my knowledge, available for any other 19th century Southwestern pueblo. These data provide an important foundation for evaluating commonly held archaeological assumptions about the meaning of pueblo room sizes and interpretations of temporal and spatial differences in room sizes.

Orayvi is located on Third Mesa, the westernmost of the three Hopi Mesas (Fig. 2). It is an ancient pueblo, perhaps first occupied in the 1100s. The Hopi Pueblos had little contact with Euroamericans until the late 1800s, which is why they are favored by archaeologists as models for prehistoric pueblos (but see James 1997). Orayvi was the largest of the Hopi villages in the late 1800s and reportedly the most conservative. In 1906, the pueblo was the scene of a dramatic factional split that resulted in the departure of half of the residents. These emigrants founded two new villages nearby.

The split and other aspects of Orayvi social organization have been studied by numerous scholars. One of the first and most comprehensive studies of Orayvi was undertaken by Mischa Titiev in the 1930s (Titiev 1944). His work, a study of social organization at Orayvi, has served as a baseline for virtually all other studies of the village, including this one. Other scholars have focused more directly on the causes of the split, attributing it to a variety of factors ranging from acculturative pressure on the Hopi by the U.S. Government (Clemmer 1978:58, 76) to an intentional effort by Orayvi’s religious leaders to overturn Orayvi’s politico-religious order (Whiteley 1988). Most recently, in a detailed study of social stratification at Orayvi, Jerrold Levy determined that economic distress, caused by a deteriorating environment, was the ultimate cause of the split (Levy 1992). Levy found that the families who were forced out of the village during the split were almost all from landless and low status lineages. Because of the work of Titiev and other scholars, a wealth of architectural and census data are available for Orayvi. These data are derived from a number of sources. A highly accurate plan of Orayvi was produced by Victor Mindeleff in 1887 (Mindeleff 1989); this map was used to calculate floor area for rooms and houses in this study. During the early 1930s, Titiev worked with elderly informants at Orayvi,
to produce a reconstructed “census” of the pueblo for the period around 1900, just before the split. He used a tracing of Mindeleff’s map and recorded the members of each household and the rooms they had occupied. Titiev used the census in his well-known monograph on Orayvi (1944), but his detailed census notes were never published.

In the 1970s, Levy discovered Titiev’s census notes at the Museum of Northern Arizona (Titiev n.d.) and undertook a new study of social organization at Orayvi and the causes of the split (Levy 1992). Levy constructed a computer file that included all of Titiev’s census information, but also included data from the 1900 U.S. census. Titiev’s census was generally accurate, but it occasionally included in a household individuals who were recently deceased in 1900 or were not yet born. The 1900 U.S. census listed the individuals in each household at a single point in time. Levy’s computer census files included the name of the female household head, her age in 1900, and the number and relationship of other people living in her house (as well as other information).

Levy generously permitted me to use his computer census in a study of architectural change at Orayvi (Cameron 1991, 1996a, 1999). These data allowed me to link the spaces on Mindeleff’s map that Titiev had defined as the lodgings of a single household with the individuals who lived in those rooms in 1900. Titiev also recorded households living in new houses that had been built during the 13 years between Mindeleff’s 1887 map and the 1900 census. I used a series of historic photographs collected from numerous museum and university archives to chronicle change to the houses over time, documenting architectural change at the pueblo over a period of more than 70 years, from 1872 to 1948. Mindeleff’s map, Levy’s census, and my study of architectural change combined provide a powerful set of data for examining the relationship between the Orayvi house and household at this historic pueblo.

Orayvi Room and House Size

In 1887 when Mindeleff mapped Orayvi it was a large settlement of about 1100 rooms arranged in long, terraced room-blocks of attached houses that generally faced southeast (Fig. 3). This “street-oriented” layout (Adams 1991:103) was common during the late prehistoric and historic time periods. Most houses were only one room wide, with approximately three ground floor rooms, two second story rooms, often a third story room, and occasionally a fourth story room (Fig. 4; Cameron 1996a). The areas between room-blocks were used as plazas for domestic activities. The Main Plaza was the scene of much ceremonial activity, as, occasionally, was the Snake Dance Plaza (Fig. 3).

Titiev (n.d.) recorded 188 households at Orayvi in 1900 and the room numbers that made up the houses they occupied (Fig. 5), but I was not able to use quite all of these households to examine the relationship between house and household size. Between the time Mindeleff mapped Orayvi and 1900 (the date of Titiev’s reconstructed census), 34 new houses had been added to the village. Titiev sketched the approximate location of new houses on his copy of Mindeleff’s map, but did not show number of rooms or stories accurately. When these new houses could be seen in photos, the number of rooms could sometimes be counted (Cameron 1999). Floor area for rooms and houses that are not on Mindeleff’s map could not, of course, be calculated.

The number of rooms for each house at Orayvi was calculated by adding together all of the room numbers listed by Titiev as the residence of a single household, then, for each room, adding the number of stories recorded on Mindeleff’s map. Adjustments were made for architectural change
observed in photographs for those houses that could be seen in photos—deleting or adding rooms that had been abandoned, demolished, or newly built between 1887 and 1900.7

Floor area measurements were obtained for 1001 rooms in 154 houses (Table 1). Rooms at Orayvi ranged in size from about 1 sq m to almost 60 sq m, averaging almost 16 sq m. James (1997) has argued, using abundant archaeological data, that room size at pueblos in the northern Southwest was below 10 sq m prior to Spanish contact. He suggests that even though the Hopi and Zuni were not in direct contact with Euroamericans from the late 16th century to the late 19th century, their architecture, including room size, was affected by Euro-American presence in the Southwest as early as the mid-19th century, if not before. As discussed above, he documents the use of new

FIG. 3. Map of Orayvi redrawn from the original produced by Victor Mindeleff in 1887 (Mindeleff 1891). The named structures are kivas. Courtesy Smithsonian Institution, National Anthropological Archives.
methods of roof support to combine rooms into a single large space. He notes that these changes were much greater at Zuni than at Hopi because the Hopi were more conservative and had restricted access to large roof beams.

