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## VERNACULAR VAULTED HOUSES IN SOUTHERN EUROPE

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**Abstract:**

*In southern Europe, a peculiar type of houses characterised by their vaulted roofs were built over the centuries with local materials and pre-industrial methods, answering the functional, cultural, climatic, and aesthetic questions of their inhabitants.*

*This article aims to study in a comparative perspective vernacular vaulted houses identified by the extrados located in European Mediterranean towns. It is intended to highlight the architectural and constructive features of vaulted domestic dwellings in Portugal, Spain, France, Italy, and Greece in order to establish a comparison of the typologies of houses, vaults' geometries, used materials and building processes. The research methodology is based on the literature review of the national surveys carried out during the mid-twentieth century on traditional, rural or popular architecture in these countries and architectural surveys carried out in situ. It is expected to understand similarities and differences of the vernacular vaulted houses, to understand the modularity composition related to the roofing technique and materials of these Mediterranean houses.*

## 1 INTRODUCTION

Vernacular vaulted houses are constructions that respond to functional, cultural, climatic, and aesthetic questions of their inhabitants, built over the centuries with local materials and pre-industrial methods, commonly characterised by vaulted ceilings rooms and located in southern Europe. The construction system of the vaults involves a millenary tradition that is an important testimony to the Construction History and to the understanding of local Mediterranean communities.

In the beginning of the twentieth century, theoretical thinking about vernacular constructions was marked by an ethnographic perspective through the elaboration of national inventories and surveys based on cataloguing, classification, and typification, that later served as a theoretical body for interventions in the building. "Use", "form" and "spatiality" were often classification categories used in surveys, especially by French theorists [1]. These approaches arose at a time when the study of vernacular constructions in Europe was associated with the urgency to catalogue and preserve the built heritage, and the introduction of new materials and constructive technologies were accelerating their disappearance. On the other hand, they support the craving for finding a national identity, in which the recognition of a peculiar architecture could play an important role.

The first European systematic studies on common constructions were carried out in Italy, in the late 1920s with the *Ricerche sulle Dimore Rurali*, published in the collection *La Casa Rurale*, between 1938 and the 1980s, in a tentative way to analyse, synthesise and typify, with the first results being presented in the exhibition *Architettura rurale italiana* [2, 3].

In France, the initiative *Chantier intellectuel 1425*, carried out between 1942 and 1945 by Georges-Henri Rivière, director of the *Musée Nationale des Arts et Traditions Populaires* [4] was the first step for a larger study and survey, *L'architecture rurale française*, published in several volumes between 1977 and 1989 and coordinated by Jean Cuisenier and Henri Raulin, who in 1964 wrote *L'architecture rurale française. Une enquête nationale inédite (1941-1948)*, where an attempt for a descriptive synthesis was made, later fully developed in the introductory chapter *Propositions théoriques et conventions terminologiques pour une typologie de l'architecture rurale* of the *L'architecture rurale française*. In this chapter, it is presented the genesis and the logics for the synthesis of the buildings<sup>1</sup>. Another chapter presents the *corpus* of the rural houses surveyed, where they were classified and grouped by types and subtypes according to formal, socio-spatial, material categories and construction processes, denoting and influence by the contemporary studies on housing<sup>2</sup>. The *corpus* includes a typological table and index of the classifications and terminologies of the buildings, regions of predominance, and the housing program restrictions, such as the implantation, family nucleus, socio-economic condition and architectural components.

In Portugal, the first approach was done by the agronomist Lima Basto in 1942, with the survey *Inquérito à Habitação Rural*, although without impact, once it was published only in 2013 [7]. Thus, the most relevant survey is *Inquérito à Arquitectura Regional Portuguesa*, carried out between 1955 and 1960 and published as *Arquitectura Popular em Portugal* [8].

In Spain, the first studies on vernacular buildings go back to the chapter *La casa popular en España*, in *Folklore y Costumbres de España*, published in 1934 by Leopoldo Torres

<sup>1</sup> "Comment passer d'une série de monographies, si bien faites soientelles, à la connaissance de l'objet que ces monographies saisissent, dans la diversité de ses présentations?" (Cuisenier, 1987, 92) [5].

<sup>2</sup> "Les genres, en architecture rurale, sont pratiqués mais non grammaticalisés. Le champ de variation, les traits pertinents, les oppositions significatives ne sont pas relevées comme tels, le pris pour données dans un projet d'articulation théorique" (Cuisenier, 1987, 13-15) [6].

