The Alhambra is famed for its beautiful site, commanding views of the fertile Granada plain and the snowy Sierra Nevadas, and for its architecture, the fourteenth-century Nasrid palaces of Comares and the Lions (Palacio de Comares and Palacio de los Leones), as well as the Renaissance palace of Charles V (r. 1516–56). Linked with this renown are efforts to explain how those structures were occupied, a critical concern given the Alhambra’s siting in a climate of extremes. While there has been much speculation about this issue, the architecture itself reveals a great deal. The Nasrid palaces illustrate a wealth of passive strategies to cope with climate, providing insight into how the palaces were inhabited and the lifestyles they reflect. The Alhambra’s later occupation by the Roman Catholic conquerors who came to inhabit Granada is a counterpoint, highlighting salient Nasrid palace features. Studying how the Alhambra was used by two successive and competing cultures leads to a better understanding of Nasrid architecture itself, as well as of the reasons for Charles V’s construction of his “new quarters” and Renaissance palace.

When the Nasrids won control of Granada, the Alhambra was greatly expanded as a royal precinct. The focus became the Comares and Lions palaces, which were constructed during the reigns of Yusuf I (r. 1333–54) and Muhammad V (r. 1354–59 and 1362–91), respectively. These works define a phase of intense construction during the Nasrids’ 260-year rule, and the palaces were the dynasty seat until their 1492 surrender to Queen Isabella I of Castile and King Ferdinand II of Aragon, commonly known as the Catholic Monarchs (r. 1474–1516). Isabella and Ferdinand added the Comares and Lions palaces to their other Spanish residences and essentially inhabited them as they were, but when their grandson, Charles V, rose to power in 1516, he had to balance his charge to preserve the Nasrid palaces with other concerns, such as his larger, more cosmopolitan court and greater status as Holy Roman Emperor. His new palace, on which construction began in 1533, was conceived as a more appropriate residence for his visits to Granada; “new quarters” were built for use until the palace was completed.

The Alhambra’s tangled past is the result of distinct, overlapping cultures, each with its own architectural vocabulary. It is necessary to address not only the Nasrids’ Comares and Lions palaces, but also the question of how those structures were occupied and found lacking by Charles V. Linked with these issues is Granada’s climate: winter–summer temperature swings, ranging from -13 to +43 degrees Celsius, demand consideration. The Nasrids themselves recognized these severe conditions, as did those who followed them. As early as 1600, Luis del Mármol considered climatic issues in relation to the habitation of the palaces, writing that the Comares Palace contained the “summer rooms,” while the Lions Palace was “where the sultans lived in winter.” Although there is no architectural basis for this summer and winter dichotomy, Mármol’s outlook has nonetheless been consecrated, repeated through the centuries. Other speculations—such as the suggestion of a Nasrid “winter palace” razed for the Palace of Charles V, itself completed over the course of four hundred years, shrouding architectural intentions and leaving questions about its potential occupation—further complicate serious discussion.

The efforts to explain how these palaces were inhabited, however, reveal the issue’s import. With only scant documentation most references to the Alhambra’s inhabitation are anecdotal and have not been subject to rigorous analysis. Even with the Nasrid Alhambra’s
continuities with other architectural traditions, it has no existing parallels on the same scale, pre-dating or con-temporary, that provide clues as to how it was occupied. The data gathered while monitoring some key rooms of the Comares and Lions palaces during both summer and winter illustrate the effectiveness of Nasrid passive environmental strategies, suggesting various occupation patterns and adding to the general discussion of Nasrid architecture. Monitoring the Renaissance palace is not possible because it houses offices and a museum, but by studying it and the “new quarters” through other means, as well as by examining how the conquerors occupied the Nasrid palaces, certain issues become readily apparent. One sees that despite cultural differences, both the Nasrids and those who succeeded them used, in the broadest sense, similar strategies in designing and inhabiting spaces, although they applied them in profoundly different ways.

THE NASRID PALACES OF THE ALHAMBRA

Like other peoples, the Nasrids coped with climate through the use of seasonal wardrobes and room furnishings such as tapestries and rugs, dressing themselves and arraying their rooms to maximize comfort. Braziers, with the warmth of burning embers in winter, and pools and basins, with their evaporative cooling effect in summer, were additional measures to moderate temperature. In addition to these interventions, which only help to temper the environment, Nasrid rulers had palaces throughout the region, where they could enjoy the benefits of different environs. This is seen in the Generalife, a summer retreat with surrounding gardens and greenery, only slightly uphill from the Alhambra palaces, yet far removed from the precinct’s confines and dense building mass (fig.1).

Besides traveling to more seasonal locations or moderating a room’s habitability, the Nasrids sought...
to make their surroundings more comfortable through the design of the architecture itself. To fully understand the palaces, it is imperative to consider the architectural means—building level, orientation, room size, wall apertures—employed to confront climatic concerns. Mindful of these factors, one sees seasonal components in the Comares Palace: the Nasrids created rooms of different character for use in the summer as opposed to the winter. In the Lions Palace, the rich variety of spaces—its wealth of varied salas, miradors, and unique alcoves, all around an arcaded patio—illustrates another means to address Granada’s climate of extremes. It becomes clear that these palaces encompassed a range of spaces with distinct environmental conditions.

Nasrid courtyard dwellings

The Comares and Lions palaces today form the heart of the Alhambra, but as the complex is really a small city, dwellings are scattered throughout. In the extant palaces and the foundations of humbler houses one sees constants creating a consistent vocabulary—basic building blocks of residential architecture—despite a wide range in dwelling scale. A courtyard, focused on a water element such as a pool, basin, or fountain, anchors the typical two-level dwelling. The courtyard/patio defines the home’s core: the stair to the upper floor originates from it and all rooms open onto it. In fact, exterior wall openings are limited. Few if any windows look outward to the street, the courtyard providing air and light to all rooms. While admitting variations, the courtyard formed the basis of the Nasrid dwelling vocabulary, further developed in the typical room—a narrow, multifunctional space. Through the use of portable furnishings, the Nasrids easily adapted these neutral spaces to serve a variety of daily needs—sitting, dining, sleeping.

The Nasrid courtyard dwelling has antecedents in the traditional Roman house. Outside of Italy itself, Iberia was the most Romanized region of the ancient empire. Muslim constructions in al-Andalus—the Aljafería of Zaragoza, the Castillo de Montearagón in Murcia, and the Patio del Crucero (Patio of the Crossing) in Seville, to name a few notable examples—followed Roman courtyard typology. The Nasrids’ Generalife and other houses in Granada’s Albaicín quarter, such as the Dar al-Horra (House of the Princess), Casa de Zafra, Casa de Lorenzo el Chapiz, and Casa en la Calle del Horno del Oro share Roman sensibilities. These Nasrid examples are on a smaller scale than the Alhambra palaces, but they share a similar architecture—a rectangular patio surrounded by elongated rooms. In fact, this pattern is so prevalent that the Tower of the Captive (Torre de la Cautiva) and the Tower of the Princesses (Torre de las Infantas), two residential structures, are the only notable exceptions in the Alhambra. In short, Nasrid architectural elements are defined and repeated in all buildings, as are its decorative and construction techniques—muqarnas (a system of projecting niches used for zones of transition and for architectural decoration) and plasterwork, masonry walls and wood roofs, mosaics and tiles.

Similar environmental strategies are also evident in Nasrid and other Hispano-Arab dwellings: the thermal mass of masonry construction minimizes temperature extremes, and water elements contribute to evaporative cooling. Another critical constant is orientation. Mosques and oratories face Mecca, but residential buildings typically develop along a north–south axis with the principal courtyard rooms facing south. Examples include those structures cited above, along with the Alhambra palaces—the Lions Palace a notable exception with its east–west elongation and patio arcade. On a grander scale, orientation dictated the planning of Madinat al-Zahra, the royal city sited on the Guadalquivir River. The general disposition is north–south, with south-facing chambers such as the Salón Rico and the Salón de la Casa del Ejercito. Variants to the preferred north–south axis inevitably result from topography or urban situation, as in the Cuarto Real de Santo Domingo, which bestrides Granada’s city walls. The principal room faces southeast, toward the surrounding terrain and away from Granada, allowing sweeping vistas: visual considerations thus supplanted orientation.

The fourteenth-century Almerian Ibn Luyun (d. 1349) confirms the ideal of the north–south orientation. In his Kitāb Ibdāʾ al-malāḥa wa-inhāʾ al-rajāḥa fi ʿusāl ṣināʿat al-fīlāḥa (Book on the Principles of Beauty and the Purpose of Learning Treating the Fundamentals of the Art of Agriculture), he offers advice, both prosaic and profound, on an Andalusian dwelling:
A house amidst gardens should be located in a dominant position for reasons of defense and vigilance. It should face the midday sun, the entrance at one side, and a well or a pond should be placed on the upper part; or instead of a well, better a canal running underneath the shade.\textsuperscript{13}

In writing of water and plants—which contribute to evaporative and evapo-transpirative cooling, respectively—Ibn Luyun mentions typical Nasrid dwelling elements. He also highlights the impact of orientation on comfort and habitability. At Mediterranean latitudes a building should, as Ibn Luyun notes, ideally face the midday sun. In summer, the high sun can easily be controlled with a portico or arcade. This design element accentuates the south face, rendering the east and west façades less important. Indeed, given the summer sun’s extremely low morning and evening inclination—making shading very difficult on the east and west sides—those façades should be de-emphasized. In this sense, Ibn Luyun’s recommendation that the garden enclosure should be “longer than wider” is sound. Courtyards were typically elongated on the north–south axis, as prescribed.

In the majority of Hispano-Arab buildings, the most important room lies to the north, with its courtyard façade facing south. Additionally, the large openings associated with this prime chamber might be sheltered by a portico or arcade—a typological element that, as mentioned above, protects the room from the high summer sun, yet conversely allows the low winter sun to enter and provide warmth and light. East and west rooms, on the other hand, have small openings, essentially just enough to illuminate and ventilate the space, and the walls might be of light color to better reflect the sun’s rays and thus limit solar gains. On the east and west elevations, then, the objective is to reduce the low sun’s impact. Aperture size and the narrow courtyard geometry thus impede the sun’s penetration into both rooms and patio at dawn and dusk. Solar radiation can be advantageously harnessed, but it also must be tempered, a fact recognized in Ibn Luyun’s writings and embodied in Hispano-Arab dwellings.\textsuperscript{14}

The Comares Palace

Nasrid architectural elements were not devised, nor were environmental strategies utilized, solely for noble and royal spaces. They were used throughout the continuum of Nasrid society. The universality and versatility of these architectural devices translates into a sense of ambiguity. Even in the most sumptuous hall it is difficult to ascertain function; with simple fittings and furnishings each space could be transformed. The Comares Palace thus shares features with Nasrid residential architecture, albeit with a difference in scale and grandeur and the important addition of public spaces juxtaposed with more private rooms (figs. 2 and 3).