Average room size at Orayvi does suggest that by 1887 rooms at Orayvi were larger than would have been the case prehistorically. The degree of change is difficult to assess because of the method used to measure room sizes: using the roofed area on Mindeleff's map means that interior walls that do not protrude above the highest roof cannot be seen. While James (1997) suggests that large rooms were created by removing interior cross walls, it is also possible that some of the largest, lower story rooms recorded at Orayvi were subdivided by cross-walls that could not be seen on Mindeleff's map (see Note 5). Even if the amount of domestic space at historic Orayvi was somewhat greater than at prehistoric pueblos, however, the relations between people and space discussed here are still pertinent to the interpretation of archaeological cases.

Houses had between 6 and 7 rooms. The floor area of houses (the combined area of each room and each story associated with one of Titiev's households) ranged in size from less than 6 sq m (a small, one room house that may have been undergoing renovation) to over 300 sq m. Average house size was more than 100 sq m, approximately the size of a typical 1950s American ranch-style home. These figures conform with cross-cultural studies that suggest that in societies with matrilocal residence, house size can be expected to range between 80 and 270 sq m (Divale 1977 cited in James 1994:19; patrilocal societies reportedly have smaller houses: 15 to 43 sq m).

The Fit between Houses and Households

More than two-thirds of the households on Titiev's census could be identified in the 1900 U.S. Census (n = 115), allowing an exact count of the individuals living in particular houses. In 1900, the number of people living in Orayvi houses ranged from one to 12 with an average of between 5 and 6 people (Table 1; Cameron 1996a). In spite of ethnographic accounts (for example, Eggan 1950) and large house size, Orayvi households were not primarily matrilineal extended families (Table 2). More than half the households at Orayvi in 1900 were nuclear families (mother, fa-
ther, and unmarried children); extended families only made up 22% of the households (Cameron 1996a, 1999; Levy 1992; Whiteley 1988). Remaining families were couples without resident children or a variety of other household types.

Examination of the fit between houses and households at Oraibi is complicated by evidence that many houses were being modified during the 13 years between Mindeleff's map and the 1900 census. Reconstruction and remodeling had always been common activities at the Hopi villages, but in the late 19th century the introduction of Euroamerican technology and architectural style and apparent population growth at Oraibi may have increased the pace of building and rebuilding. Two-thirds of the 59 houses I observed in my study of architectural change were modified between 1887 and 1900; rooms were rebuilt, abandoned, or demolished and new rooms were built (Cameron 1999).

It is likely that even if room size in-
creased during historic times, as suggested by James (1997) house size did not increase. James (1997:435–436) proposes that room size increased through the use of internal roof supports that allowed two rooms to be combined into one (an internal wall could be demolished). Combined rooms were observed at Orayvi during the late 19th century (Cameron 1999). This process would create a larger room, but not a larger house. In fact at Orayvi, although some rooms increased in size during the years between 1887 and 1990, and living rooms were moved from upper to lower stories, I found evidence that houses generally stayed within the same architectural footprint (except for evidence of expansion to the southeast; see below). For purposes of floor area calculations discussed below, I argue that houses generally stayed within the same architectural footprint (except for evidence of expansion to the southeast; see below). For purposes of floor area calculations discussed below, I argue that house size (floor area) did not change substantially between 1887 and 1900;[8] for those houses visible in photos, the numbers of rooms were adjusted to account for architectural modification.

In contrast to Crown and Kohler’s expectations for Pot Creek Pueblo, extended families did not have significantly larger houses than nuclear families at Orayvi (Table 3). Extended families were significantly larger than nuclear families (t value = 3.941, p < .0007), but they did not have significantly larger houses whether measured by numbers of rooms or as total house area (number of rooms: t value 1.045, p = .0383; mean area of house: t value .19, p = .847). Although the sample size is small, couples actually had the largest houses at Orayvi and “other” household types had the smallest houses (Table 3).

The lack of fit between house and household at Orayvi may be attributed both to historical factors and the developmental cycle of the domestic group.[9] Houses at Orayvi are highly variable in size (Table 3). They have long use-lives, but in spite of evidence of frequent remodeling and rebuilding, family configuration almost certainly changed more frequently than house size. For example, Table 3 demonstrates that couples lived in large houses with many rooms that were clearly built for, and likely once housed, a bigger family.

Titiev reported that, among the Hopi, daughters continued to reside with their mothers after marriage, their husbands joining them, as they raised their children in a matrilineal extended family (1944:46). There is evidence, however, that the extended family was only a temporary configuration until a young couple became settled and could establish an independent household (Emory Sekaquaptewa,
personal communication 1990; Levy 1992: 24). Census figures, discussed above, bear this out (Cameron 1996a; Whiteley 1988). The matrifocal extended family may have been the ideal, but it was not the most common household type at Orayvi. Orayvi in 1900 had a variety of household types and this was probably always the case. If certain household configurations, such as extended families or elderly couples, were expected to be temporary, there would be little incentive to frequently adjust house size.

Furthermore, the architectural style of Orayvi hinders the expansion of houses and, given an expected relationship between house and household size, probably always restricted the development of extended families. Orayvi houses, as in all street-oriented pueblos, are joined in long rows. Houses can expand vertically, but not horizontally without impinging on property held by someone else. The establishment of new, noncontiguous houses would be a necessity if many daughters married and started new families (Cameron 1996a). One daughter would remain to inherit the natal house, but as soon as her parents died, the house would, once again, be occupied by a nuclear family.

Floor Area per Person

Naroll (1962) found, in a cross-cultural study, that dividing roofed floor space by population resulted in an average of 10 sq m of roofed floor space per person. “Naroll’s Constant” has been repeatedly questioned and refined (LeBlanc 1971; Clarke 1974; Kolb 1985). Castleberry (1974) proposed a constant of 6 sq m per person, a figure supported by Brown (1987) and Kolb (1985), although with caveats.

