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DECODING SPATIAL FRAMEWORK OF ROMAN-AFRICAN DOMUS, CASE OF CUICUL (DJEMILA) ALGERIA

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ABSTRACT

This article focuses on a type of habitat that existed in the Roman territories in North Africa and assumes that the domestic architecture of the domus is a reflection of the collective identity of culture buried for millennia and considers that house can be a carrier of cultural information in its spatial configuration. Space syntax, through its configurational analysis techniques, allows establishing a qualitative and quantitative analysis by reconstructing the ancestral way of life and the interactions between inhabitants and strangers. We here present and discusse the results of the syntactic analyzes applied to a set of large Roman-African residences or domus in the Roman site of Djemila (cuicul) in Algeria. Topics covered include the spatial organization of the domus and the potential for integration and control of shared activity areas within the residence, with an assessment of its relationship with human use of space and functioning of the domus with the public space through its permeability. It appears that the spatial and formal models created through buildings and the way they are connected and sequenced correspond to codes that govern the activities that take place there, those that need to be separated, and which categories of people have access to them. The domus is structured by the introduction of a multitude of transitional spaces which had two major effects: creating a hierarchy from the outside world to the interior of the building and inducing movement by creating circulation alternatives and help separate areas of unrelated function and areas dedicated to a specific function.

KEYWORDS: domus, afro-roman architecture, space syntax, Djemila (cuicul), social logic of space, justified graph

1. INTRODUCTION

Ancient Roman architecture is no longer understood exclusively from the angle of art or technical exploits limited to architectural achievements with a public, sacred or funeral function, but it is also considered as a determining part of political, economic and social life. This awareness went hand in hand with an increased interest in society and the person who lived in this architectural space (Von Hesberg & al., 2010). This turns out to be a real object of study, complex and instructive for the knowledge of ancient societies because even on the basis of a purely technical and archaeological assessment, it is possible to delimit a social and cultural framework (Kent, 1990). This interest also influences research on domestic architecture and one wonders about the ways and uses of people who have lived and therefore understand their social and functional structure and thus project the architectural space on the structures of the daily life (Lafon, 2001; Wallace-Hadrill, 1988; Thébert, 1985). Dwellings represent some of the most personal elements of society, their study can provide access to the cognitive elements of human choices in the past (Sweetman, 2011).

Today, the gaze is more on the person within Roman society and the way he practiced his space. In this perspective, several studies have been carried out from different temporal and spatial contexts of the ancient era to show that ruined houses are not passive, but considered as an active and structuring place used by people to affirm their social and individual identities through systems of production and reproduction of culture (Chétima, 2015; Driessen, 2012). The shape of the house is a societal culture reflection as confirmed by Amos Rapoport (1972) in his work "*pour une anthroplologie de la maison*". In addition, domestic architecture is a truly dynamic phenomenon and involves the relationship between the built environment and cultural transformations. The shape, organization and use of spaces in domestic buildings are influenced by the behavior of the occupants (Culturaro, 2007)

The house function is inferred from the arrangement that dictates circulation and movement in general within the structure and the relationship between spatial organization and social behavior and Nevett argues that in an archaeological context, houses can offer insight into these social models (Nevett, 2007). A house can be seen as a space or a set of spaces, linked to each other both physically and socially, because a house is more than a structure, it is a sphere of social interactions between people and filled with activities that can be of a very diverse nature (Boswinkel, 2014).

The aim of this article relates to the archaeology of Roman domestic space, an archaeology that holds architectural remains that will be studied as a primary index of human behavior to constitute an architectural syntax underlying the relationships between cells. Properly diagnosing and studying ancient domestic space quickly placed us at the intersection of perceptual, social and spatial senses and systematically led us to use the analysis protocol developed by "space syntax". Four large mansions of ancient Roman Africa in Cuicul (Djemila, Algeria) were the subject of a spatio-syntactic decoding in order to reassess the relationship between social structure and the built environment. The innovation of this research lies in the fact of approaching the archaeological space in a socio-architectural aspect by the virtual reconstruction of the way of life in an archaeological structure, in this case the Domus using the software "Agraph" available and easy to use. The goal of the present work is to take us into the mental universe of an old society, through the representations and uses of its residential space.

2. RELATED WORKS

For domestic architecture, it is worth mentioning the work of Braemer (1995) who synthesizes the archaeological contexts of the house and the habitat in the Near East as well as the methods of approach and analysis that have attempted to go beyond the analysis of the architectural framework towards the identification of the ways of life, the behaviors and the activities of the man in the built framework which he constituted himself. Driessen (2007) through his research on Minoan space, perceives the house as having a spirit, a living body whose cycle differs from that of the life cycle of the people who inhabit it in a particular generation. Humans die, the house does not die - but at the same time, it gives its inhabitants a sense of immortality. Moreover, even a destroyed or abandoned house can continue to live as a mnemonic device, which appears in the work of Morvillez (2004) who questions the changes that are seen in the houses of Antioch, in the plans like the sets.

We pay spatial attention in the social context because the spatial organization and morphology reflect a form of organization of society, as well as the representations and values that operate in this society (Besse, 2003). By combining archaeological and syntactic spatial analysis (space syntax) methods, new knowledge can be generated about the physical environment in which the ancients lived their daily lives. (Stöger, 2015)

The model of space syntax entered fully into archeology in the 2000s with archaeologists Driessin & al. (2008) and Letesson (2009) who applied it to the study of the so-called "palatial" Cretan Minoan cities of the Bronze Age; Eeckhout (2013) who applied it in his archaeological studies on the complexes of the cities of the pre-Hispanic Andes or Duprè-Moretti (2019) who extended this concept to the anthropization of space,

movement or dynamic responding to rules emanating from a community. The archaeological space was also approached by the architects in particular the work of Arfaoui & al.(2019) on the urban habitat in the Carthaginian territories whose morphic logic made it possible to detect the spatial logic to deduce the common organizational principles and repetitions that give this domestic architecture its particular identity; Van Ness (2009) who has shown that the space syntax combined with archaeological data makes it possible to calculate the degrees of life in the streets of Pompeii neighborhoods and various degrees of social control for these neighborhoods. Stöger (2014), by studying the urban district, Insula IV ii, of the city of Ostia demonstrated that the syntactic tools of spatial analysis can add a valuable dimension to the archaeological assessment of the built environment. Durgun & al. (2021), Huemer (2021); Assassi & al. (2021), Twaisi (2017), Grahame (2014), Hillier & al. (1993) also used these methods to comment on the social aspects of privacy and how they influenced the movement and interactions of their inhabitants.

3. ROMAN-AFRICAN DOMESTIC SPACE AND CASE STUDY

Much research emphasizes the study of houses or domus in Pompeii or other regions in Europe, but little has been concerned with the Roman-African domestic space. For Jean-Pierre Guilhembet (2007), the analysis of prestigious domestic architecture is a key to grasping and understanding the position of Africa in the history of the ancient Mediterranean.

In Algeria, several archaeological sites testify to the power of Rome extent and the beauty of what were these ancient cities such as Djemila, Timgad, Tipaza etc. which are the classic scheme of Roman town planning with two gates located at the ends of the Cardo, the Forum in the center surrounded by buildings essential to public life: the Capitol, the Curia, the temples, the aristocratic residences adorned with rich mosaics, private dwellings and public buildings such as the Arch of Caracalla, the theater with thousands of places, thermal baths, basilicas and other religious buildings (Ennabli, 2000).