Balbás. Between 1942 and 1946, the *Dirección General de Arquitectura del Ministerio de la Gobernación* carried out a prospection of the main Spanish fishing settlements and houses in the Atlantic-Mediterranean coast, published as *Plan Nacional de Mejoramiento de la Vivienda en los Poblados de Pescadores* [9]. At this inventory was presented a typological synthesis on the fishermen's houses in the map *La vivienda del pescador en España* [9]. Despite the previous pioneering approaches (aligned with the other European similar works), it was only in the 1970s that two contemporary surveys were carried out with a national perspective: *Arquitectura Popular Española* by Carlos Flores and published in 1973 [10], and *Itinerarios de Arquitectura Popular Española* by Luis Feduchi published between 1974 and 1984 [11].

Also published in the 1980s, the architectural survey *Greek Traditional Architecture* coordinated by Dimitri Philippides and published in 1983, provided theoretical reflections on Greek vernacular buildings, as it had been done in Europe<sup>3</sup>. Although, the earliest representative syntheses on vernacular Greek architecture were developed by the folklorist Georgios Megas, in 1922, presenting an evolutionary model of Greek housing from Classical Antiquity to the contemporary house, published in the book *E elliniki oikia* [The Greek house] in 1949<sup>4</sup>.

This article aims to study in a comparative perspective European vernacular houses with vaulted roofs that are commonly identified by the extrados, the outer volume of the vault. It is intended to characterise the architectural and constructive features of domestic dwellings, in order to establish similarities or dissimilarities between types of houses considering the uses, layouts, volumes, allotments, and vaults' geometries, materials, building processes, and conservation state. The methodology was based on literature review as a support to the architectural surveys carried in situ to around 250 vaulted houses in the European Mediterranean region, between 2012 and 2018.

For the Italian fieldwork campaign, *La casa rurale nella Sicilia Occidentale* [15] led to the island of Pantelleria, located in the Strait of Sicily, between the island of Sicily and the Tunisian coast, where the houses with stone vaults, the *dammuso*, were mentioned. Also with stone vaults, the houses shown in the volume *Aegean Cyclades* of the *Greek Traditional Architecture* prepared the Greek fieldwork in the Thirasia island, located in the Santorini archipelago, in the Aegean Sea [12]. Moreover, the volume *Comté de Nice* of *L'architecture rurale française* also with references to the *casun*, houses with stone vaults, was the basis for the French fieldwork in the outskirts of Breil-sur-Roya, *Moyenne Roya*, located on the valley of river Roya, in the Alpes-Maritimes [16]. The Iberian architectural surveys feature that vaulted houses can also be constructed with bricks. In the *Arquitectura Popular Española* [10] and *Itinerarios de Arquitectura Popular Española* [11], brick vaulted houses are presented in the regions of Extremadura and Andalucía, which led to the Spanish fieldwork on the *cañon* houses, in the fishing village of Zahara de los Atunes, between the Bay of Cadiz and the Strait of Gibraltar, already on the Atlantic Coast, like the Portuguese regions *Alentejo* and *Algarve*, the last chapters of *Arquitectura Popular em Portugal* [8],

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<sup>3</sup> “The model, has clear, specific characteristics – and can therefore act as a mechanism for reproducing the form – the type is an abstraction, a notional expression, that has nothing to do with particular examples. It might be thought of as an ideogram that contains within it the basis common to all the particular examples” (Philippides, 1983, 52) [12].

<sup>4</sup> The term "organic evolution of form" is part of a set of three conceptual models that dominate the field of research of vernacular architecture as a biological organism, cultural phenomenon and architectural product/artifact. The concept that architectural forms evolve from a simple model – an original form conceived in ancient times – to a complex model (Megas, 1969, 4, 292) [13].

which conducted the fieldwork to houses with *açoteia*, in the fishing village of Fuzeta, in the Eastern Algarve.

## 2 TYPOLOGIES OF VAULTED HOUSES IN SOUTHERN EUROPE

As vernacular houses use local and available materials and therefore respectively constructive systems, vaulted houses can be built with stone or bricks, concerning the regions. In this section it will be presented five fishing or sea-related settlements with vaulted houses built with different materials, systems and geometries, from the stone to the brick, and from the simplest layout to the complex one.