Just outside the palace, for instance, is the Mexuar, a council chamber where the sultan and his advisors would meet. The imposing principal façade of the Cuarto Dorado (Golden Chamber) provided a backdrop against which the sultan might administer justice and also served as the entrance to the Comares Palace: the space functioned as both a courtroom and a palace gateway. Beyond it lies the Hall of the Ambassadors (Sala de los Embajadores), which, as epigraphic evidence suggests, was both a throne room and a reception hall—a grand chamber crowning a series of public spaces (fig. 4).\textsuperscript{15} Intertwined are the more private zones. Starting with the Sala de la Barca (Hall of the Ship), the components of the sultan’s apartment are evident. The Sala itself has a centered entry, with alcoves defined by arches at either end of the room. In the thickened zone between the Sala de la Barca and the Hall of the Ambassadors, an oratory to the east faces Mecca and stairs to the west provide access to upper-level rooms. Both the latrine just west of the Sala and the palace bath to the east met hygienic needs. The sultan’s wives might also have been at hand, housed along the palace’s east and west sides, in narrow upper and lower apartments, each identical, in accordance with the Koranic prescription to treat one’s four spouses equally.\textsuperscript{16}

The multifunctional upper and lower chambers of the private quarters of the sultan and his wives suggest seasonal winter and summer spaces. This duality is perfectly manifest in the Comares Tower, with its sophisticated development of the sultan’s rooms (fig. 5): the Sala de la Barca, more appropriate for warmer weather, lies below a smaller room, similarly barrel-vaulted, more suitable for cooler weather and embedded in the tower’s masonry. An arcade/portico shades the Sala—the high summer sun cannot strike its walls (fig. 6). In contrast,
Fig. 2. The ground floor of the Comares and Lions palaces as they existed during Nasrid rule, under Muhammad V in the latter half of the fourteenth century: A) Patio de Comares, B) Patio de los Leones, 1) Sala de la Barca, 2) wives’ quarters, 3) Hall of the Ambassadors, 4) Hall of the Two Sisters, 5) Lindaraja Mirador, 6) Hall of the Abencerrajes, 7) Hall of the Kings, 8) Hall of the Mocárabes, 9) bath of the Comares palace, 10) Cuarto Dorado, 11) Mexuar. (Drawing: Todd Willmert)

Fig. 3. Patio de Comares, looking north, with a view of the south face of the Comares Tower. (Photo: Jean Laurent y Minier, courtesy of Special Collections, Fine Arts Library, Harvard College Library)
the principal upper room is exposed to the full arc of the sun’s path. The Sala de la Barca is wedded to the relatively constant coolness of the tower masonry, with its habitable spaces, the alcoves, defined by masonry walls. Its counterpart above, however, is spatially insulated on three sides. The Hall of the Ambassadors shelters the upper room to the north. Two auxiliary chambers, seemingly carved from the massive tower wall, also insulate the upper room from above and below. Air within these three spaces helps to moderate the upper room’s environment. Volumetrically, the upper quarter is small, easily warmed by braziers as well as by other furnishings and fittings, while the lower room is over twenty times as large. The window in the upper room offers sunlight and a view. The wall openings of the Sala de la Barca, on the other hand—three small, ventilating windows above a large door opening, a size reflecting the scale of the Hall of the Ambassadors—serve other needs.

Fig. 4. The Hall of the Ambassadors as seen from the Sala de la Barca. (Photo: Garzón, courtesy of Special Collections, Fine Arts Library, Harvard College Library)

Fig. 5. The Comares Palace, section. The shaded areas, the upper room and the Sala de la Barca beneath, were monitored with respect to temperature and relative humidity during simultaneous periods in summer and winter. The noon sun angles, for Granada’s latitude of 37°, illustrate the careful attention paid to seasonal shading. Because of the geometry of the arcade/portico, direct sun does not penetrate the Sala de la Barca in the summer months. (Drawing: Todd Willmert)
Orientation, level, and insulating spatial buffers, together with room size, shading, and window vocabulary, effectively define the summer and winter rooms of the Comares Palace. On an average sunny summer day, the Sala de la Barca registers temperatures—the most important factor determining habitability in Granada’s climate—about three degrees Celsius cooler than those in the upper room, a significant difference. In sunny winter conditions, the differences are even greater—with the upper room warmer by four or more degrees. Cloudy skies, more common in winter, create more stable temperatures, limiting temperature swings and the thermal difference between the chambers (fig. 7; see the data for February 8, 9, and 10, three cloudy days). Regardless of the conditions, what is obvious is the moderating effect of the masonry’s thermal mass, which flattens daily temperature swings. These properties are advantageously utilized in the narrow upper room—the sultan’s “winter” quarters. Only two meters wide, the room’s east and west sides are thus minimized. The only real exposure is the favorable southern one, with the potential warmth of this south wall’s thermal mass especially welcome on a cool night. The Sala de la Barca, on the other hand, is more habitable in summer, given its shade-providing arcade and thermal coupling with the ground and tower mass, among other factors.

Linking temperature with relative humidity, the prime determinants of “comfort,” the full impact of these strategies becomes apparent. The Comares Palace’s environmental data, when juxtaposed with the ambient weather and the matter of the “comfort zone” (see Appendix), point to the utility of summer and winter chambers. Diurnal temperature and relative humidity extremes lie well outside of the comfort zone, oscillating widely throughout a typical summer or winter day (figs. 8a and 8b). In contrast, the room masonry and other environmental factors confine the chambers’ temperature and humidity to an extremely narrow range, as evident in the diagram. The Sala de la Barca is clearly within the comfort zone throughout a typical summer day, while the upper winter chamber lies outside the zone. In winter, the upper room is significantly closer to the comfort zone than is the Sala, where less hospitable conditions are more easily remedied with seasonal clothing, furnishings, and braziers. Such supplemental measures could make the upper room even more comfortable, especially in comparison with its summer counterpart, whose large volume limits the effectiveness of such means.

The wide range of seasonal strategies employed within the sultan’s quarters hinges on many factors, two of which—the extreme volumetric difference between his summer and winter chambers and the arcade shading the summer room—are lacking in the wives’ quarters. Other factors are unique to the wives’ rooms—for instance, the insulating effects of the winter chambers being directly above their summer counterparts. Although the apartments of the sultan and his wives vary in some respects, their common aspects—i.e., room form and aperture vocabulary—readily reveal the strategy behind inhabiting these seasonal rooms.

Fig. 6. The arcade/portico that shades the Sala de la Barca, as discussed in the previous figure. (Photo: Garzón, courtesy of Special Collections, Fine Arts Library, Harvard College Library)
Fig. 7. Graph of summer and winter temperatures in the Comares and Lions palaces. The data illustrate that outside temperature fluctuates widely throughout the day, typically about twenty degrees, except during overcast conditions, as on Feb. 8, 9, and 10. (See Table II [in Appendix] for cloud cover data.) In contrast, interior spaces remain relatively stable, varying only about two to four degrees. The summer and winter ranges illustrate that the upper room of the Comares Palace is the warmest space in either season, while the Sala de los Secretos in the Lions Palace is the coolest. Of the five rooms monitored, the temperatures of the Sala de la Barca lie between these two extremes. The upper mirador was the warmest room monitored in the Lions Palace, while the Lindaraja Mirador was consistently cooler, with temperatures between those of the upper mirador and the Sala de los Secretos. (Graph: Todd Willmert)
For instance, the narrowness of the wives’ ground-floor rooms in the Comares, as well as their centered entries, are exploited to create lateral alcoves, and above each door are two or three small, high openings that ventilate the space but offer no view and admit little light (fig. 9). During the hottest summer days, with the door closed, darkness complements the coolness of the floor and masonry walls, augmented by the chambers’ thermal coupling with the earth. In contrast, the upper rooms are entered on end, directly from stairs, with windows near the floor to offer both a view and sunlight. The central windows of the upper rooms focus the space, much as the lateral alcoves do in the rooms below.

Complementing the private domestic chambers of the Comares are the ceremonial Hall of the Ambassadors and courtyard, the core of the palace’s public sec-
tion. This throne chamber (qubba), an Alhambra tower, is the key feature elevating the building from a mere residence to a palace. Each of the three exposed sides of the Hall of the Ambassadors has three floor-level openings—nine camaritas within the tower’s three-meter-thick walls, with high windows above, all to facilitate ventilation.\(^{18}\) To the south of the Hall, a large opening leads to the Sala de la Barca, which in turn leads to its arcade/portico and the courtyard of the Comares, defined by its pool. Approximately 250 square meters in area and 1.3 meters deep, water occupies nearly one third of the courtyard, its significant surface area aiding evaporative cooling—an effect easily exploited given the low humidity of the site.\(^{19}\) The high thermal mass of the pool’s water also absorbs solar radiation and the water is typically cooler than the daytime summer air in the courtyard. The net effect is that the pool helps reduce the patio’s air temperature.

Taken together, the “public” spaces of the Comares facilitate cooling. In this sense, the Hall of the Ambassadors functions as a ventilation tower, encouraging palace air movement. Cross ventilation though the Hall’s openings fosters airflow, but more important is a wind-driven stack effect (fig. 10).\(^{20}\) High openings in
the tower allow stratified warm air to escape, especially when propelled by the south and southeast winds dominant in Granada or by breezes sweeping down from the Sierra Nevada range. To replace the evacuated warm air, the Hall draws from the patio air itself cooled by the courtyard’s vegetation and, more importantly, water. The link, or hinge, between the patio and tower of the Comares Palace is the Sala de la Barca and its arcade/portico. The large openings of the Sala foster air movement between the qubba and the courtyard, with the portico protecting the tower’s south wall from the sun, creating a thermal buffer between interior and exterior to temper incoming air. The combination of all these architectural elements—courtyard, portico, and tower—in conjunction with the thermal and physical effects of air movement, helps to ameliorate hot summer conditions. Airflow from the patio through the portico and escaping from the tower, in turn, helps to cool the palace’s dwelling chambers.

The environmental effect of ventilation is subtle. Breezes are required to effectively drive air circulation, and a narrower or more restricted tower, with higher apertures, would better facilitate the stack effect. The impact of ventilation should not be overstated; though minor air movement can help to make conditions more comfortable (as evident in fig. 8b), it is clearly just one factor, among many, contributing to the environmental design of the Comares Palace. Furthermore, the palace benefits from the cumulative impact of its multiple environmental strategies. The thermal mass of masonry positively influences habitability, as does the courtyard’s water mass; both wall openings and overhangs control solar gains, as do palace geometry and orientation. It is the amalgam of multiple strategies, not discrete and isolated environmental factors, that contributes to comfort and habitability.