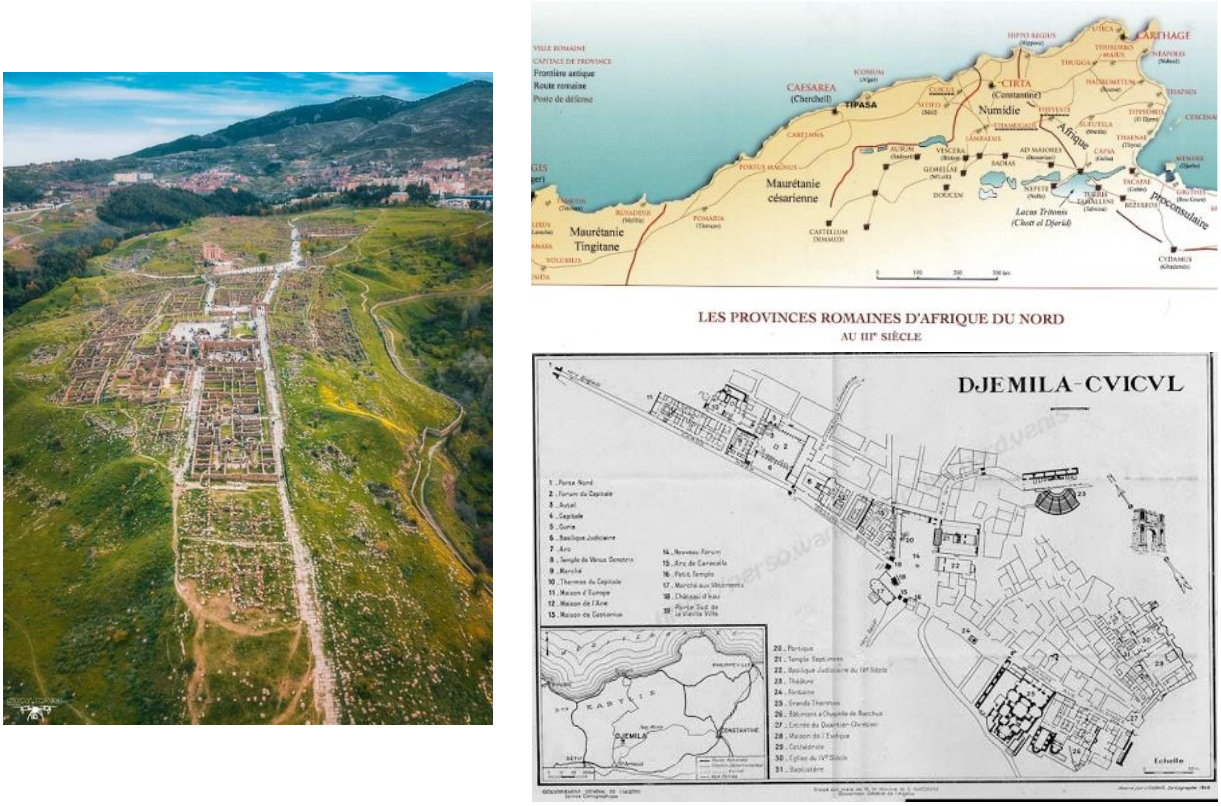


Figure 1 : The site of Djemila Cuicul, source: https://scontent.fblj1-1.fna.fbcdn.net/

At the start of the Roman-African era, townhouses in Romanized towns were numerous and small; by successive redemptions, their number has decreased in favor of large beautiful residences whose remains on the ground bear witness to this. Hybridizing Punic and Roman architectural styles, these houses are equipped with rooms, a peristyle courtyard, fountains and basins, the œcus (reception hall with columns); the triclinium (small dining room with three beds and a table, often with bay windows); the thermal baths whose presence or size varies according to the wealth of the owner. One of the essential criteria

for the establishment of Roman urban agglomerations in North Africa was the availability of water resources. Knowing that the thermal baths constitute an essential means of the social life of the Romans (Ammari, 2019) where two opposing elements (fire and water) were well mastered by the Roman (Lamare, 2016).

Djémila is the site of ancient Cuicul (figure 1), 43 km kilometers northeast of Setif (Algeria) was founded by Emperor Nerva for the veterans of the legions in 96 and 98 AD. From a small strongly Romanized agglomeration with monumental finery that seems very rich for a relatively small population, it has transformed over time into a prestigious pleasure town.

The layout of the city has a roughly triangular shape (figure2). The southern part is bordered on the west by the large artery lined with porticoes that crosses the district from north to south called Grande Rue or Grand Cardo. Besides the civic core; the largest and most beautiful residences occupy the spaces left free by the public monuments on the eastern bank of the Grand Cardo, of which the most important and best known, thanks to the main mosaic, is the *Maison d'Europe* (Duval, 1995)

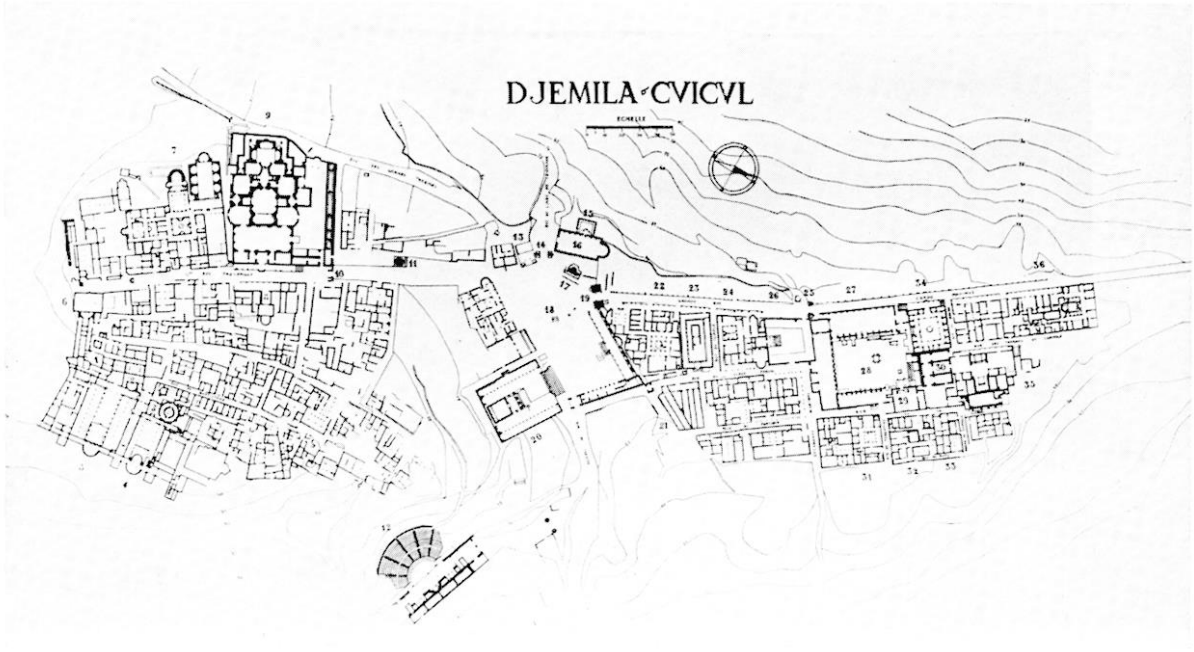


Figure 2: Cuicul: general plan (according to Y. Allais, Djemila, Paris, 1938, leaflet). Source: Rebuffat René, 1980).

4. MATERIAL AND METHOD

In the space syntax method of Hillier and Hanson, the morphological characteristics of a plane are translated into a graph called a "justified graph", whose basic models refer to the symmetry / asymmetry variables relating to the form of integration, and the distributive / non-distributive variables relating to the form of control[1] (Hillier & al, 1984; Hanson, 1998) and also refer to topological types. These topological forms of integration organize interactions between inhabitants and between inhabitants and visitors because the spatial configuration is an indication of common attitudes and the hierarchy of their different levels (Dawson, 2002; Hillier & al., 1987).

Agraph software allows getting rapid calculation of certain numerical measurements related to the properties of spatial configuration such a

- The mean depth (MD) of the spaces within the spatial system is represented by the number of spaces to cross to pass from the root space to any space in the system. The minimum depth can be reached when all spaces are directly connected to the original space (root space), while the highest depth exists when all spaces are arranged in a linear sequence away from the original space (Twaissi, 2017).
- Space integration value (Relative Asymmetry (RA) or Real Space Integration Value (RRA) describes the space permeability. Low values mean

[1] Distributivity index = (a + b) / (c + d). Symmetry index = (a + d) / (b + c).
The values a, b, c and d correspond to the number of spaces of type-a, -b, -c and -d in the system
Low Distributivity Index indicates a distributed system, high indicates a non-distributed system.
Low symmetry index refers to asymmetry, high refers to symmetry.

higher integration and high values signify high segregation (Manum, 1999).