At Orayvi, calculating floor area per person resulted in a surprisingly high figure, 21.34 sq m per person (Table 4), more than twice that originally proposed by Naroll and more than 3 times the figure estimated by Castleberry (1974) and Brown (1987). The mean conceals a high degree of variability, however. Calculations of floor area per person could be made for 92 households (Table 4), and

<table>
<thead>
<tr>
<th>Household type</th>
<th>Mean household size</th>
<th>Mean no. of rooms per house</th>
<th>Mean floor area (sq m) per house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>5.4</td>
<td>6.2</td>
<td>97.0</td>
</tr>
<tr>
<td>SD</td>
<td>1.7</td>
<td>3.3</td>
<td>45.3</td>
</tr>
<tr>
<td>No. Hhd./houses</td>
<td>54</td>
<td>46</td>
<td>45</td>
</tr>
<tr>
<td>Extended</td>
<td>7.0</td>
<td>6.8</td>
<td>100.7</td>
</tr>
<tr>
<td>SD</td>
<td>2.0</td>
<td>2.8</td>
<td>55.0</td>
</tr>
<tr>
<td>No. Hhd./houses</td>
<td>24</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Couple</td>
<td>2.0</td>
<td>6.5</td>
<td>108.4</td>
</tr>
<tr>
<td>SD</td>
<td>9</td>
<td>1.9</td>
<td>46.0</td>
</tr>
<tr>
<td>No. Hhd./houses</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Other Households</td>
<td>5.2</td>
<td>6.7</td>
<td>90.2</td>
</tr>
<tr>
<td>No. Hhd./Houses</td>
<td>1.9</td>
<td>3.5</td>
<td>56.8</td>
</tr>
<tr>
<td>All households (incl. unk. hhd type)</td>
<td>5.5</td>
<td>6.4</td>
<td>103.1</td>
</tr>
<tr>
<td>Number Hhd./house</td>
<td>109</td>
<td>160</td>
<td>154</td>
</tr>
</tbody>
</table>

Note. Fewer houses were included in the calculation of floor area than had been determined for numbers of rooms because floor area could not be calculated for any of the houses added to Mindeleff’s map by Titiev. Where these houses could be seen in photos, rooms could sometimes be counted.
these households showed a range of 1 to 90 sq m per person.

The wide deviation from proposed universal floor area requirements may be the result of patterns in the way multistoried pueblos grow. Although Dohm (1990) proposes that increased crowding at large aggregated pueblos like Orayvi increases the need for privacy and results in an increase in house size, pueblo growth patterns may be equally important. In the 1800s, much of Orayvi was three stories tall; parts of the village reached four stories. The terraced structures faced south-east both for maximum solar efficiency and because this is an important ceremonial direction for the Hopi. Front, upper story rooms were living rooms; lower story rooms were used for storage. Terraced structures were defensive; lower story rooms had no doors and upper stories could be reached only by ladders that could be pulled up in case of attack.

Photographic and documentary evidence shows that houses expanded as new rooms were built onto the front of the dwelling (Cameron 1996a, 1996b). As new, front rooms are built, rear rooms are blocked and became increasingly dark, unventilated, and difficult to access. Eventually, they are abandoned. This process resulted the slow “creep” of houses toward the southeast (Cameron 1996a,b). As a result of this process, even though households had a number of rooms and apparently a considerable amount of floor area per person, much of this floor area was not usable space. Based on studies at both prehistoric and historic pueblos, some of these unused rooms became garbage dumps (Kidder 1958; Adams 1983), although they continued to function as a defensive terrace upon which dwellings were built. If only rooms in active use were counted, floor area per person at Orayvi might approach constants derived by Naroll and others. Because the Orayvi data were exclusively external and room use could not be directly determined, such calculations are beyond the scope of this study.

**Room Size and Social Status at Orayvi**

Both ethnologists and archaeologists have traditionally considered Pueblo people to be largely egalitarian, although the point has been argued in both subdisciplines, especially during the past few decades (Lightfoot and Upham 1989 provide a summary of this controversy). Clearly, social stratification is not marked among prehistoric and historic pueblos and is only proposed consistently for certain archaeological cases, such as the Chacoan Regional System. However, even supposedly “egalitarian” societies exhibit differences in wealth and status that may have archaeological correlates. At Orayvi, the relationship between house size, wealth, and social rank is not strong, but there is some evidence that clan houses, the ceremonial home of the Clan Mother and the place where religious paraphernalia was kept, may have been larger than other houses.

In his exploration of social stratification at Orayvi, Levy (1992) found that the matrilineal clans of which Hopi society is comprised could be assigned to one of three ranks based on ownership of ceremonies, ownership of major political of-

<table>
<thead>
<tr>
<th>Household type and number</th>
<th>Mean (sq m)</th>
<th>Standard Deviation (sq m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear no. 45</td>
<td>20.6</td>
<td>10.82</td>
</tr>
<tr>
<td>Extended no. 21</td>
<td>16.1</td>
<td>8.55</td>
</tr>
<tr>
<td>Couple no. 5</td>
<td>54.2</td>
<td>23.0</td>
</tr>
<tr>
<td>Other no. 18</td>
<td>17.0</td>
<td>12.2</td>
</tr>
<tr>
<td>All houses no. 92</td>
<td>21.3</td>
<td>15.5</td>
</tr>
</tbody>
</table>

* Includes houses for which household type could not be determined.
fices, and access to good quality agricultural land. During the 1906 split, Levy found that high ranking clans and prime and alternate lineages of middle ranking clans tended to remain at Orayvi while landless clans and marginal lineages of middle-ranking clans left. Levy’s ranking system provides a method of linking house size with social status and wealth.