Environmental strategies might in fact compete or conflict with other concerns. The domestic chambers of the Comares Palace, lower summer and upper winter, are both whitewashed. The reflective color is advantageous for the summer chambers, but not for their winter counterparts—uniform façade color here takes precedence over other concerns. In short, the totality of the Nasrids’ manipulation of daylight and decoration, of color and texture, and of the sound of the water and the smell of the plants contributed to their aesthetic attainments, all within a broad, expansive context. The environmental achievements of the Comares Palace must be evaluated with a cumulative, holistic perspective, an outlook that reveals the import of climatic considerations, which were an integral part of the Nasrids’ high architectural accomplishments.

The Lions Palace

As the Comares Palace mirrors Nasrid residential architecture on a grand scale and neatly crowns a complex entry sequence from Granada below, one view posits that this was the “official” palace. In contrast, the Lions Palace was the casa de recreo (house of recreation), owing to its unique form in residential typology. Other interpretations suggest that each palace was “official,” with Muhammad V’s Lions Palace supplanting the father’s Comares. These views hint at the differences between the two independent dwellings “so close to one another, that only a wall divides them.” The key, at least for this essay, is that the Comares and Lions palaces are separate structures, serving different functions and needs, as reflected in their distinct designs (fig. 11).

As opposed to the summer–winter duality evident in the chambers of the Comares Palace, the spaces in the Lions Palace are more varied. Starting with rooms off the Hall of the Two Sisters (Sala de las Dos Hermanas), the contrasts between the two structures become readily apparent (fig. 2). Just north of the Hall of the Two Sisters, the Lindaraja Mirador epigraphy alludes to Muhammad V’s presence and the vistas and breezes he would enjoy there (fig. 12). Inscriptions compare the sultan to both “sun” and “shade”: he is like the sun in his importance, with his good works providing his people with shade. Sheltered by the Hall of the Two Sisters to the south, the Lindaraja Mirador is shaded from the sun. When Muhammad V sought repose there, he was the figurative sun in the space and did not have to compete with the literal sun. In the upper level of the Hall of the Two Sisters, another mirador offers views, through the Hall of the Two Sisters and the Lindaraja Mirador, identical to those seen from the Lindaraja Mirador itself (figs. 13 and 14). The paired miradors share vistas: the contained courtyard of the palace to the south and, to the north, the open Lindaraja Garden with the Albaicin.
Fig. 11. View of the Lions Palace, showing the patio and arcade. (Photo: Garzón, courtesy of Special Collections, Fine Arts Library, Harvard College Library)

Fig. 12. The Lindaraja Mirador as seen from the Hall of the Two Sisters. Bildarchiv Foto Marburg, no. 54675. (Photo: courtesy of Art Resource, N.Y., and Special Collections, Fine Arts Library, Harvard College Library)

Fig. 13. The Lions Palace, section. The shaded areas—the upper mirador, the ground-level Lindaraja Mirador, and the Sala de los Secretos, under the Hall of the Two Sisters—were monitored. The section illustrates the relationship of the twin miradors, each enjoying vistas of the palace patio as well as of the adjacent Lindaraja garden to the north and the landscape beyond the Alhambra precinct. (Drawing: Todd Willmert)
Beyond. However, the two miradors have different orientations. The upper one suggests a winter space. It faces south, and while the same size in plan as its twin, it has a much lower ceiling—making it volumetrically smaller—and the courtyard shelters it from the wind. Meanwhile, the Lindaraja Mirador is oriented north and, in the Nasrid epoch at least, was open to breezes and broad vistas.

Beneath the Hall of the Two Sisters is the Hall of Secrets (Sala de los Secretos), another space with distinct environmental characteristics. Its location next to the long-lost bath of the Lions Palace suggests that the space may have been part of the entrance to the bath, or simply a luxurious adjunct to it; the hall’s proximity to the Lindaraja Garden suggests other possible uses related to that outdoor space. The ground below and the Hall of Two Sisters above insulate the Hall of Secrets. These buffers create a cool summer space, a counterpoint to the Lindaraja Mirador and the upper mirador. During the extreme seasons, the temperatures in these three chambers vary significantly, reflecting their distinct characteristics: the Hall of Secrets very enclosed and insulated, and the two miradors more open, but with opposing orientations. Juxtaposing the data on the Comares Palace with those on the Lions Palace, the environmental variety of the Alhambra’s spaces is further illustrated, the data also indicating that each palace had both summer and winter spaces, refuting Már mol’s position that the Comares Palace was a summer residence and the Lions Palace a winter one (fig. 7).

In examining the wealth of spaces immediately adjacent to the Hall of the Two Sisters, it is easy to neglect the room itself. Its qualities are clearly manifest, however, when it is compared with its counterpart across the patio, the Hall of the Abencerrajes (Sala de los Abencerrajes). The former is an open hall, connected to adjacent spaces. The Hall of the Abencerrajes, by contrast, is smaller and more contained, its only apertures a door and small, high openings surrounding the ceiling. In my examination of the architecture of the Comares Palace, it became clear that the more “closed” spaces were summer areas: for example, as noted earlier, when the doors to the wives’ summer chambers were shut, the two small openings above each door provided fresh air while limiting light, thus creating a “closed” chamber (see fig. 9). The similarly “closed” nature of the Hall of the Abencerrajes suggests that it, too, was perhaps intended as a summer room, an outlook reinforced by the fountains of the two salas. Both the Hall of the Two Sisters and the Hall of the Abencerrajes have central basins, yet the water surface area in the latter is almost three times as great, to better facilitate evaporative cooling. These twin pavilions, while sharing some design features—such as their highly articulated ceilings—are distinctively developed, making them more appropriate for different seasons, days, or even parts of the day.
Despite these differences, both the Hall of the Two Sisters and the Hall of the Abencerrajes facilitate air movement in the Lions Palace—similar to the Hall of the Ambassadors in the Comares Palace. The spaces exhaust warm air through high openings, drawing it from the courtyard and thereby increasing air circulation throughout the palace. In other environmental strategies, the two palaces diverge. Consider their respective approaches to evaporative cooling. In contrast to the Comares Palace’s static, placid pool, the water of the Lions Palace bubbles and flows. Multiple fountains and jets spray water to increase its surface exposure and, thus, evaporation. Water is also constantly circulated and replenished to lower its temperature. The Comares and Lions palaces thus manifest distinct perspectives on how to utilize water, the former harnessing surface area and thermal mass, the latter movement. We must also keep in mind that the Lions Palace, with its east–west orientation, does not adhere to the standard Nasrid north–south axis—as evident in the Comares Palace. The solar control strategies typically manifest in Nasrid dwellings do not apply to the Lions Palace. The sun’s impact, however, is addressed by its courtyard arcade, and other means (fig. 15). Only 2 meters deep on the north and south sides, the arcade is 3.5 meters deep on the palace’s east and west sides, a depth augmented by the small projecting pavilions integrated with the arcade. The minimized east–west elevations, deep arcade, and pavilions help temper the low early morning and late afternoon sun.

The Lions Palace possesses, among other traits, a rich, sensual variety of open and closed chambers, miradors, and outdoor spaces, all of differing sizes and orientation. This gamut—for which the Lions Palace is renowned—contributes to varying environmental characteristics. The four different exposures of the courtyard arcade, for instance, allow occupants to seek shade or sun throughout the day. Variety is also found in the two gardens: the four sunken planting beds enclosed by the courtyard arcade, and the Lindaraja Garden, north of the Lions Palace, overlooking the Albaicín. Occupants could retreat to the Hall of the Kings (Sala de los Reyes) or the Hall of the Mocárabes (Sala de los Mocárabes [an ornament design similar to muqarnas]), which are on the patio’s east and west sides, respectively, both opening directly onto the arcade. Unlike the Hall of the Two Sisters to the north and the Hall of the Abencerrajes to the south—enclosed, more private chambers fitted with doors and windows—the Hall of the Kings and the Hall of the Mocárabes are fully integrated with the arcade and patio. Their geometry, long and narrow, further differentiates them from the Hall of the Two Sisters and the Hall of the Abencerrajes, both domed, square salas centered on basins.
Nasrid palace room articulation and fittings and furnishings

Though its elongated room volume is not unusual for the Alhambra, nevertheless the Hall of the Kings is atypical. Opening onto the patio, the Hall is defined by a series of alcoves along its east wall. Unlike most alcoves, which define the end of a closed, narrow room, these alcoves face the courtyard. The open alcoves of the Hall are distinct, their uniqueness amplified by their leather vaults. For instance, the middle alcove’s vault, painted with portraits of ten seated dignitaries, actually echoes how the space was used, with the images above reflecting the occupants seated below.32

An alcove encourages repose. Antonio de Lalaing himself suggested as much when, in 1502, he observed that: “[T]he moorish king used to lie in the Hall to be cool and he had his bed on one side of the Hall and his queen had hers on the other.”33 The series of alcoves in the Hall of the Kings, each a zone defined by three masonry walls, would offer relief during the hottest summer days, like the alcoves in the lower wives’ quarters of the Comares Palace. Though the latter are not as distinctive as their counterparts in the Hall, their subtle development points to the import placed on this architectural component. The four wives’ rooms are themselves only 3 meters wide and approximately 4 meters high. Alcoves, defined by a non-structural arch and raised 6 centimeters, are found at each end of the room (fig. 16). East–west wood joists bridge the 3 meters between the room’s long masonry walls, except at the alcove. Here, north–south joists span its 2-meter depth, supported by the room’s short masonry walls and a large wood beam, concealed in the alcove’s arch.

Thus, the masonry walls, the arch, the raised floor, and the joists all serve to articulate the alcoves of the Comares Palace: simple and subtle means create definition. The notion that alcoves are primarily ground-level summer elements is reinforced in view of the development of the Comares Palace, where the focus of the upper, winter rooms is a window, rather than an alcove at the end of a room. In fact, in other dwellings the lower-level alcove finds a corollary in architectural elements unique to the upper level—cantilevered bays or balconies.34 An alcove is aligned with and focuses a ground-floor chamber; bays or windows serve a similar purpose on the upper floor. Given space limitations, alcoves were likely occupied year round in most Nasrid dwellings. Indeed, their use in winter is suggested by the niches found within the masonry platforms of some alcoves.35 Warming elements or braziers may have been inserted into these niches to heat the alcove. These masonry platforms perhaps echo the wooden ones (sing. tarima) typically used in alcoves.36 Heating devices placed below the tarima could also discreetly add warmth, with comfort further enhanced by cushions, rugs, and fabrics.

Hypocaust heating was extensively utilized in baths, but not elsewhere—especially as an alcove’s dimensions,
only a few square meters, closely matched a brazier’s limited effective range. In fact, this heating range is alluded to in a late eleventh- or early twelfth-century Córdoban poem that describes a brazier as a “mother’s breast” or “a great cup of wine from which we all drank” for those gathered around it. Huddled under blankets to fend off the “scorpions of cold,” some alternately draw near the brazier while others move away, so that all might share in its warmth. The reference to blankets underscores that braziers are, of course, best utilized in conjunction with fabrics. The rugs and tapestries that complete the multifunctional spaces of the Alhambra were crucial elements, and would be used along with braziers, as the blanket was in the poem.