- The control value (CV)is a quantitative data allowing checking the potential of spatial control that a cell exerts locally on the spaces which surround it. The control value is more indicative of the fact that a cell forms a real local core of circulation within a building (Letesson, 2009).
- The difference factor (BDF) is the sum of the mean, minimum and maximum integration values. It would suffice to know that the closer the difference factor is to 0, the more the constituent spaces of the building envisaged are differentiated and structured and that the closer it is to 1, the more they are homogenized until the last stage in which they all have the same integration value and that, consecutively, there would be no difference in configuration between them (Hanson, 1998).

These properties play an important role in detecting the level of privacy of the interior spaces of the space (Mustapha, 2010).

According to Bill Hillier (2007), we can see two kinds of human behavior in space: occupation and movement, the requirements of which involve four basic topological properties made explicit by the justified graph. The spaces that make up the graph can be divided into four topological types. Type-a spaces have a simple connection and do not cross each other, they promote occupancy. Spaces of type-b have at least two bonds and appear on the path to (and from) at least one space of this type, they remove the possibility of the traversing movement, but also strongly control it, because each route through the type-b space is unique and because the return movement must pass through the same space. The type-c spaces have at least two bonds and are on a single ring, they also remove the possibility of the traversing movement although without the same need for the return path. The same goes for type-d spaces which contain at least two rings and which have at least one space in common. They allow movement, but with much less control because there is always the choice of routes in both directions (Hillier, 2007; Bellal T, 2007; Hamouda, 2018).

5. ANALYSIS AND RESULTS

From an archaeological point of view, the site of Djemila (Cuicul) has been the subject of several studies, in this case those of Yvonne Allais (1971), Michelle Blanchard-Lemée (1975), PA Fevrier (2019), Sonia Hewitt (2000). These researches, made us discover a series of rich residences in the central district on the edge of the cardo where are located the Europe house (*maison d'Europe),* Donkey house (*maison de l'âne*) and Castorius house which occupy the spaces left free by the public monuments on the eastern bank of the Grand Cardo and back with the Amphitrite house, figure 3.

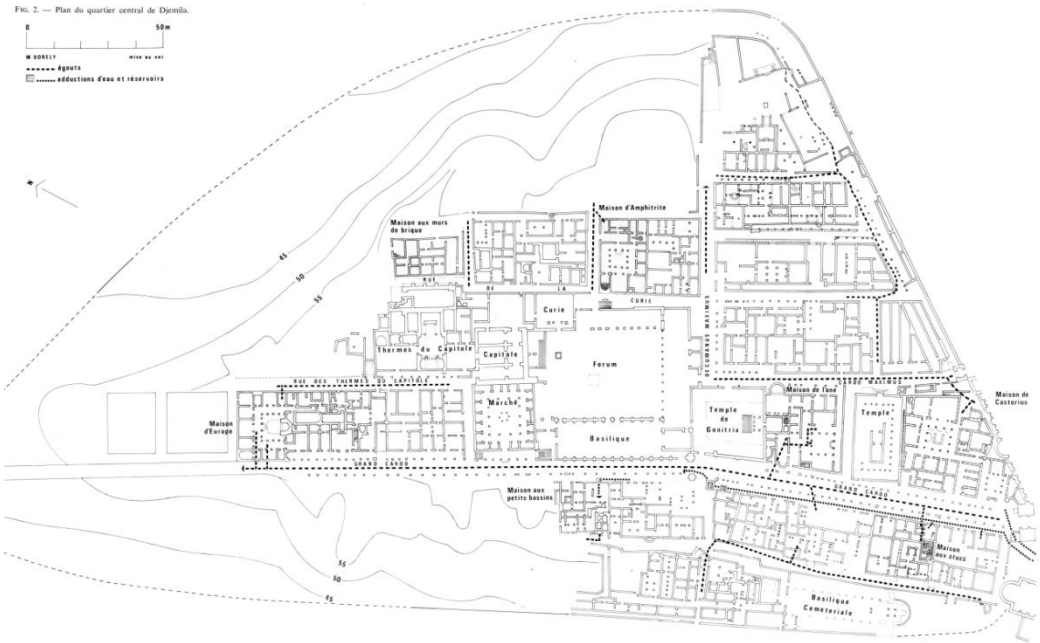


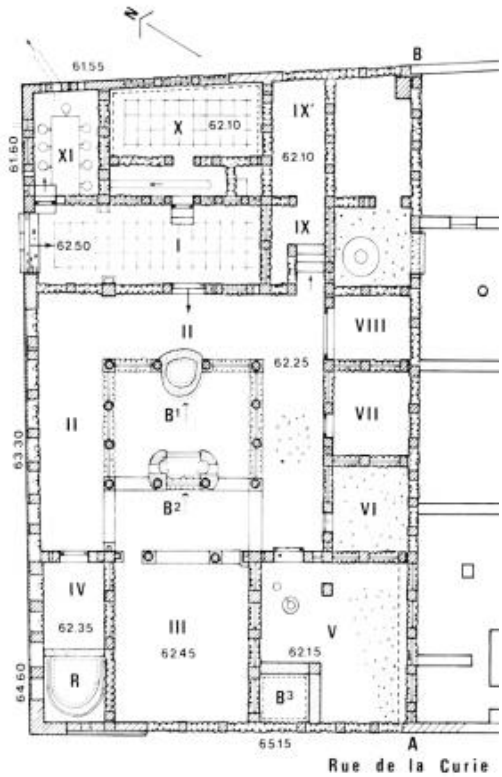
Figure 3: Central district of Cuicul (Djemila), and arrangement of the different residences to be analyzed. (Source: Blanchard-Lemé, 1975)

This article will take us into the mental universe of a society, through the representations and uses of its residential space.

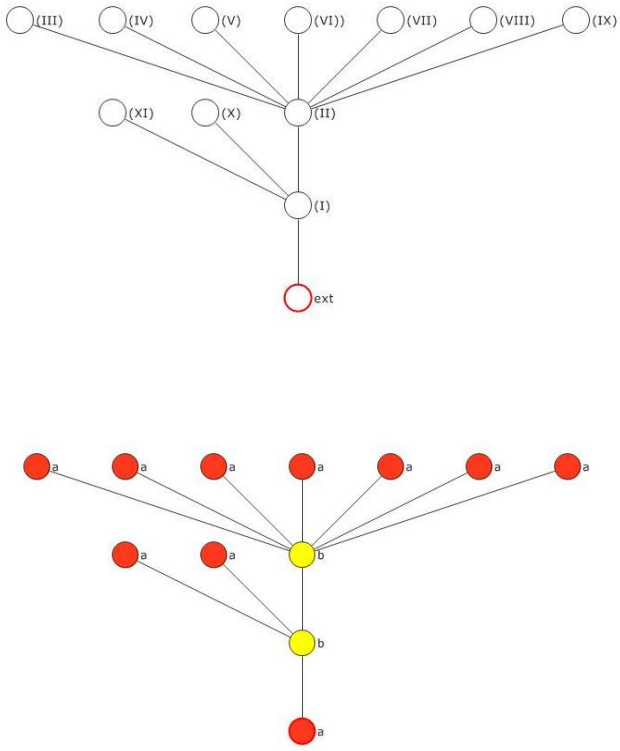
5.1. The House of Amphitrite (maison d'amphitrite)

The level wall on the cardo that delimits the amphitrite house allows to discover the very simple plan of this house. The entrance to the house is on a decumanus called "rue des bains de Terentius". It is made on a long vestibule, giving access to the two side parts of the house. On the eastern side, there are two utility rooms (X) and the eight-person latrine (XI). On the western side, a door opens onto a richly decorated peristyle which opens onto the various rooms of the house including the œcus, the artisan workshop and the rooms for domestic use, figure 4 (Blanchard-Lemée, 1975). The plan of the house was translated into a justified graph, drawn by Agraph who provided different spatial measurements given on the table 1.

A strong inequality exists among the living spaces of the house with the order: peristyle <vestibule <spaces III, IV, V, VI, VII, VIII, IX <X, XI, exterior. In this configuration, two key spaces seem to structure the house: the peristyle and the vestibule with the highest control values, namely 7.25 and 3.12 respectively. The vestibule connects and separates two functionally differentiated areas of the house and is shallow compared to the exterior. As for the peristyle, it is deeper and more integrated than the vestibule. All domestic spaces are connected to it except the exterior and service areas. They have the same integration value, they are therefore type-a spaces with an occupational vocation (dead-end spaces).



I: entrance vestibule, II: peristyle, III: œcus, IV: nymphaeum, V: oily, VI, VII, VIII, IX: rooms, X: utility room, XI: latrines



Plan of Amphitrite house.