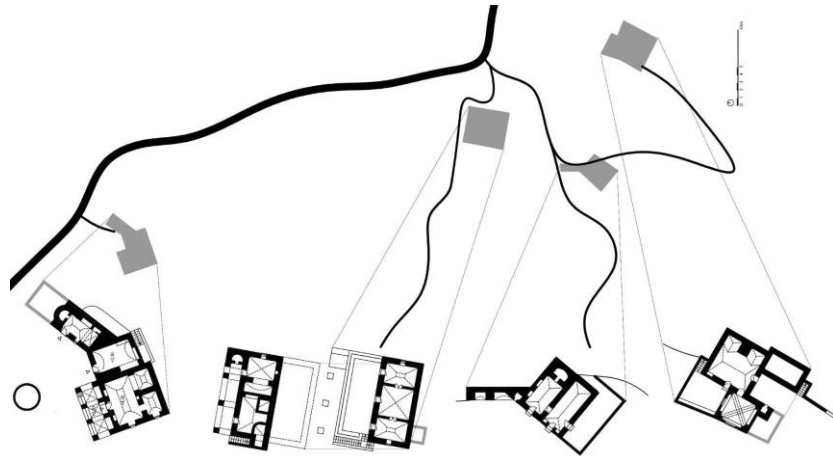
The Italian *dammuso* is an example of a vaulted roof house typology employing a volcanic stone and a constructive system using formwork with a barrel vault geometry. Although the island has a rural character, marked by isolated vaulted houses settled on agricultural land, there are a few urban settlements, Pantelleria, Scauri, Kamma and Gadir, that still conserve some urban vaulted sets. The *dammuso* is characterised by a main volume consisting of three vaulted spaces: the rectangular central space and living room (*cammara*), and two attached rooms, the bedroom (*alcove*), and the dressing room (*cammarinu*), with a storeroom, separated from the living room by a curtain. Secondary volumes are also vaulted and are attached to the main volume and have complementary uses, according to their rural or urban surroundings. The main volume is the morphological and structural basis of the three types of construction on the island: the urban (or agro-urban) palace, the rural house and the rural chapel<sup>5</sup>.

The *dammuso* rooms are covered by three cloister vaults, visible on the roof terrace, whose irregular and asymmetric forms are a result of the nature of the building materials, volcanic stone, and the local construction technique. The vaults' geometry is defined by the wooden formwork on which the mortar and stones are laid and subsequently compacted and lime washed, waterproofing the vaults' surface. The vault soffit is also lime washed, and sometimes decorated with friezes, ribs, and frames with geometric, plant and maritime motifs. In the interior of the rooms, the walls have inset niches, shelves, cabinets and benches (see figure 1).

The vaults are supported by thick stone walls with a few small windows and doors (one in the main façade oriented to north or northeast) giving a fortified aspect. Annexed to the main volume is the kitchen, the cistern and, sometimes, other complementary rooms (stable, barn, cellar, and storeroom for agricultural and fishing tools). The house is sited around an open space, usually a path, a courtyard or a threshing floor, according to solar orientation and exposure to prevailing winds, to protect from the cold winter winds and the warm south winds in the summer. The land is bounded by stonewalls, including an orchard called the "Arab garden", which has a proto-circular shape, protecting the fruit trees from the winds.



<sup>5</sup> Bonasera, 1968, 172-181 [15].



**Figure 1:** The *dammuso* vaulted houses of Pantelleria island (Sicily, Italy). Exterior and interior views of the house with barrel, groin and cloister vaults, in the street via Madonna della Margana (top). Plan of vaulted houses near Pantelleria city, streets via Farchicalà and via Madonna della Margana (bottom). (Author's drawing and photos)

In the *Greek Traditional Architecture*, Philippides identified three types of houses in the islands of Santorini with stone vaults: rural, urban and mansion, that can be built, partly-built or carved [17]. The urban house is sited in a cramped lot, with various floors, in overlapping volumes, leading to a more organic internal organisation and the absence of a façade type. In the 19<sup>th</sup> century, the urban house within the city walls, evolved into an erudite model of the house, inspired by the Italian and Venetian Renaissance house, with a monumental façade, known as the *Santorini mansion* [17]. The rural house is sited on a single floor and follows a typological internal distribution around a courtyard that is reflected in the façade.