As a first attempt to discern a relationship between house size and social status, houses at Orayvi were divided into two groups: those in which the female household head represented a prime lineage and those in which the female household head represented a marginal lineage (Table 5). Houses of prime lineages were slightly larger than those of marginal lineages, but the difference was not significant. Next, Levy’s (1992: Table 3.1) three clan ranks were used to order houses by area (Table 5). Minimum and maximum house sizes for each of the three ranks were similar. The three largest houses at Orayvi belonged to women of the middle rank. Of the three smallest houses, one belonged to a woman of rank 1, one to a woman of rank 2, and the third was unknown.

Finally, house sizes were examined for the prime lineages of the highest ranking clans and the marginal lineages of the lowest ranking clans: in other words, the sets of households which should have had the highest and lowest status at Orayvi. The mean area for houses of prime lineages of the five highest ranking clans is compared to average house size in Table 6. The Bear Clan is perhaps the highest ranking clan at Orayvi. In Orayvi oral history, it is the first clan to arrive at Orayvi and is the clan from which the village chief is always selected (Levy 1992:25,33). The three prime lineages of this high ranking clan had houses with floor areas that were considerably larger than the average house size at Orayvi. The 11 other houses owned by prime lineages of high ranking clans, however, had houses that were quite variable in size. Interestingly, of the seven houses that were below average in size, most may have been in the process of expansion. Two were under construction when Mindeleff mapped Orayvi and four were located in the small roomblocks at the edges of the village, where new construction was taking place. High ranking clans may have been better able to afford the costs of new construction and gather the materials and labor necessary to build the new structure.

Archaeologists have often assumed that clan houses would be larger than other

<table>
<thead>
<tr>
<th>Clan rank</th>
<th>Minimum house area (sq m)</th>
<th>Maximum house area (sq m)</th>
<th>Mean area (sq m)</th>
<th>No. houses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>25.11</td>
<td>232.33</td>
<td>98.6</td>
<td>24</td>
</tr>
<tr>
<td>2</td>
<td>60.9</td>
<td>306.4</td>
<td>102.74</td>
<td>62</td>
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<tr>
<td>1</td>
<td>9.1</td>
<td>239.8</td>
<td>107.7</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 5
House Size and Social Status at Orayvi

<table>
<thead>
<tr>
<th>Lineage status</th>
<th>Mean house size</th>
<th>SD</th>
<th>Number^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime</td>
<td>108.7</td>
<td>60.2</td>
<td>57</td>
</tr>
<tr>
<td>Marginal</td>
<td>100.9</td>
<td>55.0</td>
<td>60</td>
</tr>
</tbody>
</table>

^a t value = .74, significance = .463.
^b Lineage status was unknown for 37 houses.
^c Clan rank from Levy (1992) Table 3.1 (Rank 3 = highest).
Houses (Creamer 1993:117) and Adams (1983) demonstrated this relationship with data from Walpi Pueblo. Titiev (1944:47) reported the great concern that people at Orayvi had for clan houses and even today extraordinary efforts are made to preserve these special houses in Hopi villages. While it was not possible to determine from Titiev’s notes exactly which houses were clan houses (Levy, personal communication 1997) the clan house would have been located in the home of a woman from one of the clan’s prime lineages (Levy 1992:24; Titiev 1944:47). Therefore, one of the homes of each of the five high ranking clans on Table 6 must have been the clan house. For each of these clans, except the Parrot Clan, one house is considerably larger than the

<p>| Table 6 |
|-----------------|----------------|
| Houses of the prime lineages of the five highest ranking clans |</p>
<table>
<thead>
<tr>
<th>HHd No.</th>
<th>House size (sq m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bear Clan</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>113.7</td>
</tr>
<tr>
<td>161±</td>
<td>152.8</td>
</tr>
<tr>
<td>162</td>
<td>121.1</td>
</tr>
<tr>
<td>Mean house area, Bear Clan: 129.2, SD 20.8</td>
<td></td>
</tr>
<tr>
<td>Spider Clan</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>(no area)</td>
</tr>
<tr>
<td>110±</td>
<td>76.1</td>
</tr>
<tr>
<td>134</td>
<td>112.0 (faces Main Plaza)</td>
</tr>
<tr>
<td>166±</td>
<td>76.9</td>
</tr>
<tr>
<td>Mean house area, Spider Clan: 88.31, SD 20.54</td>
<td></td>
</tr>
<tr>
<td>Parrot Clan</td>
<td></td>
</tr>
<tr>
<td>9±</td>
<td>55.1</td>
</tr>
<tr>
<td>73±</td>
<td>47.4</td>
</tr>
<tr>
<td>Mean house area, Parrot Clan: 51.2, SD 5.4</td>
<td></td>
</tr>
<tr>
<td>Bow Clan</td>
<td></td>
</tr>
<tr>
<td>1±</td>
<td>28.1</td>
</tr>
<tr>
<td>131</td>
<td>127.8 (faces Main Plaza)</td>
</tr>
<tr>
<td>165±</td>
<td>213.9</td>
</tr>
<tr>
<td>Mean house area, Bow Clan: 123.3, SD 93.0</td>
<td></td>
</tr>
<tr>
<td>Patki Clan</td>
<td></td>
</tr>
<tr>
<td>5±</td>
<td>30.6</td>
</tr>
<tr>
<td>36±</td>
<td>84.1</td>
</tr>
<tr>
<td>61±</td>
<td>232.3</td>
</tr>
<tr>
<td>Mean house area, Patki Clan: 115.7, SD 104.5</td>
<td></td>
</tr>
</tbody>
</table>

| House size for the marginal lineages of the lowest ranking clans |
|-----------------|----------------|
| Mean house size: 103.8 |
| Standard deviation: 52.3 |
| Largest house: 239.8 (household 137) |
| Smallest house: 36.3 (household 141) |
| Number: 17 (for which floor area could be measured) |

Note. Mean house area for all Orayvi houses (for which floor area could be measured) = 103.1 m², SD 58.95, n = 154.