Statement by J. Meunier (1937) revised and completed by M. Blanchard-Lemée

Figure 4 : Amphitrite house with its justified graph and topological types

Table 1: Results of justified graph analysis of Amphitrite house calculated with and without exterior

With exterior

	space	TDn	MDn	RA	i	CV
0	**ext**	28	2,54	0,3	3,23	0,25
1	**(I)**	18	1,63	0,12	7,85	3,12
2	**(II)**	14	1,27	0,05	18,33	7,25
3	**(III)**	24	2,18	0,23	4,23	0,12
4	**(IV)**	24	2,18	0,23	4,23	0,12
5	**(V)**	24	2,18	0,23	4,23	0,12
6	**(VI))**	24	2,18	0,23	4,23	0,12
7	**(VII)**	24	2,18	0,23	4,23	0,12
8	**(VIII)**	24	2,18	0,23	4,23	0,12
9	**(IX)**	24	2,18	0,23	4,23	0,12
10	**(X)**	28	2,54	0,3	3,23	0,25
11	**(XI)**	28	2,54	0,3	3,23	0,25
	Min	14	1,27	0,05	3,23	0,12
	Mean	**23,66**	**2,15**	**0,23**	**5,45**	**1**
	Max	28	2,54	0,3	18,33	7,25

BDF=0,49

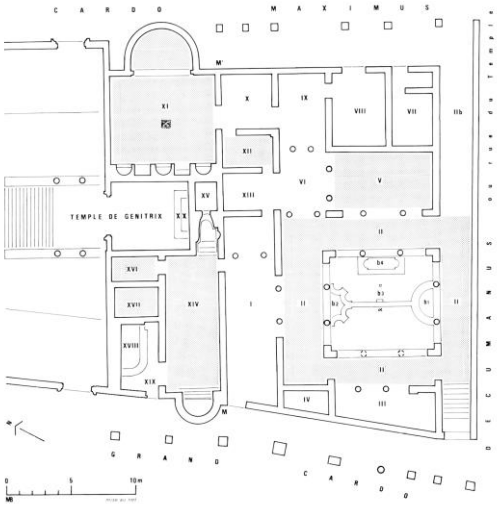
Without exterior

	space	TDn	MDn	RA	i	CV
0	**(I)**	17	1,7	0,15	6,42	2,12
1	**(II)**	12	1,2	0,04	22,5	7,33
2	**(III)**	21	2,1	0,24	4,09	0,12
3	**(IV)**	21	2,1	0,24	4,09	0,12
4	**(V)**	21	2,1	0,24	4,09	0,12
5	**(VI))**	21	2,1	0,24	4,09	0,12
6	**(VII)**	21	2,1	0,24	4,09	0,12
7	**(VIII)**	21	2,1	0,24	4,09	0,12
8	**(IX)**	21	2,1	0,24	4,09	0,12
9	**(X)**	26	2,6	0,35	2,81	0,33
10	**(XI)**	26	2,6	0,35	2,81	0,33
	Min	12	1,2	0,04	2,81	0,12
	Mean	**20,72**	**2,07**	**0,23**	**5,74**	**1**
	Max	26	2,6	0,35	22,5	7,33

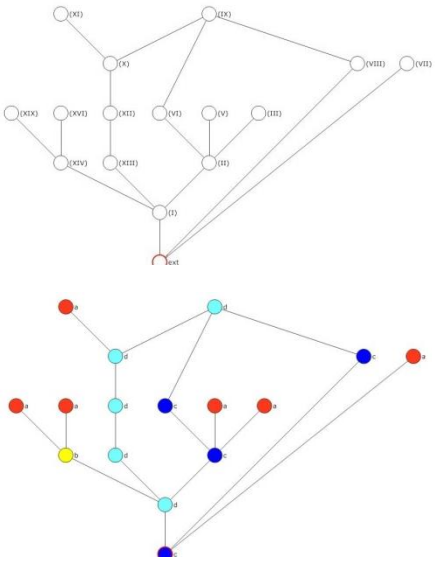
BDF=0,51

5.2. *The Donkey house (maison de l'âne)*

So-called because the image of this animal appears twice accompanied by the inscription ASINUS NICA on the pavements decorating it, is a complete and harmonious residence with its peristyle with large basins, its small baths, and its reception rooms decorated with mosaics. It opens onto the two main cardines and is made up of two architectural ensembles. To the south extends a large peristyle around which are grouped rooms and corridors accessible by entrances on the most important arteries of the city. To the north, a large room on the eastern façade and thermal baths on the western façade directly adjoin the courtyard and cella of the temple of Genetrix. The limit between these two sets is formed by the northern wall of vestibule I, rooms X, XII and XIII (Blanchard-Lemé, 1975).



Source, Blanchard-Lemé (1975)



I: vestibule 1, II: peristyle, III: room, IV: tanks, V: room, VI: room, VII: shop, VIII: vestibule 2, IX: room, X: passage room, XI: room with sump, XII and XIII: rooms, XIV: frigidarium, XV: tank, XVI: tepidarium, XVII: hot room, XVIII; hot pool, XIX: stove.

Figure 5 : Donkey house, its justified graph and its topological types

With 37.5% of type-a spaces, 6.5% of type-b spaces, 25% of type-c spaces and finally 31.25% of type-d spaces, the graph justified is globally distributed with an index of 0.77 and moderately symmetrical with a symmetry index of 2. The configuration thus presents two important rings: an external and an internal (figure 5).

The building opens at two points: vestibules I and VIII, both being of type-d, offer a great flexibility in terms of circulation and so lose in control potential. The two vestibules lead simultaneously to a series of type-d spaces (IX, X XII and XIII) which are rooms which open onto each other, and which belong to the inner ring. The vestibule I for its part also opens, on the one hand on a type-b space: the frigidarium (XIV) which has a potential of control vis-à-vis the spaces which are linked to it in the occurrence the tepidarium (XVI) and the furnace (XIX) which constitute the set of thermal baths, and on the other hand on the peristyle, being of type-c, it offers more than one option of circulation but retains a certain potential of control on two type-a spaces: room III and the triclinium (V) and on a type-c room communicating with room IX of type-d shown on the two rings of the system (external and internal). The thermal baths form a coherent spatial entity but isolated from the rest of the building. The entity, organized around the peristyle, is also isolated but communicates with the two access vestibules. The type-d rooms seem to create intermediate spaces between the thermal baths and the reception areas.

Table 2: Results of justified graph analysis of Donkey house calculated with and without exterior

With exterior

		TDn	MDn	RA	i	CV
0	**c**	36	2,4	0,2	5	1,75
1	**(I)**	30	2	0,14	7	1,41
2	**(II)**	34	2,26	0,18	5,52	2,75
3	**(III)**	48	3,2	0,31	3,18	0,25
4	**(V)**	48	3,2	0,31	3,18	0,25
5	**(VI)**	39	2,6	0,22	4,37	0,58
6	**(XIII)**	37	2,46	0,2	4,77	0,75
7	**(XIV)**	40	2,66	0,23	4,2	2,25
8	**(XVI)**	54	3,6	0,37	2,69	0,33
9	**(XII)**	43	2,86	0,26	3,75	0,83
10	**(XIX)**	54	3,6	0,37	2,69	0,33
11	**(X)**	44	2,93	0,27	3,62	1,83
12	**(XI)**	58	3,86	0,4	2,44	0,33
13	**(IX)**	40	2,66	0,23	4,2	1,33
14	**(VIII)**	41	2,73	0,24	4,03	0,66
15	**(VII)**	50	3,33	0,33	3	0,33
	Min	30	2	0,14	2,44	0,25
	Mean	**43,5**	**2,9**	**0,27**	**3,97**	**1**
	Max	58	3,86	0,4	7	2,75