A Nasrid poem describing December mawlid festivities at the Alhambra touches on the fabric furnishings: the floor is covered with matting and cushions, and the walls are lined with fine, beautiful cloth. Such elements could transform Nasrid spaces, as the poem indicates. The Nasrids’ recognition of the import of braziers is also captured in poetry. The term for brazier in Arabic, kānūn, also means “January.” One poet from Granada, Ibn al-Jayyab (d. 1349), some of whose verses grace the Alhambra’s walls, made use of this double entendre in a poetic riddle:

What is the name of two homonyms not of the same class?
Though when one comes, I always am aware of the other.
One has no price, the other costs a few cents.
One originates from the earth, the other [from] the sun...40

The poet plays with the idea that come January, one lights fuel and uses the brazier. With Granada’s cold and the Sierra Nevada’s year-round snow, it is perhaps not unusual that a native poet would allude to winter, and a means to assuage its cold, by highlighting their latent linkage in Arabic.

While the Granada winter was united metaphorically with the brazier, and certainly the Alhambra has winter spaces, its design features ultimately manifest a greater concern with addressing summertime conditions. Given the prominence of water in Nasrid architecture, harnessed symbolically as well as for evaporative cooling, this should be expected. Similarly, windows, with stained glass and other shading elements, were additional means to counteract the sun and heat, to say nothing of alcoves and other architectural measures and strategies. One soon sees the merit in Washington Irving’s observation that the Alhambra “possesses retreats graduated to the heat of the weather.” Irving and other nineteenth-century Romantics, so instrumental in making the Alhambra world-famous, were certainly captivated by the sensuality of its rich spatial variety, a sensibility that forged an environmentally diverse architecture.

The Nasrids created spaces—a framework for habitation—where figurative and literal concerns overlapped. In Granada, the Zirid poet Abu Ishaq (d. ca. 1067) recognized the difficulty in simultaneously resolving the practical and the profound:

If it were not for winter, for the heat of summer, for fear of thieves, to preserve food and because women need to be hidden, I would build myself a house of spider webs.44

The poet longs to live in a fanciful house of cobwebs, a yearning impeded by mundane concerns, such as being sheltered from the seasonal climate extremes of winter and summer. Written in the eleventh century, well before the Nasrids rose to power, the poem foreshadows the construction, at the height of their reign, of the Comares and Lions palaces—the architecture of which does not recognize a poetic/prosaic dichotomy.

THE ALHAMBRA’S “NEW QUARTERS” AND THE PALACE OF CHARLES V

The post-conquest occupation of the Alhambra

The Nasrid Alhambra supported that dynasty’s lifestyle, one that was alien to Charles V and his court, despite the fact that the Christians used similar means, such as tapestries, braziers, and seasonal wardrobes, to make their surroundings more comfortable. They had residences throughout their realm, as did the Nasrids, and could thus take advantage of favorable environs to the extent feasible. Indeed, the same strategies exploited by the Nasrids to create a habitable architecture were advocated in non-Muslim treatises and manifest in architecture from Roman times to the Renaissance.
methods for coping with Granada’s climate foreshadow the ones used by those who came to occupy the city after them. Nevertheless, despite these common threads, each culture interpreted those methods in a way that mirrored or reflected its traditions and mores.

Non-Muslim European travelers viewed the Nasrid conception of public and private space as odd and alien to their sensibilities. When the German Hieronymus Münzer visited in 1494, he described neighborhoods full of narrow streets, many of which “Ferdinand had ordered widened.”48 Granada was a city of average-size houses, at least according to one Arabic source,49 but Münzer saw them as:

...almost all small, with such tiny rooms...that a Christian house occupies more than four or five Moors’, which are so intricate and labyrinthine that they appear like swallows’ nests.50

Münzer also commented on the Nasrid notion of façade and interior space. While Nasrid homes had running water and “very clean” interiors, the compact and dense Nasrid city did not support a “Western” sense of façade. That the homes were “dirty outside” highlights this fact.51 Visiting the Conde de Tendilla, the well-educated, well-traveled governor of Alhambra, in his palace, Münzer related that he “made us sit on silk cloth” and that they spoke in Latin.52 This Christian official occupied the spaces as a Nasrid might, sitting on the floor. The Conde must have recognized that most Nasrid spaces did not readily accommodate non-Muslim furnishings.

Isabella and Ferdinand constructed no royal residences during their reign, living itinerantly in refurbished Moorish castles or quarters added to monasteries.53 Like their Alhambra governor, they inhabited the Nasrids’ architecture largely as they found it. At the Alhambra, for instance, it is suspected that they occupied upper rooms in the Cuarto Dorado, at least on their second and third Granada visits. Yet even though the Catholic Monarchs refurbished Nasrid dwellings, the architecture remained alien to them. For instance, their Santa Fé residence, constructed near Granada during their final conquest, was unlike any Nasrid dwelling54 in that it had no patio; instead, the windows looked outward and were ordered to create a façade. Even though the dwelling was “temporary,” they put much care into creating a building befitting their station and reflecting their culture’s architecture, one distinct from that of the Nasrids.55

During Charles V’s 1526 stay, a “honeymoon” after his Seville wedding, his court members made comments about Granada and Nasrid housing that underline the clash between Nasrid architecture and non-Nasrid expectations. The Albaicín and the Alcazaba were characterized by the Venetian Andrea Navagero as “densely populated and full of small houses, because the Moors are used to living in narrow, tight” quarters.56 This simple observation, directly addressing Nasrid housing, only hints at part of the problem, as echoed in the complaints of others. Dantisco, for example, did not specifically describe accommodations, but expressed general concern about their high cost and inadequacy, and complained of scarce supplies and the weather in early December.57 Once the conquest was complete, reforms were undertaken in Granada and throughout Andalusia: streets were widened and houses transformed, combined, and enlarged to meet the needs of their new occupants.58 The captivating qualities of the Comares and Lions palaces—evident to all commentators—were not sufficient compensation for Granada’s housing inadequacies.59

The decision by Isabella of Portugal (d. 1539) to leave the Alhambra reflects this housing problem. Charles V and his court arrived in June—thereby avoiding the summer heat in Seville60—and remained until early December, but before their stay was over, Charles V’s wife had left for the presumably more comfortable convent of San Jerónimo. Even though the Catholic Monarchs had refurbished her Cuarto Dorado rooms, they remained unsatisfactory.61 Charles V, too, had other expectations. Raised in Northern Europe, with a different idea of court life and accommodations, he desired familiar surroundings befitting his high station, not only as the Spanish king, but also as the Holy Roman Emperor. With Granada the center of a tenuously gripped, newly conquered territory, Charles V found the Alhambra’s compound aspect welcoming; nevertheless, more suitable accommodations were needed.62

Post-conquest construction in the Alhambra

With the need to maintain a royal presence in Granada—to show support for the local population and illustrate the defeat of Islam on the continent—the remedy was a
new palace, whose planning started shortly after Charles V’s visit in 1526. However, construction of the palace only commenced in 1533, as the first project was the “new quarters”—six rooms and a glazed corridor—to be used until the palace was completed (fig. 17).\(^63\) That work started on these rooms, instead of the palace proper, perhaps best illustrates how unsatisfactory the typical, alcove-based Nasrid chamber was to Charles V and his court. In fact, the contrast between a Nasrid room and the squarish geometry of Charles V’s “new quarters” could not have been more striking. Charles dined in the Hall of the Two Sisters, a larger “ceremonial” space that he evidently enjoyed.\(^64\) Inhabiting the typical, more elongated, reduced Nasrid chambers, however, was another matter.

The differences between the “new quarters” and a typical Nasrid room do not stop at geometry, although that is the most prominent distinction. The Nasrids did not use stoves or fireplaces, but fireplaces with ornate mantelpieces anchor two rooms of the “new quarters.”\(^65\) The Nasrids’ successors even installed some form of large heating elements in the Alhambra rooms, as indicated in images of the Comares Palace from the mid-1800s (fig. 18).\(^66\) The wall-opening vocabulary varied as well. The windows of the “new quarters” fuse view, light, and ventilation, similar to those in the upper rooms of the Comares Palace. There were no small ground-floor openings above doors to provide air and light, such as the ones favored by the Nasrids. Windows were at some point punched into the Nasrid palace’s ground-floor walls, in the Sala de la Barca and elsewhere, perhaps an indication of how cramped the long, narrow rooms felt to those who came after the Nasrids; it also reflects a poor understanding of how the alcove-based rooms were meant to be occupied (fig. 19).\(^67\)

While the “new quarters” were raised—by means of a ground-level arcade—the motivation was not to create elevated winter rooms, even though their fireplaces, and the glazing in some spaces, might suggest otherwise. As Spanish royalty were more likely to visit in the summer or intermediate seasons, the Catholic Monarchs’ 1492 post-conquest stay excepting, winter quarters were not critical. Probably for this reason, the Nasrid palaces shade the “new quarters,” to create rooms more favorable for occupation in summer. Given the seasons in which the post-conquest royalty normally visited the

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Fig. 17. Charles V’s “new quarters”: A) Comares Palace, B) Lions Palace, 1) the emperor’s office, 2) the antechamber, 3) the emperor’s bedchamber, 4) the empress’s bedchamber, 5) first Sala de las Frutas, 6) second Sala de las Frutas, 7) the glazed gallery, 8) Patio de Lindaraja, 9) Patio de la Reja, 10) Torre del Peinador de la Reina. (Drawing: Todd Willmert)
Alhambra, fireplaces would have combated summer’s morning chills and inclement weather conditions in the intermediate seasons. To otherwise keep the cool weather at bay, one might enjoy the afternoon sun in the glazed west-facing corridor closing the “new quarters” courtyard. Thus, the “new quarters” were not elevated to create winter rooms; rather, they were built level with the principal Nasrid palace ground-floor rooms, to keep them adjacent with the existing spaces. The “new quarters” were thus shoehorned between the two Nasrid palaces, the Torre del Peinador de la Reina, and the Alhambra’s fortification wall.

The odd angles and idiosyncrasies of the “new quarters” contrast radically with the strict geometry of Charles V’s Renaissance palace. The latter, attributed to Pedro Machuca (d. 1550), who studied in Italy, recalls other royal palaces in its emperor and empress quarters, reinforced with distinct façade frontispieces (portadas), vestibules, grand staircases, and service

Fig. 18. Lithograph showing the chimney that was added to the Comares Palace. (After Joseph Philibert Girault de Prangey, *Monuments arabes et moresques de Cordove, Séville et Grenade* [Paris, 1837], pl. XV)

Fig. 19. Lithograph showing the windows added to the Sala de la Barca in the Comares Palace. (After Girault de Prangey, *Monuments arabes et moresques*, pl. XXI)
courtyards, the last elements planned but not constructed (fig. 20). With a sophisticated entry sequence leading to the upper level and its special rooms above the vestibules behind the portadas, the palace’s principal spaces are on the upper level, with the lower level and the two unbuilt courtyards devoted to service areas. Bedrooms would have been found in the palace’s south-east quadrant, a telltale sign being the “secret stair” that often signaled the private chambers. The royal couple was united physically in that corner and metaphorically in their separate tribunes on opposite sides of the octagonal chapel. The activities of their respective households unfolded between the bedroom and chapel, his along the west and north sides of the palace and hers along the south and east.