± Clan status and prime and marginal lineage status from Levy 1992.
± Houses under construction in 1887.
± Houses at the edge of the village.
± Possible clan houses.
others. These larger houses may have been clan houses and the home of the Clan Mother.

While most prime lineages of high ranking clans do not tend to have significantly larger houses that average, neither do marginal lineages of low ranking clans have very small houses. House size for marginal lineages of the lowest ranking clans is presented in Table 6. Average size for the 17 houses for which data were available matched exactly the average size for all Orayvi houses (103 sq m). With the possible exception of clan houses, house size and social status do not seem to be correlated at Orayvi.

While house size and status seem to be poorly correlated at Orayvi, the location of houses is another potential status indicator. The most important house sites at Orayvi were likely those surrounding the Main Plaza or the Snake Dance Plaza where most ceremonial activity takes place. For example, when Bacavi was built after the split by emigrants from Orayvi, the village was planned so that the houses of the most prominent families (especially the Bear clan) were located on the plaza (Whiteley 1988:125). At Orayvi before the split, however, this pattern was not apparent: only two of the 14 houses of the prime lineages of the highest ranking clans were located around the plaza (Table 6). House location did not seem to be a status indicator.

Room Function and Room Size at Orayvi

Both Hill (1970) and Adams (1978, 1983) proposed multiple indicators of room function, including floor features, such as hearths or mealing bins, ventilators, wall niches, doorways, and story in the village structure. Both found room size to be a strong indicator of room use. Because data from Orayvi are based largely on maps and photos of house exteriors, there is little direct evidence concerning room use for this pueblo. But if, as Hill and others have suggested, pueblo rooms come in three sizes (small storage rooms, large habitation rooms, and very large ceremonial rooms), then room sizes at Orayvi should show a tri- or at least bi-modal distribution. This is not the case, however. A histogram of Orayvi room sizes shows a normal distribution across a wide range of room sizes (Fig. 6); there is no patterning that would suggest that room sizes fall neatly into two or more size classes.

Another measure of room function that was observable at Orayvi is the level or story at which a room is located. Adams (1983) found that at the Hopi Pueblo of Walpi, storage and granary rooms tended to be on ground floors. Living rooms were in upper stories. Using the story of rooms at Orayvi as an indicator of room function, the size of rooms of different stories was calculated. (Measurements are of rooms sizes in 1887 before Euro-American influence changed significantly the location of Hopi storage and living rooms). Because of the assumption used in this study that each story of a multistoried room is the same size, only the top floors of each room were used in this calculation. In fact, then, the comparison is between different terraces rather than different stories: front, single-story terraces, middle, two-story terraces, and rear, three-story terraces (Fig. 4). The assumption that front, lower story rooms will be storage rooms and recessed upper stories, living rooms, is still appropriate. There is a significant difference in room size for rooms in different stories (Table 7). Front, first floor rooms, most likely to be storage, have the lowest mean area, and rooms increase in size as the story increases.

Although room sizes at Orayvi are not clearly bi- or tri-modal, based room position, rooms of different function seem to be differently sized. Ciolek-Torrello suggests that at Grasshopper (1985) the frequent remodeling that characterizes Hopi architecture may have blurred a once more clear-cut relationship between room size and
room function. But it is also likely that the household-based construction evident at Hopi did not produce rooms in standardized sizes. Factors such as the size of available roof timbers and the number of people who could be persuaded to work on a building project may have been important determinants of room size. This combination of factors would produce the variety of room sizes apparent at Orayvi.

A comparison of patterns of room sizes at Orayvi with those found at prehistoric sites highlights apparent differences in the organization of construction throughout the northern Southwest. Rooms at Orayvi were variable in size, but at some prehistoric pueblos, especially certain Eastern Pueblos, rooms size is quite uniform. This is also true for a few Western Pueblos. Ladder type construction (described above), may account for some of the modularity and may result in sites with characteristic layouts: linear plaza pueblos with relatively straight rows of rooms outlining one or more plazas. Uniform room sizes, ladder type construction, and linear plaza pueblos may be the result

**TABLE 7**

Orayvi Room Size by Story

<table>
<thead>
<tr>
<th>Story</th>
<th>Mean</th>
<th>SD</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>12.3</td>
<td>6.7</td>
<td>207</td>
</tr>
<tr>
<td>Second</td>
<td>14.4</td>
<td>8.9</td>
<td>202</td>
</tr>
<tr>
<td>Third</td>
<td>18.1</td>
<td>10.4</td>
<td>171</td>
</tr>
<tr>
<td>Fourth</td>
<td>21.5</td>
<td>10.0</td>
<td>12</td>
</tr>
</tbody>
</table>

*Only the top story for each "story" type is used in calculating the mean as each lower story is assumed to be the same size as the top story.*
of a coordinated construction effort involving a large portion of a community. Where these characteristics are not observed, construction may be organized at the household level. A few suggestions concerning the origin of these different organizational types is made here.

Table 8 shows room sizes for a number of large, late prehistoric (post A.D. 1200) Western and Eastern Pueblos. Comparison with Orayvi required large, extensively excavated pueblos with room sizes reported or mapped at a scale that would allow for measurement of rooms. Eastern Pueblos for which individual room size data could be obtained are from a restricted region of the northern Rio Grande, south of Santa Fe: the Galisteo Basin and surrounding areas. A majority of these sites were excavated by Nels Nelson (1914) early in this century and he provided a table of room dimensions for the rooms that he excavated. Room sizes for Western Pueblos were more difficult to obtain and as a result, the sample is smaller and more widespread, including sites both above and below the Mogollon Rim (Fig. 1).