BDF=0,47

Without exterior

		TDn	MDn	RA	i	CV
0	**(I)**	44	3,14	0,32	3,03	1,08
1	**(II)**	44	3,14	0,32	3,03	2,83
2	**(III)**	56	4	0,46	2,16	0,25
3	**(V)**	56	4	0,46	2,16	0,25
4	**(VI)**	47	3,35	0,36	2,75	0,58
5	**(XIII)**	48	3,42	0,37	2,67	0,83
6	**(XIV)**	52	3,71	0,41	2,39	2,33
7	**(XVI)**	64	4,57	0,54	1,82	0,33
8	**(XII)**	51	3,64	0,4	2,45	0,83
9	**(XIX)**	64	4,57	0,54	1,82	0,33
10	**(X)**	52	3,71	0,41	2,39	1,83
11	**(XI)**	64	4,57	0,54	1,82	0,33
12	**(IX)**	50	3,57	0,39	2,52	1,83
13	**(VIII)**	62	4,42	0,52	1,89	0,33
14	**(VII)**	210	15	2,15	0,46	0
	Min	44	3,14	0,32	0,46	0
	Mean	**64,26**	**4,59**	**0,55**	**2,22**	**0,93**
	Max	21	15	2,15	3,03	2,83

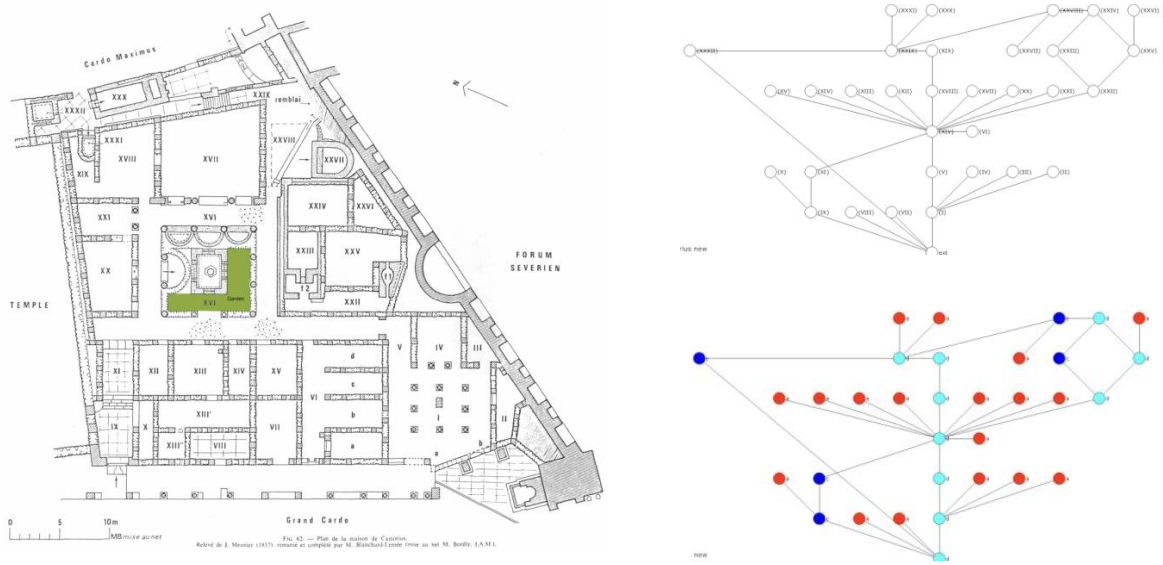
BDF=0,58

The numerical values (Table 2) show a clear difference between the results obtained from the calculations with and without exterior which is found to be more integrated compared to the other spaces after the vestibule and the peristyle. This means, a priori, that the spatial configuration emphasizes the relationship between residents and visitors. In general, the most integrated spaces are in order: vestibule1 <peristyle <exterieur <roomXIII <roomVI <frigidarium = roomIX <vestibule2 <roomXII <roomX <roomIII = roomV <shop <tepidarium = furnace <sump room

The control values are not high however, the highest goes to the peristyle which controls the private entity of the house followed by the frigidarium which controls the entity of the thermal baths.

5.3. The house of Castorius (maison Castorius)

The so-called Castorius house brings together, in a vast irregular quadrilateral, premises and architectural ensembles of dissimilar proportions and importance (figure 6). On the façade follow one another from south to north a courtyard surrounded by small rooms, then a series of premises communicating either with the street or with the center of the house, finally the main entrance, which opens into the west gallery of a vast peristyle. This gallery, with its extensions to the north and south, divides the house into two very distinct parts: to the west the series of modest premises that we have just mentioned, to the east two monumental sets designed to the measure of an exceptionally large remains: a peristyle and thermal baths (Blanchard-Lemé, 1975).



Source : (Blanchard-Lemé, 1975)

I: atrium, II: room, III: room, IV: œcuce 1, V: corridor, VI: rooms, VI: room, VIII: room, IX: vestibule 1, x: guardian lodge, XI: vestibule 2, XII, XIII, XIV, XV: rooms, XVI: peristyle, XVII: œucus 2, XVIII:, XIX: XX:, XXI: XXII: fireplace area, XXIII: hot room, XXIV: tepidarium, XXV: hot room XXVI: XXVII: cold pool, XXVIII: frigidarium, XXIX: corridor, XXX: hot bath, XXXI and XXXII: cold pools.

Figure 6: The Castorius house, its justified graph and its toplological types

The justified graph (figure 6) shows a majority of type-a spaces (18 cells at 54.54%), followed by 5 type-c cells at 15.15%, and finally 30.30% of type-d spaces. with total absence of type-b spaces. The graph is clearly distributed with an index of 1.2. This distributivity is an indication of the complex arrangement of circulations and of a certain spatial flexibility with the presence of four rings, three of which are important, one external which opens on the one hand onto two type-c spaces: the entrance to the small thermal baths (XXXIII) intended for slaves and the open-air vestibule (IX) which gives access to a second paved vestibule (XI) connected to the peristyle and on the other hand the house opens onto a type-d space : the atrium (I), whose access requires the user to take a linear sequence of d-type spaces, until reaching the peristyle at the third level of depth and which forms the meeting point of the three rings . True core of circulations, it offers multiple options in terms of movement and therefore loses control potential and from which a highly symmetrical tree-like configuration is deployed distributing the different rooms that open to it but also gives access to the two sets of thermal baths: private thermal baths and those intended for slaves. The peristyle, atrium and vestibules are the most integrated points in the system, but in terms of control, it is the peristyle that has a much higher value compared to the others.

Table 3: Results of justified graph analysis of Castorius house calculated with and without exterior

	With exterior					
	space	TDn	MDn	RA	i	CV
0	**ext**	98	3,06	0,13	7,51	3,03
1	**(I)**	93	2,9	0,12	8,13	3,7
2	**(II)**	124	3,87	0,18	5,39	0,2
3	**(III)**	124	3,87	0,18	5,39	0,2
4	**(IV)**	124	3,87	0,18	5,39	0,2
5	**(V)**	90	2,81	0,11	8,55	0,28
6	**(XIV)**	75	2,34	0,08	11,53	9,83
7	**(VII)**	129	4,03	0,19	5,11	0,2
8	**(VIII)**	129	4,03	0,19	5,11	0,2
9	**(IX)**	97	3,03	0,13	7,63	1,7
10	**(X)**	128	4	0,19	5,16	0,33
11	**(XI)**	94	2,93	0,12	8	0,41
12	**(VI)**	106	3,31	0,14	6,7	0,08
13	**(XII)**	106	3,31	0,14	6,7	0,08
14	**(XIII)**	106	3,31	0,14	6,7	0,08
15	**(XIV)**	106	3,31	0,14	6,7	0,08

	Without exterior					
	space	TDn	MDn	RA	i	CV
0	**(I)**	170	5,48	0,29	3,34	3,5
1	**(II)**	198	6,38	0,35	2,78	0,25
2	**(III)**	198	6,38	0,35	2,78	0,25
3	**(IV)**	198	6,38	0,35	2,78	0,25
4	**(V)**	148	4,77	0,25	3,97	0,33
5	**(XIV)**	128	4,12	0,2	4,79	9,83
6	**(VII)**	992	32	2,06	0,48	0
7	**(VIII)**	992	32	2,06	0,48	0
8	**(IX)**	178	5,74	0,31	3,16	1,5
9	**(X)**	206	6,64	0,37	2,65	0,5
10	**(XI)**	152	4,9	0,26	3,84	0,58
11	**(VI)**	156	5,03	0,26	3,72	0,08
12	**(XII)**	156	5,03	0,26	3,72	0,08
13	**(XIII)**	156	5,03	0,26	3,72	0,08
14	**(XIV)**	156	5,03	0,26	3,72	0,08
15	**(XV)**	156	5,03	0,26	3,72	0,08