The upper-level piano nobile (the main floor of a large house) in the palace of Charles V carries important environmental ramifications, suggesting that the palace was designed primarily for winter occupation. The upper-level fireplace and the extensive glazing in the empress’s south portada, to cite two elements, reflect obvious environmental concerns, reinforcing this notion. However, environmental issues were ultimately of negligible importance, as is best illustrated by the palace’s patio, whose round form is the building’s most salient feature (fig. 21). Though commonly utilized to introduce light and air to its surrounding rooms and as a circulation zone between rooms, the patio in Charles V’s Granada palace does not serve these uses. In fact, raised roughly 1.5 meters above the ground-floor

Fig. 20. The palace of Charles V shown in relation to the Nasrid palaces, after an unsigned, undated plan attributed to Pedro Machuca, ca. 1528. The two outer forecourts to the palace were not constructed. Charles V’s “new quarters” are also indicated, just north of the Lions Palace and east of the Comares Tower. (Drawing: Todd Willmert, after the plan in the Archive del Palacio Real de Madrid)
level, it cannot perform its typical roles. The sixteenth-century architect Lázaro de Velasco (d. 1585), versed in a patio’s traditional role, remarked that the “round patio is so useless for rooms and halls that it will never amount to anything.” The palace patio has perplexed commentators, who have offered various suggestions as to its intended uses, ranging from a secret garden to a bullfight plaza.

The round courtyard, in conjunction with the square building block, makes a striking architectural scheme, but the long period it took to construct the palace and the lack of supporting documents make it impossible to ascertain the builders’ original intentions. It is often acknowledged that the palace of Charles V, juxtaposed with its Nasrid predecessors, is “misplaced”; nevertheless, the purity of its platonic forms captivate. This view explains how one nineteenth-century visitor could find the juxtaposition of the palaces “disgust[ing],” yet still hold that the Renaissance structure itself “is in every way adapted to the climate; and its interior, which is of a circular form, unites convenience and splendour.”

A cursory look at the extant palace plans and the features of the building itself reveals unresolved aspects, such as partition walls colliding with window openings and the neglect of poche space. Perhaps details regarding the habitability of the palace were not resolved either, despite comments to the contrary.

Although there are no direct clues or documents regarding the consideration of environmental concerns in the construction of Charles’s Granada palace, certainly the dwelling could be adapted for use in any season. As political needs—not climate, seasons, or weather—dictated royal movements and travels, a residence might be occupied at any time of year. However, Charles V’s retirement “villa” at Yuste, built in the mid-1550s adjacent to the Jerónimo monastery near Plasencia, directly addressed climatic concerns. Yuste was a year-round dwelling from which Charles V never planned to leave. This represented a change from his peripatetic reign and was a factor influencing the design of various quarters so as to help moderate the severe winters and scorching summers characteristic of
Spain’s Extremadura region. The summer and winter apartments and miradors, as well as the fountain and pond to the villa’s south, among other features, encompass a range of architectural elements intended to confront environmental issues (fig. 22). Inventories show braziers and other portable warming elements, as well as tapestries, rugs, and various furnishings that would complement the passive strategies employed to create habitable rooms.

Yuste served basic needs, all reflected in its design and development, as well as in its appointment. The most prominent features of the villa are its four winter rooms—each with a fireplace—and four similar summer rooms constructed below them, only one of which had a fireplace, presumably to combat summer chills. Interestingly, the dimensions of the eight main Yuste rooms correspond to the four principal rooms in the Alhambra’s “new quarters,” built in the late 1520s, as well as to a series of rooms constructed in Brussels in 1533. Each is roughly square, between 5 and 8 meters in either dimension. This “typical” chamber, often with a focal fireplace, whose warming range influenced room form and volume, certainly offers a radical contrast to the typical elongated, narrow, alcove-based Nasrid room. Both Charles V and the Nasrid rulers might construct summer and winter chambers and embellish rooms with fabric fittings, thus sharing environmental strategies. But cultural factors had an impact on room size and shape, with important ramifications—as becomes clear when we compare the room volumes favored by Charles V versus those of the Nasrids.

Yuste manifests a wealth of well-established approaches to controlling the environment within its compact design. Other features, however, were unique, specifically designed to address Charles V’s infirmities. Yuste’s prominent ramp, for instance, allowed the aging ruler to ascend with ease by foot, litter, or horseback. His upper winter bedroom enjoys a view of the monastery chapel altar, permitting him to hear and see Mass while lying in bed. Additionally, the room is particularly
well sheltered by the chapel to the north and by one of the villa’s chambers to the south, helping to moderate the winter’s cold. After his first year in residence, Charles built a tiny room that could be superheated by a stove. Located in the villa’s southeast corner, on the upper winter level, the stove room was yet another architectural means to help to alleviate Charles’s gout.77 These and other similar environmental measures taken at Yuste contrast to Charles’s Granada palace, only one of many residences in Spain and the rest of Europe where symbolic issues took precedence. As a retirement villa, environmental concerns and comfort could come to the fore at Yuste, the trappings of court ceremony, protocol, and symbolism being not as critical in the isolated Extremadura location.

Charles V’s sister, among other advisors, had suggested that he retire to a more benign climate.78 Their arguments did not dissuade the emperor, who made a preliminary visit to Yuste, expressing pleasure with the “villa’s” design and its beautiful location. He reportedly believed that it was cold in winter and hot in summer throughout Spain, obviating the need to search for some ideal spot.79 Perhaps because of this attitude, environmental issues were regarded as critical at Yuste. Charles V’s grandfather had counterintuitively put forth that “one ought to pass summer in Seville and winter in Burgos.”80 As one should logically summer in northern Burgos and winter in Seville, Ferdinand’s insight highlights that the architecture of Burgos was designed to counteract the winter’s cold and that of Seville the summer’s heat. Charles V, too, appreciated that architecture could respond to climate.81 Yoking disparate architectural elements at Yuste was an attempt to tackle the region’s climatic extremes.

CONCLUSION

The juxtaposition of the Comares and Lions palaces of the Nasrids with the palace of Charles V suggested specific occupation patterns to Juan Velázquez de Echeverría. Writing in the 1760s, he concluded that the palace of Charles V “was made only for winter habitation, leaving the Arab palace for summer.”82 The idea that the Nasrid palaces served as summer residences—given their more “open” nature—and that Charles V constructed a more “closed” palace for winter occupation is an interesting outlook, but one lacking in merit. Similar environmental strategies were employed by the Nasrids and those who inhabited the Alhambra after them. Velázquez de Echeverría thus posited a simplistic dichotomy. The advantageous utilization of orientation, building level, and material, among other factors, had an impact on comfort and habitability across cultures, as is evident in the Nasrid palaces and Charles V’s residences.

Variations in the application and interpretation of environmental principles and strategies helped to create the notable architecture that struck Velázquez de Echeverría and other Alhambra commentators. With the Alhambra palaces devoid of furniture and fittings, it is difficult to imagine what they were like when the Nasrids and their successors lived there. Braziers, tapestries, and other portable furnishings, however, complemented and completed the architecture, which is only a framework for creating a habitable space. Though aspects remain shrouded in mystery, considering the Comares and Lions palaces in light of environmental concerns highlights their salient architectural features. The post-conquest occupation as well offers insight, the commentary and construction of the Alhambra’s later occupants magnifying how two successive and rival cultures inhabited the Alhambra. Taken together, this broad study highlights the passive strategies utilized at the Alhambra to confront Granada’s climate of extremes.

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APPENDIX

Notes on monitoring and assessing “comfort” in the Alhambra

The buildings of the Alhambra lack many of their windows and doors, nor are Nasrid room furnishings in place. Although it is not possible to replicate Nasrid conditions exactly, their basic environmental strategies can still be studied. Tinytalk-Temp loggers (with an accuracy of ± 0.2 degrees Celsius) and Tinytalk-RH

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generally falls within a range that limits its influence. The fact that cooler air holds less moisture than warmer air is reflected in the RH. As the temperatures fall, the RH conversely rises. This is reflected in the humidity data in Table II, which also includes a description of sky conditions each day, expressed as a percentage of available sunlight. The total potential sunlight, the time between sunrise and sunset, relates to the actual sunlight hours. A low number reflects overcast conditions, a high number clear weather.

Nasrid Alhambra architecture is distinguished by its use of walls, as seen in its narrow rooms and alcoves. Since walls define occupiable space, it was appropriate to locate the monitors near them. It must, however, be recognized that the temperature monitored is that of the layer of air adjacent to the wall, which in turn is certainly influenced by the wall temperature itself. One might take the air temperature of a room in a pyramid’s center, but given the thermal inertia and mass of all the surrounding stone, the temperature will not measurably vary, especially in contrast to the outside air temperature, which in most climates oscillates widely from day to night. The intertwined nature of air and radiant temperatures makes it extremely complicated to unravel specific temperature influences. Thus, in order to show a general, relative difference between spaces, monitoring consistency is of the utmost importance.

In many buildings, one detects environmental differences caused by temperature stratification between levels and the impact of orientation. Beyond this, the issue of comfort comes into play. One’s comfort level is typically framed by six parameters, four particular to a given space—dry-bulb air temperature, humidity, radiant temperature, and air movement—and two particular to an individual—activity level and clothing. At a basic level, radiant temperatures are assumed to approximate dry-bulb air temperature. While the two most important components—air temperature and humidity—are emphasized, a room’s fittings also have an impact on its comfort level, as does the presence of breezes or calm, sun or shade.

While the influence of the sun’s warmth on a room and its furnishings might be minor, environmental changes are still readily apparent. For instance, studies have illustrated an individual’s capacity, each quanti-

Table I. Average monthly weather data for Granada, temperature in degrees Celsius and precipitation in centimeters.

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<th>PRECIPITATION AVERAGE IN CM</th>
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MONTHLY AVERAGE 15° 3.3
Table II. Weather data during the monitoring period from the Instituto Nacional de Meteorología. The airport weather station is 570 meters above sea level, the Generalife station 783 meters. Granada itself is roughly 680 meters above sea level, the Alhambra about 750 meters.