Thirasia is a small island at the northwest side of Santorini's main island where stone vaulted houses prevail, with an urban and constructive coherence, unlike the urban areas of Fira, Pyrgos, Karterados or Oia, on Santorini, partly destroyed in the 1956 earthquake, and largely reconstructed using new techniques and adapted to the needs of tourism. Manolas is one of the three settlements on Thirasia Island, located along the ridge line. It is an urban settlement, with longitudinal pedestrian streets along the ridge line set into the slope, and a regular lot division perpendicular to the streets. The narrow lots fomented the construction of row houses with the same architectural type and in a solid block, with greater resistance to earthquakes, such as in houses in other Greek islands [18]. As the width of the lots are directly influenced by the typology of the roof, in Santorini islands the houses are covered by vaults made with volcanic stones, differing from the flat roofs of other Cyclades houses<sup>6</sup>.

The Manolas house consists of two rooms, similar to *spiti* Greek house, where the smaller one connects with the kitchen (*parastia*). The interior alcove lies in the continuation of one of the rooms, depending on the lot geometry. The façade reflects the two main rooms with corresponding doors and windows. The main room has two windows, one each side of the door, and is more than 6m deep. The secondary room has just one window and is the same depth or less, allowing an inner alcove three metres deep. There is also a difference between the two rooms in terms of width, with the secondary room with the alcove usually being wider.

<sup>6</sup> Philippides, 1983, 155, 158 [12].



**Figure 2:** The *spiti* vaulted house of Thirasia island (Santorini, Greece). Plan of the houses in Potamos (top left) and Manolas (bottom left) and respective exterior and interior with barrel and groin vaults (right). (Author's drawing and photos)

Like in Santorini, the houses of Thirasia are covered by barrel vaults built with volcanic stone and mortar. The common barrel vault's geometry approximates to a semicircle, with an irregular and sometimes inaccurate aspect, due to the irregularity of the raw material, the stone, and the popular nature of the construction process. Until the first quarter of the 20<sup>th</sup> century, the barrel vault was executed by assembling volcanic stones with mortar perpendicular to the vaults' curvature. Later, the vault construction process changed to the use of a mortar composed of small volcanic stones, pozzolan and pumice placed on the formwork, creating a lighter vault [19]. The morphological analysis of a Thirasia house emphasises the spatial composition based on the aggregation of spaces covered by a barrel vault, according to the local and traditional house typology, whose basic compositional unit is the *spiti* room (see figure 2).

The French *casun*, a stone vaulted house in Breil-sur-Roya region, in Maritime Alps, is a two-storey house with vaulted roof settled in blocks with regular allotments, around 4.5m front, imposed by the vault building system, with perpendicular and/or parallel orientations. The ground floor is a semi-basement and intended for shelter of animals, to the granary and storage of farm tools. The upper floor is intended for housing and consists of two vaulted compartments: a kitchen and a bedroom. The barrel vault used in the *casun* is made of stone masonry with lime mortar, and has an arched profile that tries to approach the semi-circle. It was made using a wooden formwork, with a filling that reaches the highest thickness in the corners, giving strength and reducing the inclination of the extrados, currently protected by a lime screed or coated with a layer of earth and the soffit is whitewashed (see figure 3).

The three previous case-studies of vaulted houses have in common the vaults made of local stones (in the case of the islands, of volcanic stones) and the use of formworks to shape the materials (stones and mortar) to the vault geometry, usually barrel vault and sometimes barrel with lunettes, groin or cloister vaults. The vaults' extrados are not used and are plastered and whitewashed (with limestone or pozzolana).