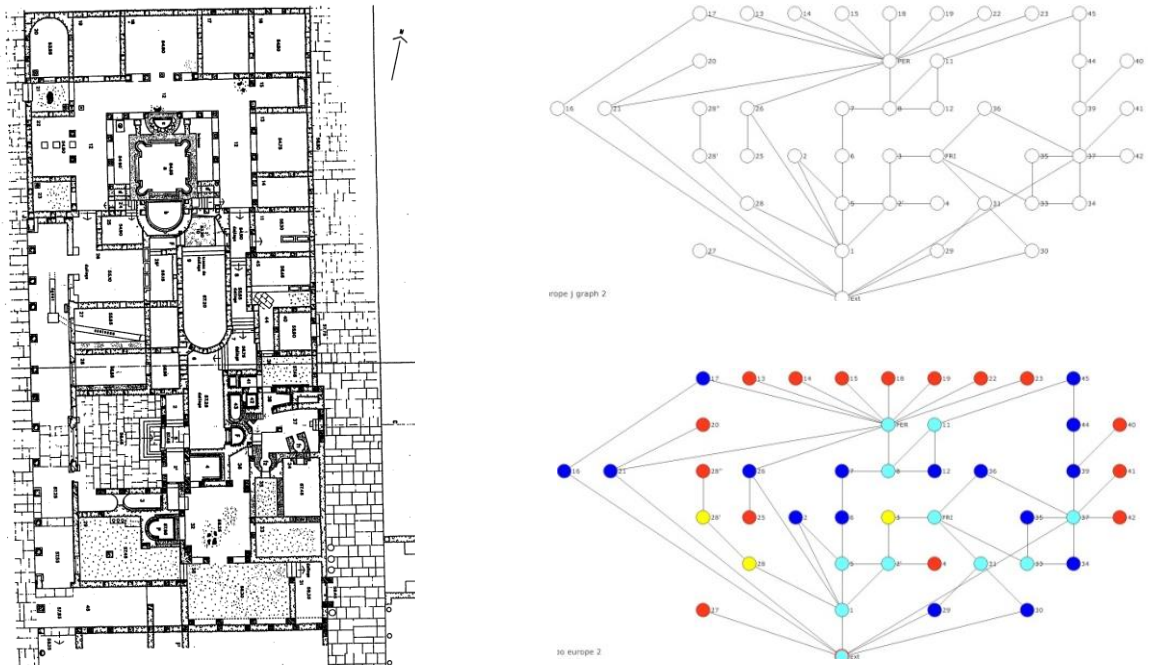
16	**(XV)**	106	3,31	0,14	6,7	0,08
17	**(XVIII)**	92	2,87	0,12	8,26	0,58
18	**(XVII)**	106	3,31	0,14	6,7	0,08
19	**(XIX)**	103	3,21	0,14	6,98	0,7
20	**(XX)**	106	3,31	0,14	6,7	0,08
21	**(XXI)**	106	3,31	0,14	6,7	0,08
22	**(XXII)**	94	2,93	0,12	8	0,91
23	**(XXIII)**	111	3,46	0,15	6,27	0,66
24	**(XXV)**	109	3,4	0,15	6,44	1,66
25	**(XXVI)**	140	4,37	0,21	4,59	0,33
26	**(XXVII)**	148	4,62	0,23	4,27	0,33
27	**(XXVIII)**	117	3,65	0,17	5,83	1,53
28	**(XXX)**	129	4,03	0,19	5,11	0,2
29	**(XXXI)**	129	4,03	0,19	5,11	0,2
30	**(XXXII)**	107	3,34	0,15	6,61	0,4
31	**(XXIX)**	98	3,06	0,13	7,51	3,33
32	**(XXIV)**	118	3,68	0,17	5,76	1,16
	Min	75	2,34	0,08	4,27	0,08
	Mean	**110,54**	**3,45**	**0,15**	**6,58**	**1**
	Max	14	4,62	0,23	11,53	9,83
	BDF=0,30					

16	**(XVIII)**	142	4,58	0,23	4,18	0,58
17	**(XVII)**	156	5,03	0,26	3,72	0,08
18	**(XIX)**	156	5,03	0,26	3,72	0,7
19	**(XX)**	156	5,03	0,26	3,72	0,08
20	**(XXI)**	156	5,03	0,26	3,72	0,08
21	**(XXII)**	144	4,64	0,24	4,11	0,91
22	**(XXIII)**	158	5,09	0,27	3,66	0,66
23	**(XXV)**	156	5,03	0,26	3,72	1,66
24	**(XXVI)**	184	5,93	0,32	3,03	0,33
25	**(XXVII)**	210	6,77	0,38	2,59	0,33
26	**(XXVIII)**	182	5,87	0,32	3,07	1,53
27	**(XXX)**	194	6,25	0,35	2,85	0,2
28	**(XXXI)**	194	6,25	0,35	2,85	0,2
29	**(XXXII)**	194	6,25	0,35	2,85	0,2
30	**(XXIX)**	166	5,35	0,29	3,44	3,83
31	**(XXIV)**	168	5,41	0,29	3,39	1,16
	Min	12	4,12	0,2	0,48	0
	Mean	**220,5**	**7,11**	**0,4**	**3,26**	**0,93**
	Max	99	32	2,06	4,79	9,83
	BDF=0,42					

By omitting the exterior, (Table 3) the system loses integration and appears more isolated, which attests of permeability of the house and its openness to public space and highlighting the residents / visitors interface.

5.4. The Europe House (maison d'Europe)

On the eastern edge of the Grand Cardo at the northern end of the city, the Europe house stands with its 1250m² of massive construction in several levels, its basements, its monumental facade, its vast thermal baths, its shops, its varied premises and winding corridors. To the north it opens onto a small decumanus, to the east on a secondary cardo separating it from the thermal baths of the capitol (Blanchard-lemé, 1975).



Source : Hewitt, 2000

1: courtyard, 2: niche, 3: airlock, 4: reservoir, 5: landing, 6: corridor, 7palier, 8: corridor, 9: apse room, per: peristyle, 11 and 12: utility rooms, 13, 15, 17, 22, 23, 25: rooms, 14: triclinium, 16: secondary entrance vestibule 18: œcus, 19: kitchen, 20: room annexed to the entrance, 21: secondary entrance vestibule, 26: open-air vestibule, 27, 28, 46: shops, 29: entrance vestibule of the thermal baths, 30 and 31 vestibule and secondary entrance courtyard of the thermal baths, fri: frigidarium, 33: tepidarium, 34: caldarium, 34 and 35 : fireplaces, 37: boiler room, 39, 45 and 40 rooms, 44, corridor

Figure 7 : The house of Europe, its justified graph and its topological types

The house presents a justified graph of the most complex (figure 7), with a distributed configuration (index = 0.66) counting 10 rings: 5 external including 3 important and 5 internal of trivial importance whose effect is very localized. With a majority of type c (35.5%) and d (24.44%) spaces, thus promoting free movement. The system can be entered by several accesses, but the most remarkable access is the one that leads to the courtyard (1). Two external rings converge towards a sequential series of spaces of type-c and -d starting with courtyard 1 passing through spaces 5, 6, 7, 8 until arriving at the peristyle which distributes several spaces of type-a therefore dead end spaces of an occupational nature including the œcus, presenting a symmetrical configuration at this depth level.

Two other outer rings are deployed to converge on the frigidarium which serves the entity reserved for the thermal baths kept very far from the domestic space, but stay connected with the transition spaces through the 5th outer ring. This access is very close to the thermal baths which open onto the two opposite streets.