Like Orayvi, several of the prehistoric Western Pueblos have rooms of variable size, ranging from a little more than 1 sq m to more than 35 sq m. Standard deviation of room sizes for these pueblos is smaller than Orayvi, and Orayvi has a number of very large rooms; however, all of the prehistoric sites have far fewer total rooms than Orayvi, so some of Orayvi's variability may be due to sample size. Rooms at the Eastern Pueblos were of very standard size: mean areas were between 6–7 sq m and most had standard deviations of 2 sq m or less from the mean. Several Western Pueblos also show significant regularity in room sizes: the Homolovi Pueblos and Roomblock D at Fourmile Ruin. The remarkable regularity in the sizes rooms at some prehistoric pueblos suggests a standardization of building techniques at these pueblos that is lacking at other pueblos.

Ladder-type construction is just beginning to be recognized and reported by Southwestern archaeologists. Although most of the Eastern Pueblos on Table 8 were excavated at the turn of the century before much attention was paid to construction methods, ladder type construction has been noted at some Eastern Pueblos (Creamer et al. 1993, Cordell 1996, Roney 1996). There was no evidence of ladder type construction at Orayvi although it has been reported at a few prehistoric sites in northeastern Arizona (Dean 1996, Gilpin 1989), including several of the Homolovi pueblos (Adams personal communication 1997).

Ladder type construction results in a characteristic, linear site layout. For example, most of the Eastern Pueblos on Table 8 are characterized by a few rows of rooms which define several, relatively large, generally enclosed plazas (Fig. 7). The same is true at Homolovi II. At Fourmile Ruin, the latest part of the site (including Roomblock D) is composed of linear roomblocks, although the plaza they define is not fully enclosed. These linear plaza layouts likely result, at least partly, from the construction of long continuous walls required for ladder type construction. In contrast, at a number of Western Pueblos on Table 8, especially those below the Mogollon Rim, plazas are present, but the organization is much less formal. For example at Turkey Creek and Grasshopper Pueblo, dense clusters of rooms surround small plazas (Fig. 8). This layout, which may have begun at the large Classic sites of the Mimbres region, such as Galaz and Swartz, has been termed “agglomerative” (Mills 1998).

These two different settlement patterns may reflect differences in the organization of groups of people who moved about the Southwest during the centuries just before Spanish contact—a time of dramatic,
large-scale abandonments and aggregation of population into large villages (Adler 1996). Linear plaza pueblos may have been designed to accommodate the immigration of large, relatively well-organized groups of people; agglomerations...
FIG. 7. Arroyo Hondo Pueblo (Component 1), located near Santa Fe, New Mexico, was built and occupied during the early 13th century. It has a linear, plaza-oriented settlement layout typical of many Eastern Pueblos. Reprinted, by permission, from The Architecture of Arroyo Hondo Pueblo, New Mexico by Winifred Creamer. Drawing by Katrina Lasko. © 1993 by the School of American Research, Santa Fe.
FIG. 8. Turkey Creek Pueblo, located in east-central Arizona, shows an agglomerative layout with rooms massed around plazas, which characterizes some Western Pueblos. Reprinted, by permission, from Prehistoric Households at Turkey Creek Pueblo, Arizona by Julie Lowell, Copyright 1991 The University of Arizona Press.
tive pueblos could more easily accept the occasional household (Cameron 1999; but see Cordell 1996:235). At agglomerative pueblos, a new house could simply be tacked to the outside of the existing structure. This design would allow individual families to join the community at any time and the pattern of site growth would be accretional. Linear plaza pueblos could not be as easily expanded. New roomblocks would have to be built surrounding new plazas and the builders would have to agree on the size of plaza space to outline. Construction would be organized at a level above the household.

A Consideration of Differences in Length of Settlement Occupation

Standardized room sizes, ladder type construction, and linear plaza site layouts all suggest that construction at some prehistoric pueblos was coordinated above the household level. At other sites, these features are not observed suggesting that construction was more likely undertaken by individual families. Differences in the length of settlement occupation must be considered, however. Historic pueblos, like Orayvi, have been occupied for hundreds of years. It is possible that the earliest construction at these villages may have been an organized endeavor by a number of families resulting in a “planned core” of buildings that have been obscured by centuries of rebuilding.

A comparison of the Hopi Pueblo of Walpi and the Pueblo of Acoma, both of which were built about 300 years ago, suggests that this is not necessarily the case and supports a fundamental organizational difference in construction methods among prehistoric pueblos (Fig. 1).11 Robinson found room size, house plan and the number and size of vigas was highly variable. Even though these two pueblos have been occupied for approximately the same length of time, a planned core was visible at Acoma, but not at Walpi.

Robinson (1990) attributes the differences in construction between these two pueblos to a higher degree of social integration at Acoma, although he cannot rule out the possible influence of Spanish priests there. Robinson notes that Acoma has existed as a community for over 600 years and suggests that its leaders may have been able to exert considerable control over construction. In other words, he finds greater social integration at Acoma that is expressed architecturally.

Organization of Construction among Prehistoric Pueblos

If length of settlement occupation can be ruled out as the primary cause of differences in room sizes, settlement layout, and the prevalence of ladder-type construction, then social or cultural differences that affect the organization of construction may be investigated as a factor. Although no one has directly attributed variation in this suite of attributes to particular prehistoric social or ethnic groups, two studies from the Western Pueblo area show that archaeologists are beginning to find room sizes, construction methods, and site layout key pieces of evidence for exploring ethnicity and tracking the massive population movements that characterize the late 13th and 14th centuries (Adler 1996, Cameron 1995; see Reid 1998 for a recent overview of population movement in the Southwest).

In the Silver Creek drainage of east-central Arizona, Mills (in press) has observed differences in room size and site layout and attributed them to ethnic differences. During the period from A.D. 1275–1325, sites in the Silver Creek drain-
Rooms at these sites are very large, about 15 square meters, comparable to rooms at Grasshopper Pueblo, 30 miles to the south (Table 8). Between 1325 and 1390, Mills believes that architectural and ceramic change suggest immigration into the area. She observes that at least part of Fourmile Ruin (dated to the mid- to late 14th century) has an “open plaza” layout (equivalent to linear plaza) and Roomblock D shows evidence of rapid construction. The rooms at Fourmile are also much smaller—about 10 square meters. Mills notes, however, that bond and abut sequences indicate that Roomblock D was not built in one construction episode (i.e., no ladder construction). In spite of the linear form of late Pueblo IV sites in the Silver Creek drainage, the lack of coordinated (ladder type) construction at these sites leads Mills to suggest that construction was organized at the household level.