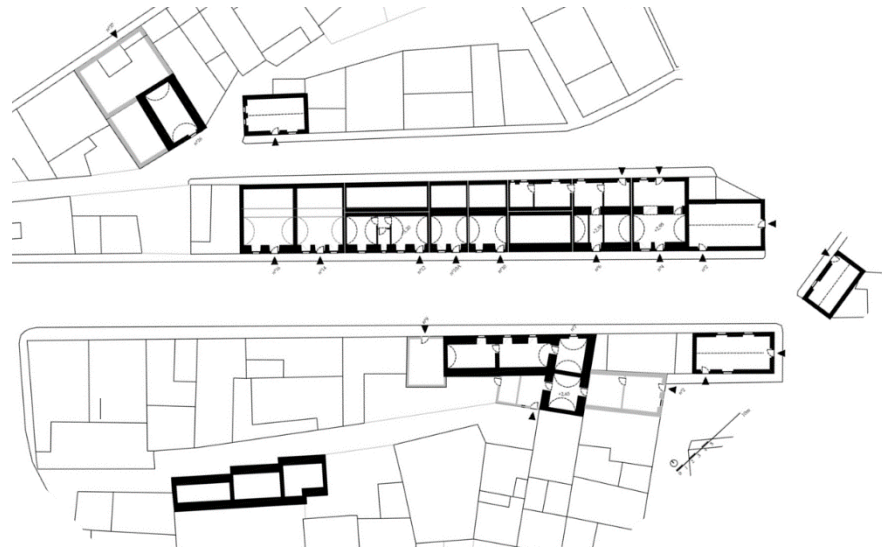


**Figure 3:** The *casun* vaulted houses of Breil-sur-Roya region (Maritime Alps, France). Plan of the houses in Cotte village (left). Exterior and interior views of the house with barrel vault with lunettes in street Chemin de Mauriana (right). (Author's drawing and photos)

Furthermore, in Iberian Peninsula, vaulted houses are usually made of bricks. The fifth volume of *Itinerarios de Arquitectura Popular Española*, entitled “La Mancha, del Guadiana al Mar” [20], carried out by Feduchi between 1968 and 1969, revealed the existence of these houses in the region of Extremadura, between the Tagus and Guadiana Rivers. However, the brick vaulted house of Zahara de los Atunes, locally called *cañon*, remained unidentified.

Zahara de los Atunes was established based on a seasonal settlement of huts and masonry houses located next to the seaside, at the mouth of a river. The urban form was based on parallel streets to the maritime and fluvial margins, originating an irregular grid. The vaulted buildings date back to at least the 16th century and were composed by few and multipurpose compartments. They are covered by a single barrel vault made of bricks placed in straight rows perpendicular to the top walls, like the Roman constructive system using formworks for its construction. Barrel vaults present variable arches' geometries, heights, and imposts (between 2.65m and 3.20m) with arches starting at 1.5m height. The vaults' intrados and extrados are covered and whitewashed, and the filling of the corners attenuates the curvature, although the roof terrace is not used. The oldest vaults have a more irregular soffit due to the use of some stone masonry (see figure 4).





**Figure 4:** The *cañon* vaulted houses of Zahara de los Atunes (Cádiz, Spain). Exterior and interior views of the houses with barrel vaults settled in street Agustin Medina Chico (top) and plan of the houses with barrel vaults settled in the same street (bottom). (Author's drawing and photos).

In Portugal, as mentioned in *Arquitetura Popular em Portugal* [8], there are some common houses in the south of Portugal, in Alentejo and Algarve regions, that have vaulted roofs made of bricks. In the fishing village of Fuzeta, on Eastern Algarve, the vaults are the roof structure for a terrace, locally known as *açoteia*. The firsts vaulted houses in Fuzeta were built in the first quarter of the 19<sup>th</sup> century [21-22], although since the previous century masonry houses were being built to replace fishermen huts. The construction of vaulted masonry houses in Fuzeta was associated with a typology of house characterised by contiguous dwellings with a single floor, placed in narrow and regular lots (front's widths of 5,5m and 6,6m, related to old Portuguese measurement 5 and 6 *varas*) considered "standard lots". The houses have a modular composition, organised in 2 or 3 sectors – façade, middle and back – majority with individual brick vaults ceilings with terraces above, except for the pitched roof (*telhado-de-tesouro*) in the façade sector, which has recently disappeared [21].

The houses in standard lots have a main façade composed of two windows and a door and topped by a frieze protecting the terrace and hiding the roof system. Usually in the façade sector is the living room, called the *outside room* ("casa de fora"), with a square layout that can be covered by a sail vault (*de vela*) or cloister (*barrete de clérigo*) or the formerly pitched roof, and a corridor covered by a barrel vault. The middle sector consists of two or three alcoves covered by a continuous barrel vault perpendicular to the façade and an interior living room, an "inside room" (*casa de dentro*), and a kitchen, usually in the back sector covered by a barrel vault parallel or perpendicular to the previous sector. Perhaps, the indoor kitchen is complemented by a covered outdoor space with a fireplace and oven, embedded in the roof terrace's stairwell, extended by a porch to the back courtyard where and frequently there is a water well.