If the domus has several accesses, each of them exercises a significant potential for control through the succession of type-c spaces. The difference between the BDF with and without exteriors is of the order of 0.16 which suggests that the domus is very permeable and is an integral part of the public space through the multitude of openings on the street, its shops and its thermal baths open to the public. The inequality genotype is revealed in the following order: exterior <courtyard <peristyle <vestibules <shops <thermal baths <private rooms. It shows, unlike other domus, that the exterior is the most integrated space compared to other spaces (Table 4)

Table 4: Results of justified graph analysis of Europe house calculated with and without exterior

	With exterior					
	space	TDn	MDn	RA	i	CV
0	**ext**	108	2,45	0,06	14,78	3,14
1	**1**	115	2,61	0,07	13,32	1,97
2	**28**	154	3,5	0,11	8,6	0,66
3	**28'**	195	4,43	0,15	6,26	1,5
4	**28''**	238	5,4	0,2	4,87	0,5
5	**27**	151	3,43	0,11	8,84	0,14
6	**21**	121	2,75	0,08	12,28	1,23
7	**20**	164	3,72	0,12	7,88	0,33
8	**2**	155	3,52	0,11	8,52	0,41
9	**26**	127	2,88	0,08	11,39	1,25
10	**25**	170	3,86	0,13	7,5	0,33
11	**5**	144	3,27	0,1	9,46	1,41
12	**2'**	145	3,29	0,1	9,36	1,91
13	**4**	188	4,27	0,15	6,56	0,25
14	**3**	167	3,79	0,13	7,69	0,5
15	**FRI**	175	3,97	0,13	7,22	1,66
16	**31**	174	3,95	0,13	7,27	1,25
17	**30**	145	3,29	0,1	9,36	0,47
18	**29**	145	3,29	0,1	9,36	0,47
19	**36**	161	3,65	0,12	8,08	0,39
20	**33**	190	4,31	0,15	6,47	1,25
21	**35**	165	3,75	0,12	7,81	0,47
22	**34**	165	3,75	0,12	7,81	0,47
23	**37**	127	2,88	0,08	11,39	3,97
24	**42**	170	3,86	0,13	7,5	0,14
25	**41**	170	3,86	0,13	7,5	0,14
26	**39**	158	3,59	0,12	8,29	1,64
27	**40**	201	4,56	0,16	6,02	0,33
28	**44**	182	4,13	0,14	6,85	0,83
29	**45**	190	4,31	0,15	6,47	0,83
30	**6**	167	3,79	0,13	7,69	0,75
31	**7**	173	3,93	0,13	7,33	0,75
32	**PER**	121	2,75	0,08	12,28	8,41
33	**23**	164	3,72	0,12	7,88	0,09
34	**22**	164	3,72	0,12	7,88	0,09
35	**19**	164	3,72	0,12	7,88	0,09
36	**18**	164	3,72	0,12	7,88	0,09
37	**15**	164	3,72	0,12	7,88	0,09
38	**14**	164	3,72	0,12	7,88	0,09
39	**13**	164	3,72	0,12	7,88	0,09
40	**17**	147	3,34	0,1	9,18	0,59
41	**16**	137	3,11	0,09	10,17	0,64
42	**12**	187	4,25	0,15	6,61	0,58
43	**8**	149	3,38	0,11	9	1,42
44	**11**	175	3,97	0,13	7,22	1,25

	Without exterior					
	space	TDn	MDn	RA	i	CV
0	**1**	189	4,39	0,16	6,18	1,83
1	**28**	226	5,25	0,2	4,93	0,7
2	**28'**	265	6,16	0,24	4,06	1,5
3	**28''**	306	7,11	0,29	3,43	0,5
4	**27**	1892	44	2,04		0
5	**21**	229	5,32	0,2	4,85	1,09
6	**20**	270	6,27	0,25	3,97	0,5
7	**2**	227	5,27	0,2	4,9	0,45
8	**26**	191	4,44	0,16	6,1	1,29
9	**25**	232	5,39	0,2	4,77	0,33
10	**5**	204	4,74	0,17	5,6	1,45
11	**2'**	196	4,55	0,16	5,9	1,95
12	**4**	237	5,51	0,21	4,65	0,25
13	**3**	208	4,83	0,18	5,47	0,5
14	**FRI**	220	5,11	0,19	5,1	1,66
15	**31**	257	5,97	0,23	4,21	2,25
16	**30**	298	6,93	0,28	3,54	0,33
17	**29**	298	6,93	0,28	3,54	0,33
18	**36**	240	5,58	0,21	4,58	0,41
19	**33**	248	5,76	0,22	4,4	1,25
20	**35**	268	6,23	0,24	4,01	0,5
21	**34**	268	6,23	0,24	4,01	0,5
22	**37**	245	5,69	0,22	4,47	3,83
23	**42**	286	6,65	0,26	3,71	0,16
24	**41**	286	6,65	0,26	3,71	0,16
25	**39**	245	5,69	0,22	4,47	1,66
26	**40**	286	6,65	0,26	3,71	0,33
27	**44**	240	5,58	0,21	4,58	0,83
28	**45**	229	5,32	0,2	4,85	0,83
29	**6**	219	5,09	0,19	5,13	0,75
30	**7**	217	5,04	0,19	5,18	0,75
31	**PER**	190	4,41	0,16	6,14	8,58
32	**23**	231	5,37	0,2	4,8	0,09
33	**22**	231	5,37	0,2	4,8	0,09
34	**19**	231	5,37	0,2	4,8	0,09
35	**18**	231	5,37	0,2	4,8	0,09
36	**15**	231	5,37	0,2	4,8	0,09
37	**14**	231	5,37	0,2	4,8	0,09
38	**13**	231	5,37	0,2	4,8	0,09
39	**17**	229	5,32	0,2	4,85	1,09
40	**16**	270	6,27	0,25	3,97	0,5
41	**12**	232	5,39	0,2	4,77	0,58
42	**8**	203	4,72	0,17	5,64	1,42
43	**11**	217	5,04	0,19	5,18	1,25

Min	10	2,45	0,06	4,87	0,09
Mean	**161,42**	**3,66**	**0,12**	**8,43**	**1**
Max	23	5,4	0,2	14,78	8,41

BDF=0,25

Min	18	4,39	0,16	0,48	0
Mean	**276,81**	**6,43**	**0,25**	**4,61**	**0,97**
Max	18	44	2,04	6,18	8,58

BDF=0,41

6. DISCUSSION

According to the cells arrangement observed on the justified graphs, the domus, apart from the Amphitrite house whose graph is symmetrical bushy undistributed, present annular planes whose complexity depends on the number of rings and cells that compose them.

The Amphitrite house is an example of the basic house: It is an impermeable bushy structure showing some segregation of the overall system from the outside (integration value of the whole system from the outside of 0, 30) and whose cells are moderately connected to each other (a mean integration of 0.23) establishing a precise demarcation between the interior domain and the exterior world. This configuration refers directly to the sphere of relations between residents (Hanson, 1998).

With a single external ring, the Donkey house timidly opens to the outside with certain permeability (value of integration of the global system from the outside of 0.2) and whose cells are less connected to each other (mean integration of 0.3). Ring configuration (annularity) is less influential with a distributivity index of 1.43 but strongly asymmetric with a lowest index (0.88): the more the symmetry index of a building tends to approach 0, the more the movements within it tend to be part of well-defined and potentially more predictable traffic networks (Letesson, 2009).

External annularity can be considered as a powerful interpretive vector of the relations between residents and visitors, and according to Hillier and Hanson (1984) the cell located in the deepest part of the external ring in relation to the carrier is often the most important in terms of mediating the relationship between the interior and the exterior world, this is the case of room IX of the Donkey house which serves the two reception spaces: the œcus and the triclinium which overlooks a sumptuous peristyle. This external annularity is more pronounced at the level of Europe house and to a lesser degree at the level of the house of Castorius. It is essential to remember that a ringy system can globally have two essential functions: it can offer various choices of movement to the people evolving there but is also used in order to register within the frame the different circulation models of the different groups of users (residents and visitors) (Hanson, 1998).

The Europe house is marked by the joint existence of a multitude of external and internal rings due to the fact that the building has an elaborate configuration. Its distributivity index (0.66) is the lowest attesting to the impact that annularity has on this building, its symmetry index is 1.36, a value low enough to qualify the asymmetric configuration: the cells which compose it tend to follow one another in linear sequences of spaces of type-c and -b with a proportion exceeding 42% to the detriment of spaces of type-a and -d. This is a structure with pronounced permeability (value of integration of the global system from the outside of 0.15) but attenuated by the sequencing of spaces and in which the cells are strongly connected to each other (mean integration of 0,19). The Castorius house has a ringy plan of substantial importance (index of 1.2); but is relatively symmetrical (5.6) just like the house of Amphitrite (asymmetry index = 5), the movement options are more numerous and clearer. It is a structure with pronounced permeability (integration value of the whole system from the outside of 0.19) and whose cells are strongly connected to each other (mean integration of 0.17).