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<th>HIGH TEMP</th>
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<td>24.8°/3AM</td>
<td>16.5°/3AM</td>
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<td>31 AUG 94</td>
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<td>14.2°/6AM</td>
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<td>17.0°/4PM</td>
<td>36%/4PM</td>
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<td>-1.7°/7AM</td>
<td>21.6°/4PM</td>
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<td>22.2°/4PM</td>
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<td>15.9°/5PM</td>
<td>52%/4.5PM</td>
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<td>2.5°/19.0°</td>
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<td>1.7°/7AM</td>
<td>13.1°/4PM</td>
<td>69%/11AM</td>
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<td>4.0°/12.0°</td>
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<td>13.8°/11AM</td>
<td>67%/11AM</td>
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<tr>
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<td>10.2°/6AM</td>
<td>6.1°/3AM</td>
<td>14.4°/1PM</td>
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<td>7.5°/15.5°</td>
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The Alhambra Palace Architecture 181

fied differently, to perceive very small variations in air and radiant temperature. The environmental changes that the Nasrids attained through passive strategies are notable: their architecture helped them to inhabit Granada’s extreme climate. The monitoring done for this study begins to attach some quantitative values to this achievement within the Alhambra’s palaces, aiding in the monument’s interpretation and reinforcing its architectural significance.

NOTES

This work was made possible by a Fulbright scholarship that I held between 1993 and 1995. At the Universidad de Sevilla, Jaime López de Asís Martín, José María Cabeza Lainéz, and Jaime Martínez Davison must be singled out both for their hospitality and for sharing their knowledge of Spanish architecture. I note the innovative modeling and monitoring of the Alhambra by Benito Jiménez Alcalá of the Escuela Politécnica Superior, Universidad San Pablo-CEU (Madrid), as well as his important insights. At the Alhambra, Rocio Liñan, Jesus Bermudez Lopez, and Catalina Johnson were most helpful. My work also profited from the close readings of Jesus Escobar, Robert Ferguson, Vicente Lleo Canal, and John Reynolds.


2. Guillermo Yañez Parareda, Energía solar, edificación y clima: Elementos para una arquitectura solar, 2 vols. (Madrid, 1982), 1:583–84, gives climatic data. In Granada, the average temperature is 15.3°C, with average maximum 22.2°C and minimum 9.4°C; the average relative humidity is 60%. See Table I (in Appendix). See also Todd Willmert, “The


4. Luis del Mármol Carvajal, *Rebelión y castigo de los Moriscos* (orig. pub. as *Historia de la rebelión y castigo de los Moriscos del reino de Granada* [Málaga, 1600]; repr. Málaga, 1991), 38. Gallego y Burín, *La Alhambra*, 113 n. 191, believes that in describing the Lions palace as the winter residence, Mármol refers only to its upper level, citing Antonio de Lalaing’s 1502 statement concerning the Hall of the Kings, where “the moorish king used to lie in the Hall to be cool and he had his bed on one side of the Hall and his queen had hers on the other.” Based on this anecdote, Gallego y Burín posits that the Hall of the Kings was a ground-level summer space, with Mármol’s thought supporting the idea that the palace’s upper-level rooms were winter quarters. See Antonio de Lalaing, “Primer Viaje de Felipe el ‘Hermoso’ a España,” in *Viajes de extranjeros por España y Portugal*, ed. José García Mercadal, 3 vols. (Madrid, 1952), 1:429–599, 475.


8. There are several extant Alhambra braziers (*braseros*): see Leopoldo Torres Balbás, “Los braseros de la Alhambra,” *Al-Andalus* 2 (1934): 389–90; Antonio Fernández Puertas, “Braseros hispano-musulmanes,” *Cuadernos de la Alhambra* 8 (1972): 77–86. Water at the Alhambra is considered in articles such as Leopoldo Torres Balbás, “Letrinas y bacinces,” *Al-Andalus* 24 (1959): 221–34. The wintertime use of wood, or its derivative, charcoal, in a brazier is clear, but less evident perhaps is the effect in summer of water in a basin, fountain, or pool. In this respect, evaporative cooling merits mention. While the Alhambra climate is not extremely hot or arid, evaporative cooling is nonetheless effective there, given the site’s relatively low humidity. (See Table II [in Appendix] for the relatively low humidity levels during summer afternoons.) Evaporative cooling relies on the principle that when moisture is added to the air, relative humidity increases while temperature decreases, thereby creating a cooling effect.


14. Victor Olgyay, Design with Climate: Bioclimatic Approach to Architectural Regionalism (Princeton, 1963), 53, notes that in winter, at a 40° latitude, close to Granada’s 37°, “a southern exposure receives nearly three times as much total sun energy as the east or west sides; while in summer the radiation falling on south plus north sides is only half of that absorbed by the east plus west elevations.” At Granada’s latitude, a south-facing façade maximizes winter solar energy benefits. If properly protected with an arcade or portico, summer heat is minimized. Another common way of avoiding winter’s excessive solar gains is to use white or light colors on building surfaces to reflect the sun’s rays, thus absorbing less solar energy (see pp. 113–14). In any case, the most effective method of solar control is the general orientation of the building with respect to the sun and proper façade development.


16. See Koran 4:3: “If ye fear that ye shall not be able to deal justly with the orphans, marry women of your choice, two or three or four; but if ye fear that ye shall not be able to deal justly (with them), then only one, or (a captive) that your right hand possess, that will be more suitable, to prevent you from doing injustice.” The fact that dignitaries would have had to traverse the sultan’s private quarters to reach the throne room might have created protocol problems, but in general the sequence of spaces and rooms is well conceived. Aside from the possible wives’ quarters on the east and west sides, the smaller rooms adjacent to the baths were probably for bath attendants. In the Comares Palace, the room to the south, only the façade of which remains, the rest destroyed in the construction of Charles V’s palace, probably “was reserved for service and concubinage,” as posited by Dickie, “Palaces of the Alhambra,” 140–41. The Comares Tower has suffered much damage, from earthquakes and from subsequent inhabitants, as noted in Gallego y Burín, La Alhambra, 85–88, and Leopoldo Torres Balbás, “Pasadizo entre la Sala de la Barca y el Salón de Comares, en la Alhambra de Granada,” Al-Andalus 2 (1934): 377–80. In examining historic plans and sections, one sees that the stair and oratory were altered, as were the tower’s winter rooms. For drawings of the late 1760s, see those by Villanueva and de Hermosilla in Rodriguez Ruiz, La memoria fragil, pls. VI, VI-2a, VII. See also Joseph Philibert Girault de Prangey, Recuerdos de Granada y de la Alhambra (Paris, 1837; repr. Madrid, 1887), pls. XXIX, XXX. Accurate drawings of the Alhambra can be found in Carlos Vilchez, La Alhambra de Leopoldo Torres Balbás: Obras de restauración y conservación, 1923–1936 (Granada, 1988). In a personal communication, Jesús Bermúdez López suggested that the tower’s upper room might have had windows looking into the Hall of the Ambassadors, making them more luxurious. Dickie misstated that the upper-level rooms of the Comares Palace were for summer, the lower for winter: Dickie, “Alhambra: Some Reflections,” 137, 139, and James Dickie, “Toward an Aesthetic of Granadine Art,” Oriental Art 26 (1980): 322–31, 331 n. 5. This misinterpretation is not found in Dickie, “Palaces of the Alhambra,” 139–41. See also Emilio García Gómez and Jesús Bermúdez Pareja, La Alhambra: La casa real (Granada, 1967). Both authors have brief essays in this short, unpaginated picture book. In his short essay, Bermúdez Pareja postulates that the Comares Palace had summer–winter wives’ quarters.

17. The Sala de la Barca is 24 meters long by 4.35 meters wide by 12 meters high. Its southern wall is about 85 centimeters thick. Gallego y Burín, La Alhambra, 83, gives the room’s dimensions. Its height was determined from drawn sections. The vaulted upper room is 10 meters long by 2.2 meters wide by 3.4 meters high at the top of the barrel vault. A door opening on the west end of the room is 1 meter wide by 1.3 meters high, and there is a center window, double-arched, approximately 1 meter wide by 1.2 meters high. The southern wall of this room is approximately 80 centimeters thick.

18. See the camaritas described in Gómez Moreno, Guía de Granada, 1:53.

19. See Gallego y Burín, La Alhambra, 74, for dimensions. With a row of hedges contributing to evapo-transpirative cooling on either side of the pool, about half of the patio surface area is occupied by water or plantings.


21. See particularly Dickie, “Palaces of the Alhambra,” 142–43, 146; Dickie, “Alhambra: Some Reflections,” 132. The text to M. Jules Goury and Owen Jones, Plans, Elevations, Sections, and Details of the Alhambra: From Drawings Taken on the Spot in 1834 by the Late M. Jules Goury and in 1834 and 1837 by Owen Jones, Architect, 2 vols. (London, 1842–45), 1: pl. XV, pl. XVII, posits the private Lions Palace/public Comares Palace dichotomy: “The Hall of the Two Sisters appears to have formed a portion of the private apartments of the Moorish Kings. The alcoves, or sleeping rooms, on either side of the Hall, with the charming suite of apartments on the upper story, give it more the character of a residence,
than the Hall of Ambassadors, which was, doubtless, as its
traditional name implies, destined only for public recep-
tions.” Albert Calvert, The Alhambra: Being a Brief Record
of the Arabian Conquest of the Peninsula with a Particular
Account of the Mohammedan Architecture and Decoration
(London, 1906), 66–67, echoes this interpretation. Both
Mármol, Rebelión, 39, and Simonet, Descripción del reino
de Granada, 43, 46, refer to buildings as casa de recreación
or sitios de recreo (houses or places of recreation or retreat).

22. This is the argument of Emilio García Gómez, Foco de anti-
gua luz sobre la Alhambra: Desde un texto de Ibn al-Jatib
en 1362 (Madrid, 1988), 74–81, a view refuted by Dario
Cabanelas Rodríguez, “The Alhambra: An Introduction,”
in Dodds, Al-Andalus: The Art of Islamic Spain, 127–33,
129, and Ángel C. López López and Antonio Orihuela
Ural, “Una nueva interpretación del texto de Ibn al-Jatib sobre la
Alhambra en 1362,” Cuadernos de la Alhambra 26 (1990):
121–31. The Comares Palace was reformed and remodeled
by Muhammad V—as were the Muxuar and Cuarto Dorado,
crucial elements of that palace’s entry sequence—suggesting
that the Lions Palace did not simply supplant the Comares

23. Mármol, Rebelión, 38. Luis Seco de Lucena, Plano de
Granada árabe (Granada, 1910), 63, similarly describes
the Nasrid palaces. The Lions and Comares palaces were
separate in the Nasrid era, each having its own bath. The
demolished bath in the Lions Palace was in the northeast
corner of the palace, situated similarly to the extant bath

and Vision in the Alhambra’s Lindaraja Mirador,” Gesta 36,
2 (1997): 180–89. See also Lafuente y Alcántara, Inscriptio-
nes árabes, 135–44.