The houses in narrow lots (with less than 5m front) are also composed of 2 or 3 sectors. The difference stands in the façade sector, without corridor and just the "outside room". The middle and back sectors are like the other type of house, covered by barrel vaults perpendicular or parallel to the façade. The houses settled in large lots (with more than 6m front or resulting from the junction of two standard lots), are composed of 2 or 3 sectors too. They have an internal distribution with a central corridor, similar to the Portuguese

traditional house called *risca ao meio* (symmetrical plan and façade) and has also a symmetric façade composed by a door in the middle flanked by one or two windows, and a courtyard in the back, depending on the geometry and location of the lot. The façade sector is made up of two main rooms, the living room, and the bedroom, covered by dominical vaults and separated by a corridor with a barrel vault. The middle sector is covered by two continuous and parallel barrel vaults, one covering the bedrooms or alcoves; and other covering the interior living room and the kitchen (see figure 5).



**Figure 5:** The *açoteias* vaulted houses of Fuzeta (Algarve, Portugal). Exterior and interior views (right) of the blocks bounded by streets Dr. Teófilo Braga (former *Rua Direita*) and *da Boavista* (top) and plan of the blocks bounded by the same streets (bottom). (Author's drawing and photos)

These vaulted houses – *dammuso* (Pantelleria), *spiti* (Thirasia), *casun* (Breil-sur-Roya), *cañon* (Zahara de los Atunes) and *açoteia* (algarve) – have in common the typology of the roof that can be identified from the outside, as well as the inside ambience of the room's vaulted ceiling as a unit that composes the building layout and the roof's structure [23].

At the same time that firsts European surveys were conducted, during the 1920s, architectural research on modulated houses' layouts through units was a subject also in vogue, expressing a European culture that valued the rationality behind the scientific and technological approaches, founding answers to new ways of life that Industrial Revolution had raised, and Modern Movement had dealt with. In this regard, at the 2<sup>nd</sup> International Congress of Modern Architecture (CIAM), held in Frankfurt in 1929, it was presented *The Minimum Dwelling* [24] a topic itself paralleled with the rooms' dimensions of the vernacular vaulted houses. Another contribution to the idea of a "housing cell" as spatial composition unit was outlined in 1957 by James Stirling, who set about the "dynamic cellularism" of Mediterranean architecture in the article *Regionalism and Modern Architecture* [25].

### 3 CONCLUSIONS

Previously it was highlighted how vaulted houses have a modular composition, directly related to the roofing technique and the use of local materials, characterising an architectural particular type of houses in the European Mediterranean area. As the interior of the vaulted rooms are usually limewashed, they have a morphological homogeneity, although the variety of characteristics behind the constructive systems. These common vaulted houses were built without the engagement of an architect or planner, thus being difficult to secure a construction date. It would be biased to try it in this study. Instead, the case-studies were grouped by material and constructive techniques and geography closeness: the volcanic stone vaults with the use of formwork in Pantelleria and Thirasia islands, followed by stone vaults in Breil-sur-Roya, close to the Mediterranean coast, and then the brick vaults with formwork in Zahara de los Atunes and without formwork in Fuzeta, both in the Atlantic coast but with Mediterranean-influenced culture.

Such lecture led to the emphasis on the most frequent types of geometries related to a specific material or a technique: the volcanic stone vaults with formwork use tend to be barrel (or roughly barrel) and rarely groin, and the brick vault without formwork present a range of varieties (barrel, groin, sail and cloister) with a technical clearance tending towards scholarly geometrical forms. A connection that can be found between the material and the geometry of the vaults and the dwellings' layouts: stone vaults with rough geometry can be related with minimal houses' layouts, with just a few rooms with multipurpose uses, when brick vaults with more complex geometries and also more complex houses with hierarchical uses layouts. Simple houses' layouts, such the ones in Thirasia and Zahara de los Atunes, are eventually older than the most complex ones, which were built in a moment when living conditions had more needs, as some of the houses in Pantelleria, Cotte and clearly, in Fuzeta. Either the more simple or complex vaults' geometry may be explained by whether the builders' familiarity with the vaults' constructional techniques originated from more "popular" or "erudite" knowledge.

The different vaults' constructional methods and their knowledge origins are reflected in the quality of the material assemblage and surfaces finishing and are thus the result of the local transmission of knowledge.

The study and comparison of similar vaulted houses allowed to establish their regional and Mediterranean architectural affinities,

Based on the use of the vaulted room as a unit of morphological composition, the use of local materials and constructive systems, the employment of architectural geometries coming from erudite sources, it is possible to establish the regional and Mediterranean architectural affinities of vernacular vaulted houses settled in different countries.

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