At the Homolovi Pueblos in the Middle Little Colorado area, Adams (1998; see also Adams 1996) finds settlers from both the Hopi Mesas and the Silver Creek area occupying several large pueblos with noticeable architectural differences. For example, Homolovi IV had relatively small rooms (Table 8) and a clustered layout built on the top and sides of high butte. In contrast, Homolovi III was a linear roomblock with rooms that at first averaged more than 11 sq m and then decreased, with later rooms averaging 7.5 sq m (Table 8). Based on ceramic and other evidence, Adams shows that the inhabitants of Homolovi III originated in the Silver Creek area, while the Homolovi IV populations derived from the Hopi Mesas.

It seems apparent that there were social organizational differences in among large, late pueblos that are reflected in prehistoric architecture. Similarly, there are organizational differences between modern Eastern and Western pueblos that may be pertinent to understanding differences in the organization of construction among prehistoric pueblos in both areas. Ware and Blinman (in prep), in a recent paper, have emphasized the importance to archaeology of ethnographic reports of highly integrated social systems among the Eastern Pueblos. They show that sodalities operated as centralized polities and they cite Jorgensen (1980:222) who finds the Eastern Keres and Tanoan Pueblos villages “… more integrated and more centrally controlled in economic, social, ceremonial, and warfare matters than all other political communities in western North America.”

A review of Hill’s (1982) comprehensive ethnography of Santa Clara Pueblo illustrates the centralization of powers in the two caciques, who headed the religious hierarchy for each of the two moieties. Hill describes the functions of the caciques at Santa Clara as “…extensive. They were charged with responsibility for the internal well-being of the village… (including) the guidance of political and secular affairs (1982:185).” During his stays among the Eastern Pueblos, Adolph Bandelier noted “much communism” among the Eastern Pueblos in the accomplishment of public works such as bridge building and care of the irrigation systems (1966:111–114, 196). As described above, both Hill and Bandelier found that house construction was accomplished, at least part of the time, by village-directed parties of male workers.

In contrast to the highly organized Eastern Pueblos, Ware and Blinman point out that the Hopi and other Western Pueblos were dominated by kinship groups (matrilineal clans) and that “…the weakest sodality expressions in western North America developed among groups with the strongest kinship-based polities….” In other words, the strong clan system in the Western Pueblos, like Orayvi, prevented the kind of centralization evident...
among the historic and prehistoric Eastern Pueblos. Ethnographic and archaeological evidence suggest that construction at some Western Pueblos was not organized above the household level. Mindelleff described much of the work of house construction at Hopi as being carried out by a woman and her female relatives (1989:101). At Turkey Creek Pueblo, Lowell (1989:193) found evidence for household autonomy in a number of types of activities, including food production and food storage. Although Lowell (1989:188) did find groups of rooms defined by unbroken walls which she defined as "supra-households" (groups of households that may have shared some activities), room size and overall site layout suggests that house construction was generally undertaken at the household level.

Ware and Blinman's (in prep) most intriguing suggestion is that the highly structured Eastern Pueblos may represent an historic continuity with the 10th–12th century Chaco Regional System, the most readily acknowledged complex social system in the Southwest. Ware and Blinman believe that the highly centralized sodality system evident in modern and historic Eastern Pueblos may echo the even more centralized and complex Chacoan political system. Other scholars have also found connections between Chaco and modern Puebloan peoples living along the northern Rio Grande (Ford, Schroder, and Peckham 1972).

The distinguishing characteristic of Chacoan Great Houses, besides their wide walls, is the extraordinary degree of planning that went into their construction (Lekson 1986). Great Houses were obviously the result of a highly coordinated effort by a number of skilled masons who built 100 or more rooms in one construction event following a preconceived plan. None of the pueblos on Table 8 were made with elaborate Chacoan masonry techniques (in fact, coursed adobe is a common material) nor were they built at the same scale as Chacoan Great Houses. The planning and organization that went into construction at Eastern and some Western Pueblos, however, might be seen as a muted echo of Chacoan building techniques. Aspects of the highly organized building traditions developed in Chaco—including coordinated construction of many rooms in one building event—may have been applied by post-Chacoan peoples in the construction of later Pueblos.

Differences in the gender of house builders may be an important aspect of the organization of pueblo construction. In his study of patterns of residence and descent among prehistoric Southwestern peoples, Steven James (1994) argues that in matrilineal societies women built and owned houses and rooms were small (he notes that men may procure building materials). In patrilineal societies, men built and owned houses and rooms were large. Based on room size, James classifies most of the prehistoric pueblos in the northern Southwest as the product of societies with matrilineal residence and descent where women build houses. He makes an exception for Chacoan Great Houses. "Given the monumental architecture at Chacoan Great Houses, the majority of room construction probably would have been performed by men in the society (James 1994: 188)."

Gender issues in the organization of pueblo construction deserve far more study than they can be given here. There seems, however, to be a dramatic organizational contrast between the construction of Chacoan Great Houses by groups of highly skilled male (?) masons and the construction of individual houses by women as observed at modern Western Pueblos like Orayvi and inferred for many prehistoric pueblos. James believes that the Chacoan building tradition ended in A.D. 1150 (1994:201). It is possible, however, that some highly organized settle-
ments in the 13th, 14th, and 15th centuries reflect a continuation of pueblo building as an hierarchically directed male activity. Of course, the relationship between Chacoan peoples and later Southwestern populations remains to be discovered.