25. The twin miradors are mirrored in the twin patios or gar-
dens. Epigraphy in the Hall of the Two Sisters alludes to two
patios, stressing the importance of duality. Emilio García
Gómez, Poemas árabes en los muros y fuentes de la Alhambra
(Madrid, 1985), 118. The relationship of the two miradors is
noted by Francisco Prieto-Moreno, Los jardines de Granada,
2nd ed. (Madrid, 1983), 72.

26. The Hall of Secrets is called “a cool cryptoporticus” by
Dickie, “Palaces of the Alhambra,” 144.

27. The Lindaraja Mirador is approximately 3.5 meters long by
2.25 meters wide. The arched doorway is 2.6 meters wide by 3.3
meters high. The north window is double arched, measuring
2 meters wide and 1.45 meters high. The windows on the
east and west sides are both 1.45 meters high and about
1 meter wide. The upper mirador is approximately 3.5 meters
long by 2.25 meters wide. The room has a pyramidal wood
vault—the ceiling height varies between 4 and 5 meters.
There is a large, south-facing triple-arched window, about
2.5 meters wide by 1.5 meters high, above which are four
smaller arched windows, each 0.4 meters wide by 0.6 meters
high. Pairs of these smaller windows are also found on the
mirador’s east and west sides. The door opening to this mira-
dor runs almost the entire width of the room, stepping down
to a corridor ringing the Hall of the Two Sisters. In this way,
the room is extremely open. The Hall of Secrets, about 15
meters by 15 meters, has three door openings: the main one,
under Lindaraja, is arched, measuring 1.8 meters wide by 3.2
meters high; two smaller ones, on the room’s north and east
sides, are both 2 meters high and, respectively, 1 meter wide
and 1.3 meters wide. Given the room’s masonry vaulting, its
height varies, but is roughly 3 meters. Measurements were
taken on site, except for the global dimensions of the Hall
of Secrets, which were determined from plans.

28. To Dickie, the closed nature of the Hall of the Abencerrajes
suggests a winter room: see Dickie, “Palaces of the Alham-
brara,” 144.

29. The radiiuses of the basins are approximately 110 and 65
centimeters, respectively.

30. See Jiménez Alcalá, “Natural Cooling in Hispano-Moslem
Residential Architecture.” In fact, since the Hall of the Two
Sisters and the Hall of the Abencerrajes are narrower and
more restricted than the Hall of the Ambassadors, they bet-
ter facilitate air movement in the rooms. Jiménez Alcalá’s
ideas inform my arguments in this paragraph.

31. In the Nasrid epoch, the planting beds were 80 centimeters
below their present level. Elevated walkways and sunken
planting beds were common in Islamic gardens: James
Dickie, “The Islamic Garden in Spain,” in The Islamic Gar-
den, ed. Richard Ettinghausen and Elisabeth MacDougall
(Washington, D.C., 1976), 89–105, at 100. De Lalaing,
“Primer viaje de Felipe el ‘Hermoso’ a España,” 475, reports
that the orange trees in the planting beds provided cooling
shade.

32. Jerrilynn Dodds, “The Paintings in the Sala de Justicia of
the Alhambra: Iconography and Iconology,” Art Bulletin
61, 2 (1979): 186–97, at 195–96, postulates that the portraits
might be of Muhammad V and his ancestors, especially since
he was Granada’s tenth Nasrid monarch.

33. De Lalaing, “Primer viaje de Felipe el ‘Hermoso’ a España,”
475, and Antoine de Lalaing, “Relation du premier voya-
dge de Philippe le Beau en Espagne, en 1501,” in Collection
des voyages des souverains des Pays-Bas, ed. Louis Gachard,

34. See Leopoldo Torres Balbás, “Algunos aspectos de la casa
hispanomusulmana: Almacerías, algorfas y saledizos,” Al-

35. This treatment of a masonry platform is seen in an Alcazaba
residence. In smaller dwellings, the lower level was likely
used year round, with the upper level used for storage or
shops as well as living quarters. That a home’s upper level
has a specific name in Spanish, algorfa—from the Arabic
al-ghurfa—hints at its importance in the architecture. The
upper level might also have served as a retreat for women
when male guests entered the house. Ibid., 181–85.

36. The Spanish word tarima was adopted directly from the
Arabic.

37. In the Alcazaba, the fire of the neighborhood oven was evi-
dently utilized to heat part of a house as well, using hypo-
caus principles, but braziers were the heating standard. See

38. See the poem by Ben Sara de Santarén (d. 1123), as translated by Emilio García Gómez, Poemas arabígoandaluces, 4th ed. (Madrid, 1959), 79. García Gómez describes the poet, who was from Córdoba, as an "enemy of cold" (p. 35).


42. On the stained glass, see Leopoldo Torres Balbás, "Ventanas con vidrios de colores en los edificios hispanomusulmanes," Al-Andalus 14 (1949): 197–201.


44. Emilio García Gómez, Cinco poetas musulmanes: Biografías y estudios, 2nd ed. (Madrid, 1959), 125. Abu Ishaq was born in the late tenth century, writing and working in the eleventh: see García Gómez, Cinco poetas musulmanes, 102–5. The spider web imagery certainly makes one think of the unique ceilings of the Lions Palace. Calvert, Alhambra, 100, uses the word "cobwebs" to describe Nasrid design elements. The image of a house of spider webs depicts fragility in the Koran 29:41: "The parable of those who take protectors other than Allah is that of the spider, who builds (to itself) a house; but truly the flimsiest of houses is the spider’s house; if they but knew."

45. Ibn Khaldun distinguished between the primary purpose of architecture as a protective screen against the elements, and secondary concerns, such as the display of wealth, power, or even sensual aspects. In general, there is a progression from necessities to conveniences to luxuries: Ibn Khaldun, Muqaddimah, 1:1xxxi–lxxixi, 249–50; 2:111, 357–59. The Koran 76:13 in part considers this theme, characterizing paradise as a luxurious, sensual place, and, more practically, with neither the intense heat of the sun nor the cold of the moon: "Reclining in the (Garden) on raised thrones, they will see there neither the sun’s (excessive heat) nor (the moon’s) excessive cold."

46. The anecdotes of court members illustrate the necessity of seasonal wardrobes in Granada. See Juan Dantsisco (Jan Dantsyszek), "El embajador polaco Juan Dantsisco en la corte de Carlos V," in Mercadal, Viajes de extranjeros, 1:789–834, esp. 792, 794, 805. Tapestries were a portable means of decoration as well as insulation: see Barbara von Barghahn, Age of Gold, Age of Iron: Renaissance Spain and Symbols of Monarchy (New Haven, 1980), 148. In discussing the Buen Retiro in the early 1600s, Brown and Elliott illustrate that many of the same environmental strategies were utilized in the seventeenth century: braziers are mentioned (p. 2); summer and winter apartments were furnished differently according to their use (p. 89); and tapestries were used in winter for insulation, paintings being substituted in warmer months (pp. 105–6). Braziers were listed in the royal inventories cited in Francisco Igüéez Almecí, Casas reales y jardines de Felipe II (Madrid, 1952), 33. Lastly, a 1626 document describing Spanish royal residences throughout the country mentions seasonal apartments within specific palaces and how royalty took advantage of them: Juan Gómez de Mora (1586–1648): Arquitecto y trazador del rey y maestro mayor de obras de la villa de Madrid (Madrid, 1866), 379–97, esp. 381, 383, 386, 389–90, 391, 397.

47. See Patricia Waddy, Seventeenth-Century Roman Palaces: Use and the Art of the Plan (New York, 1990), chap. 2, "Comfort," in which architectural strategies and the writings of Vitruvius, Palladio, and Alberti, among others, are considered in depth.

49. Simonet, *Descripción del reino de Granada*, 50, cites an account in Arabic describing Granada’s houses and buildings as neither “muy grandes ni muy pequeños.”


51. Ibid., 358.

52. Münzer, “Relación de viaje,” 353–54. Münzer traveled with three companions (pp. 327–28), thus his use of the plural. He met the governor, apparently in his palace, a structure built in the early 1400s. When the hereditary office was suppressed in the early 1700s, the palace became redundant and was destroyed. Dickie, “Palaces of the Alhambra,” 148–49. The Conde’s background is considered by E. Rosenthal, *Palace of Carlos V*, 7–10, and José Cepeda Adán, “El Conde de Tendilla, primer alcaide de la Alhambra,” *Cuadernos de la Alhambra* 6 (1970): 21–50. The practice of sitting on the floor was observed away from Granada, long after the conquest. Brown and Elliott describe theatrical events that took place in 1836 at the Buen Retiro, during which many in attendance sat on the floor: Brown and Elliott, *Palace for a King*, 204.

53. In 1492, there might not have been enough time to prepare rooms, as the palaces were in ill repair. See Leopoldo Torres Balbás, “Los Reyes Católicos en la Alhambra,” *Al-Andalus* 16 (1951): 185–205, at 188, 190–91; Juan Antonio García Granados and Carmen Trillo San José, “Obras de los Reyes Católicos en Granada (1492–1495),” *Cuadernos de la Alhambra* 26 (1990): 145–68. See also Münzer, “Relación de viaje,” 355.

54. Eladio de Lapresa Molina, “La Casa Real de Santa Fé a través de documentos de la Alhambra y otros archivos,” *Cuadernos de la Alhambra* 7 (1971): 57–80. In this article, archives are used to “reconstruct” the royal residence. As Johannes Lange wrote in 1526, Santa Fé was more than a military encampment. During the six-year final conquest, Ferdinand “constructed a town called Santa Fé” (construyó un pueblo llamado Santafé). See Lange, as cited in Antonio Gallego Morell, “La corte de Carlos V en la Alhambra en 1526,” in *Miscelánea de estudios*, 1:274.

55. Events such as the capitulation of Granada and discussions with Columbus occurred there. The Alhambra was occupied the first week of 1492, the rendition signed in Santa Fé the previous October. The Monarchs left Granada in late spring and stopped briefly in Santa Fé, meeting Columbus there in April. See de Lapresa Molina, “La Casa Real de Santa Fé,” 58, 63; Torres Balbás, “Los Reyes Católicos en la Alhambra,” 189.


57. Dantisco, “Embajador polaco,” 811–12. That these concerns came from someone well disposed to Charles V illustrates the severity of the situation, as perceived by the Alhambra’s new occupants. See also A. Paz y Meliá, “El embajador polaco Juan Dantisco en la corte de Carlos V,” *Boletín de la Real Academia Española* 11 (1924): 54–69, at 63–64; Earl Rosenthal, “El programa iconográfico-arquitectónico del palacio de Carlos V en Granada,” in *Seminario sobre arquitectura imperial* (Granada, 1988), 159–177. On page 169, Rosenthal notes that members of the court were housed “in the Moorish style, ‘to which they were not accustomed, resulting in much inconvenience’” (“a la morisca ‘a que no estaban acustombrados[s] y le[s] resulta muy incómoda’”). The source of this quote is not revealed, nor was it located in the course of my research.


59. See Münzer’s comments in “Relación de viaje,” 354, as well as those of others, such as Navagero, in Brothers, “Renaissance Reception of the Alhambra,” 80–81.

60. See Frederick Wernstedt, *World Climatic Data* (Lemont, Pa., 1972), 227, 229. In June, July, August, and September, the average monthly temperatures are, respectively, 22°, 25°, 25°, and 22°C in Granada, and 25°, 28°, 28°, and 25° in low-lying Seville. In December, January, and February, temperatures average 7°, 7°, and 8°, respectively, in Granada, and 11°, 11°, and 12° in Seville. The Catholic Monarchs, too, took advantage of the climatic differences between Granada and Seville. During their second and third stays, in 1499 and 1501, they summered in Granada, wintering in warmer Seville. Torres Balbás, “Los Reyes Católicos en la Alhambra,” 189–90.

61. See E. Rosenthal, *Palace of Carlos V*, 4, 22–45. See also Bermúdez Pareja, “Obras en el Cuarto Dorado”; Gallego Morell, “La Corte de Carlos V.” The convent was sponsored by the Catholic Monarchs and occupied a few years before the royal visit in 1526.

62. Charles V’s court had 4,000 members, against his grand-parents’ 1,000 to 1,500. For background on the courts and royal residences, see E. Rosenthal, *Palace of Carlos V*, 3–4, 31–33. See also Vicente Lampérez y Romea, “Los palacios de los reyes de España en la Edad Media,” *Arte Español* 3 (1914): 213–35; Fernando Chueca Goitia, *Casas reales en monasterios y conventos españoles* (Bilbao, 1982).


66. See Girault de Prangey, *Recuerdos de Granada*, pl. XV, from 1832–33. See also *La imagen romántica del legado andalusí* (exhibition catalogue) (Barcelona, 1995), 177, 186. The lithograph on p. 177, which is from 1850, looks north, and shows a chimney on the west side of the Comares Palace, near the Sala de la Barca. The image on p. 186, a drawing from 1829, looks south and shows a chimney on the east side. This
later image nearly replicates the view in Girault de Prangey, Recuerdos de Granada, pl. XV.

67. See Girault de Prangey, Recuerdos de Granada, pls. XV, XXI. See also the images in Pedro Galera Andreu, La imagen romántica de la Alhambra (Madrid, 1992), 130, 177; La imagen romántica del legado andalusí, 177, 179, 186. Dickie, “Alhambra: Some Reflections,” 128–29, succinctly summarizes the Alhambra’s post-Nasrid fate.

68. Charles V reviewed at least one plan relating his palace to its Nasrid counterparts. E. Rosenthal, Palace of Carlos V, 37–38.

69. Ibid., 22–45.

70. For a discussion of the fireplace and south portada, see ibid., 62–74, 82–89, 138–39, 149.


72. E. Rosenthal, Palace of Carlos V, 219–22, suggests a secret garden. Ford felt that the patio was “well contrived, if the emperor meant to use it as an arena for bull-fights”: Ford, Hand-Book for Travellers, 1:371, believed that the plan “cut up with a disproportioned Doric circular Patio...must destroy the proportions of all rooms near it.”

73. James Cavanah Murphy, The Arabian Antiquities of Spain (London, 1815), 8. He further relates: “In any other situation but this, the palace of Charles V. would excite admiration: but here it is misplaced, and produced only disgust....” Similarly Calvert, Alhambra, 364, writes: “It is, in every way, adapted to the climate; and its interior, which, in its chief feature, takes a circular form, is spacious and splendid. In any other situation the Palace of Charles V. would justly excite: but here it is misplaced. With all its grandeur and architectural excellence, Washington Irving could only look upon the structure as ’an arrogant intrusion.’” (The Irving quote is from the chapter “Interior of the Alhambra” in Tales of the Alhambra.) Henry Swinburne wrote: “The magnificence, the unity of this whole pile, but, above all, the elegance of the circular court, quite transported me with pleasure, on the first view, and I have ever since found my admiration increase in proportion to the number of visits.” See his Travels through Spain in the Years 1775 and 1776, 2 vols. (London, 1787), I:275. Even today, climatic concerns receive attention: “The circular court of King Charles V’s addition to the Alhambra, with its two storeys of colonnade, provide a continuous space to track or avoid the summer or winter sun.” Eoin O. Cofaigh, John A. Olley, and J. Owen Lewis, The Climatic Dwelling: An Introduction to Climate-Responsive Residential Architecture (London, 1996), 26.


75. A long-handled warming pan, braziers, and a metal stove were also listed in Yuste’s inventories. See Stirling-Maxwell, Cloister Life, 477–85; Modesto Lafuente, Historia general de España, 25 vols. (Barcelona, 1888), 9:372–73. Rodríguez Domingo and Gómez Roman, “En torno a las habitaciones,” 197, and von Barghahn, Age of Gold, 1:49–50, discuss the portable furnishings, tapestries, rugs, etc., that accompanied Charles V on his peregrinations.


77. Martín González, “El palacio de Carlos V en Yuste,” 40, describes the stove room, constructed after the first year in residence; Stirling-Maxwell, Cloister Life, 224, cites a new stove. In Madrid’s Alcázar, another of Charles’s residences, tiny rooms for easy heating, mentioned as the chimenea de alcobas (alcoves’ chimney) and estufa (stove) in plans, might have been precedents for the Yuste stove room. Veronique Gerard, De castillo a palacio: El Alcázar de Madrid en el siglo XVI (Bilbao, 1984), 18, 27.
78. Stirling-Maxwell, *Cloister Life*, 92, cites the comments of the
queen of Hungary “entertaining him to think twice before he
settled in a spot ‘so unhealthy as Yuste.’”

are based on letters from the Archivo de Simancas. The
villa’s detractors argued that at least the monastery’s chapel
sheltered the cloisters, while Charles V’s quarters were sub-
ject to the full force of the sun. Charles V’s decision to retire
to Yuste, out of all his European territories, has never been
satisfactorily explained. Its proximity to hunting grounds
might have been a factor: Stirling-Maxwell, *Cloister Life*,
75–77. Yuste’s isolation from political activity might also
have been an issue: von Barghahn, *Age of Gold*, 1:43.

80. Navagero, “Viaje por España,” 851. As the Venetian dip-
loget was in Charles V’s court, Ferdinand’s statement was
evitably repeated after his death.

81. Charles V died one and a half years after retiring to Yuste.
Given his infirmities, as evidenced by the stove room con-
structed after the first winter, perhaps it is not unusual
that the lower level was scarcely used. Martín González, “El pal-
cicio de Carlos V en Yuste,” 33.

82. Juan Velázquez de Echeverría, *Paseos por Granada y sus
The author refers to the two Nasrid palaces as one palace
(Palacio Arabe), similar to the reference of the Academia
de San Fernando to the “Palacio Arave” and the “Palacio del

83. The loggers are small, battery-powered devices that track
either temperature or humidity at regular intervals. This
information is later downloaded to a computer. In the
Comares Palace, monitors were placed in the southeast
corner of the Sala de la Barca and in that same corner in
the upper room. In the Lions Palace, the device monitoring
the upper mirador was located in the southeast corner.
In both the Lindaraja Mirador and the Hall of Secrets, loggers
were placed in the northeast corner. Other factors merit
attention. The monitors were in the shade at all times dur-
during their operation and located in room corners, away from
openings as much as possible, to lessen the impact of room
air changes. All the monitored spaces were either buffered
by patios, to limit air movement through them, or were
very enclosed, experiencing few air changes despite a lack
of windows or open doors.

84. Wernstedt, *World Climatic Data*, 227. The data were com-
piled over a thirty-year period.

85. Olgyay, *Design with Climate*, 117–18, considers the differ-
cence between a light wood structure and one with nine-inch-
thick brick walls, both construction systems having equal
insulation values and both in a Baghdad housing develop-
ment. The wood building’s heat transmission curves show
a time lag of two hours, those of the brick structure a lag of
ten hours. The heat flow curve of the brick structure is nearly
flat in July, while that of the wood building nearly mirrors
the radical outdoor temperature swings. See also Baruch
Givoni, *Man, Climate and Architecture*, 2nd ed. (London,

86. Dry-bulb temperature measures the ambient mixture of air
and water vapor in the normal way with a simple thermo-
meter. In contrast, wet-bulb temperature is that shown by a
thermometer with a wetted bulb. At 100% relative humidity,
dry and wet bulb temperatures are equal.

87. Of these factors, it is especially difficult to determine the
mean radiant temperature of a space’s surfaces. To bypass
the difficulty in balancing radiant and air temperatures, the
operative temperature—essentially an average of a space’s
air and surface temperatures—is often used. See Benjamin
Stein and John Reynolds, *Mechanical and Electrical Equip-
ment for Buildings*, 9th ed. (New York, 2000), 42, which
touches on the complexities involved in determining mean
radiant temperature. Chapter 2 of that work, “Comfort, Cli-
mate, and Design Strategies,” considers relevant issues, such
as the insulating values of clothing, metabolic rates, and
other factors that define comfort.

88. In the comfort zone, dry-bulb air temperature and air veloc-
ity have the greatest impact on an individual’s skin tem-
perature. Only at high temperatures does the wet-bulb tem-
perature, related to humidity, become significant. Givoni,
*Man, Climate and Architecture*, 49–50.

89. Givoni, *Man, Climate and Architecture*, 55–56, cites studies
in which the thermal sensation is graded according to the
severity of cold or warmth, 0 being unbearably cold and 9
unbearably hot. On this scale, people can distinguish not
only between 4, comfortable, and 5, slightly warm, but also
intermediate levels such as 4.2, not entirely comfortable but
definitely not slightly warm; 4.7, less than slightly warm but
definitely not comfortable; and 4.5, which is somewhere in
between. Every individual has his/her own scale, meaning
that thermal sensation is extremely subjective, although each
person is consistent within his/her own evaluations. Cultural
factors are also important. Olgyay, *Design with Climate*, 17,
notes “that the British comfort zone lies between 58° to
70°F; the comfort zone in the United States lies between 69°
and 80°F; and in the tropics it is between 74° and 85°F; with
the relative humidity between 30 and 70%.” Psychological
factors, the cooling or warming suggestion of a fountain
or burning embers, also merit attention, as does acclima-
tization. See also S. Olesen, P. O. Fanger, P. B. Jensen, and
O. J. Nielsen, “Comfort Limits of Man Exposed to Asymmet-
ric Thermal Radiation,” in *Thermal Comfort and Moderate
Heat Stress: Proceedings of the CIB Commission W45 (Human
experiment, room air temperature remained stable while
the temperature of one room surface was elevated. When
the wall temperature was raised 5°C, a majority of subjects
noticed a minor change in the average radiant temperature.