CONCLUSIONS

This paper demonstrates that the size of architectural space has important implications for the interpretation of prehistoric social systems. It is one aspect of material culture that is readily preserved, easy to measure, and is conditioned by a variety of technological and social behaviors that can be investigated in archaeological cases. Although archaeologists tend to see social requirements as the most important determinants of room size, the Orayvi data and comparison of Orayvi with prehistoric Eastern and Western Pueblos highlighted two other important determinants: the technology of puebloan construction and the organization of construction.

Room sizes at Orayvi are quite variable and while room function may account for some of this variability, the technology of puebloan construction may be a more important factor. This may also be true at other large, multistoried pueblos. Available building materials, especially the size of roof beams, limits room size. In multistoried pueblos, because of the need for wall support, the size of lower story rooms generally determines the size of upper stories (but see James 1994, 1997). The nature of pueblo construction also affects presumed constant relationships between numbers of individuals and quantities of roofed space. While there appears to be a great deal of space for each individual in Orayvi house, much of that space may function only as an architectural platform or a trash disposal area; average active space per individual may actually be similar to that found in cross-cultural studies.

Certain archaeological expectations linking house size and social variables were not supported by the Orayvi data. Closely packed puebloan houses cannot be easily expanded which places a limit household size. Furthermore, frequent changes in household configuration mean that there is not a close link between house and household size at Orayvi. Such shifting domestic arrangement were likely always a feature of puebloan society making it difficult to use changes in arrangement were likely always a feature of puebloan society making it difficult to use changes in prehistoric house size as an indicator of changes in household organization. Furthermore, house size does not seem to be determined by social status in Pueblo society as it sometimes is in other "egalitarian" societies. Clan houses of high ranking clans, which would house individuals who control important religious ceremonies and their associated paraphernalia, may be larger than other houses, but, in general, the relationship between status and house size was not strong.

A comparison of room sizes, site layout, and the prevalence of ladder type construction at Orayvi and at prehistoric Eastern and Western Pueblos suggests differences in the organization of construction across the prehistoric Southwest. Planning and coordination of construction exhibited by some large, late Pueblos, especially Eastern Pueblos, suggests organization above the household level and possibly by males. It implies that population movement and the establishment of towns may have been accomplished by relatively large, coherent groups. Planned and coordinated building construction may even reflect historical connections with the complex Chacoan Regional system. On the other hand, construction organized at the household level, likely undertaken by women, seems to characterize some of the Western Pueblo area and suggests the aggregation of much more loosely knit groups of households with much weaker village-wide ties.

Room size is an important indicator of the organization of pueblo construction and may provide an avenue for exploring
social boundaries and, potentially, migration paths in the prehistoric Puebloan Southwest. The examination of a far larger sample of sites and exploration of technological and social variables other than room size will almost certainly deepen our understanding of organizational differences among prehistoric pueblos as well as the origins of these differences.

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NOTES

1 The spelling of Orayvi follows the Hopi Dictionary (1998).
2 Chacoan Great Houses were large, aggregated, and multi-storied beginning in A.D. 900, but they were not primarily domestic structures.
3 Lower story rooms could, of course, be subdivided. The frequency with which this occurs in either prehistoric or historic pueblos is unknown.
4 Coursed adobe is common in the southern Southwest, for example at Classic Period Hohokam sites in southern Arizona and in the El Paso/Casas Grandes area of southern New Mexico and northern Chihuahua (Cameron 1998).
5 Similar large rooms have been reported by Mills (1998) at Bailey Ruin. E. Charles Adams (personal communication 1997) emphasizes that the large, late pueblos below the Mogollon Rim (such as Grasshopper Pueblo) have much larger, more multifunctional rooms than do pueblos above the Mogollon Rim.
6 Holschlag (1975) reports that houses at Taos have double walls separating the rooms used by one household from those of another, allowing easy identification of houses. Neither Crown and Kohler (1994) nor Kulisheck et al. (1994) mention this construction feature, nor does it seem to have been reported elsewhere in the Southwest.
7 Mindeleff's map was used to calculate floor area for rooms and houses at Orayvi. Measurements were taken from of Mindeleff's five original field maps, provided to me by the Smithsonian Institution's National Anthropological Archives as photographs reduced to 8 by 10 inches. I enlarged the photographs to double Mindeleff's original field scale (1 inch = 20 feet) to allow rooms to be easily measured. Because of the probable distortion involved in enlarging and reducing the maps, length and width were measured only to the nearest 1/2 foot. Measurements were taken from the interior of one wall to the interior of the opposite wall. Length and width measurements for rooms were then converted to meters. Measurements were taken of upper story rooms visible on Mindeleff's plan view and each lower story was assumed to be the same size as the top story. This is a reasonable assumption given the difficulty of building an upper story wall without the support of a lower story wall. Bottom story rooms might, of course, be divided which would increase lower story room counts and decrease room sizes, but not affect floor area for houses.
8 At the Hopi Pueblo of Walpi, house size did increase as many areas of the pueblo were abandoned during the 20th century; the number of rooms per house decreased and house size increased (E. Charles Adams, personal communication 1997). The figures for Orayvi are from before the split and the abandonment of much of the village.
9 Ferguson (1996:125–126) found a similar wide variability in the number of square meters per person in houses at modern Zuni Pueblo. He attributes the variability both to the developmental cycle of the domestic group and to the occurrence of a number of different household types at Zuni.
10 Dean (1996) found “spinal” roomblocks in Kayenta area which he notes are similar to “ladder type” construction found in the Eastern San Juan Basin, but notes “we currently lack the data to assess functional similarities between the two architectural forms (1996:38).”
11 Note that Eggan (1950) considered Acoma a Western Pueblo. However, it is geographically close to the Rio Grande (Eastern) Pueblos and residents speak Keres (Fox 1967).
12 The difference in the average room size shown on Table 8 (6.7 sq m) and reported by Mills (1998; 10 sq m) results from differences in how room measurement were made (Mills, personal communication 1998).
13 The availability of driftwood used in roof construction is also a factor in room size in the middle
Little Colorado area; the area is a considerable distance from forests.

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