Three main components of the domus studied: the transition spaces (vestibule, peristyle, corridor and atrium) which structure the private spaces and the thermal baths. From a syntactic point of view, various clues allow us to understand the scope of the transition spaces within a building. The first and most basic relates to topological types. Thus, a simple visual examination of the justified plans can make it possible to appreciate the way a transitional space contributes to structure the internal layout of a building. Finally, the control value provides a valuable clue about the impact of transition spaces. A transition space displaying a high control value therefore has a strong impact on local circulation, that is to say the movements which are directly linked to it. The very nature of a transitional space is on the one hand it can be a vector of accessibility and help to set up a spatial connection, on the other it has the potential to divide the space, separating activities and / or people. In all cases, the presence of transition spaces betrays the existence of a certain elaboration in terms of articulation of the cells of a building, and whatever the cause, highlighting the care with which the Afro-Romans designed the circulations within their buildings, creating complex models of potential movements. Although this

complexity has often been attributed to a wish making a building simultaneously usable by various categories of people.

Almost all houses have a vestibule to accessing the interior. Its main function is to form a clear boundary with the exterior. Generating asymmetry, this transitional space probably helped to isolate certain activities from each other without blocking all communication between them. The existence of the entrance vestibule contributes to increasing the segregation of the overall system from the outside. If it is followed by one of the best integrated spaces, in this case the peristyle, this illustrates its role as a control interface between the outside world and the internal domain (Amphitrite house). The impact of a vestibule within an external or complex ring plane is less significant on the scale of the building as a whole (the Castorius and Europe houses). However, if we only take into consideration the entrance to which it is associated, it is obvious that it adds a level of depth to the access graph and so increases the segregation of the building since the entrance in question (Donkey house).

When associated with a porter's lodge, this clearly illustrates a concern to be able to guard against unwanted intrusions and refers, as regards most of the halls, to the concept of trans-spatial solidarity: This device may have contributed to accentuating the limit between exterior and interior.

The internal corridor forms a boundary zone between different cells and ensures efficient communications between them.

As for the peristyle or atrium, it structures the domestic space which is composed of the œcus and private rooms whose configuration is always symmetrical and appearing from the second depth point (Amphitrite) to the 6th depth point (Europe).

Transition spaces structured parts of building. Obviously, the more a building presents transition spaces with a high control value, the more its internal layout is structured by them.

Another very important sector is essential in the Roman-African domus, it is the thermal baths sector. From a syntactic point of view, these are reclusive spaces with pronounced segregation. They are connected to the system through the frigidarium from which an internal effect ring is deployed, sanctioning well-defined circulations. They are isolated from the outside since their functionality is residential except in the case of the Europe House where they are open to the outside, they must probably accommodate foreigners. The houses of the rich notables have thermal baths for slaves.

These few remarks illustrate in particular the degree of complexity with which Romano-African architects often declined transitional spaces, sometimes to isolate particular rooms, sometimes to establish efficient communication between different cells, sometimes to offer alternative circulation.

It is quite revealing that the transition area is also the area best integrated across the building. It therefore forms not only the transition between the exterior and the interior but also, and above all, the mandatory transition between the other three sectors, which are well differentiated from each other.

7. CONCLUSION

The analysis of the space syntax has helped us to make a new reading of the architectural configuration of the archaeological space, fleshed out by reflections on the use of the built by the practices of occupation and movement.

Two spaces seem to structure the Romano-African domestic space:

- the entrance vestibule, which is often located on an external ring, is in a dominant position facing the exterior, serving as the main interface between the internal domain and the exterior of the building.
- the peristyle as a pole of convergence acts as the point of intersection of several internal and external rings and provided with subordinate spaces in a marked symmetrical relationship presenting itself as the internal gathering place.

These spaces, by marking out the circulatory movement inside the domus, help to increase the control of the internal domain over the external sphere. if the house is permeable by the presence of several accesses or openings to the outside, the preservation of the intimate private space was cleverly controlled and marked out by the sequencing which increases the depth of the space and to structure the activities more clearly and categories of persons associated with it in this case the female and male genders, residents and foreigners and finally slaves.

The spatial configuration of the domestic space of the domus seems to show three distinct spatial categories and territorial types : the intimate activities linked to the person by the presence of type-a spaces of an occupational nature, the residents / residents interface and the link between residents within the house through the presence of type-b or -c spaces such as the peristyle and the residents / foreigners interface through the permeability of the house and its link audience with the outside world.

The domus is structured by the introduction of a multitude of transitional spaces which had two major effects. On the one hand, they help to create a hierarchy from the outside world to the interior of the building. On the other hand, they induce movement and create circulation alternatives and often help to separate unrelated function areas and areas dedicated to a specific function from each other.

The concern was to decode the spatial framework in order to understand the social organization of the archaeological space buried underground because it was one day and at a certain time the theater of a series of activities forming part of sequences of movements and particular spatial circumstances.

AUTHOR CONTRIBUTIONS

Conceptualization: Abida Hamouda and Lamia Benyahia; Methodology: Abida Hamouda; software: Abida Hamouda; validation: Abida Hamouda, Lamia Benyahia and Nafaa Brinis; formal analysis: Abida Hamouda; investigation: Abida Hamouda; resources: Abida Hamouda, Lamia Benyahia and Nafaa Brinis; data curation: Abida Hamouda; writing—original draft preparation: Abida Hamouda; writing— review and editing: Abida Hamouda; visualization: Abida Hamouda; supervision: Abida Hamouda; project administration: Abida Hamouda; funding acquisition: Lamia Benyahia. All authors have read and agreed to the published version of the manuscript.

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REFERENCES

Allais Y. (1971) Le quartier occidental de Djemila (Cuicul). *Antiquités africaines*, No.5. pp.95-120; doi: https://doi.org/10.3406/antaf.1971.921.

Ammari, A. and Remini B. (2019) L'eau dans les villes romaines – quelques cas algériens. *Larhyss journal*, No.37, pp.129-149.

Arfaoui, W. (2019). Application of space syntax to the study of the housing in the Phoenician Punic era. *Proceedings of 12th International Space Syntax Symposium:* Beijing, China.

Assassi, A. and Mebarki, A. (2021) Spatial configuration analysis via digital tools of the archeological roman town Timgad, Algeria. *Mediterranean Archaeology and Archaeometry* Vol. 21, No 1, pp. 117-130.

Bellal, T. (2007). Spatial interface between inhabitants and visitors in m'zab houses. *The 6th international space syntax symposium,* Istambul, Turkey, pp 61.1-61.13.

Besse, J. M. (2003) Le paysage, entre le politique et le vernaculaire. Reflexions à partir de John Brinckerho Jackson. *ARCHES*, *Association Roumaine des Chercheurs Francophones en Sciences Humaines*, vol. 6, pp.9-27.

Blanchard-Lemé M. (1975) *Maisons à mosaïques du quartier central de Djemila (Cuicul).* Paris, Centre National de la Recherche Scientifique. pp.3-260. (Études d'antiquité africaines); https://www.persee.fr/doc/etaf_0768-2352_1975_mon_3_1.

Boswinkel, Y. (2014), Identifying houses; A case-study from archaeological survey. *Theoritical approach to ancient housing, Graduate School workshop* April 24 / 25, pp51-55 The Netherlands Printed by Sidestone Press, Leiden.

Braemer F. (1995) Habitat et architecture domestique dans le levant des âges des métaux. Quelques orientations de la recherche des dix dernières années. *Topoi*, vol. 5, No.1, pp. 89-110; doi : https://doi.org/10.3406/topoi.1995.1559

Chétima, M. (2016), Une maison n'est pas seulement un abri ; une maison est aussi un humain. *Anthropologica. Canadian Journal of Anthropology,* Vol. 58, No 11, pp.106-120.

Cultraro, M. (2007), Domestic architecture and public space in Early Bronze Age Poliochni (Lemnos*). British School at Athens Studies,* Vol. 15, Building Communities: House, Settlement and Society in the Aegean and Beyond (2007), pp. 55-64 https://www.jstor.org/stable/40960574.

Dawson, P. C. (2002). Space syntax analysis of central Inuit snow houses. *Journal of Anthropological Archaeology* No.21, pp 464–480.

Driessen, J. and Farnoux, A. (2012) A house model from Malia. Studies in honour of V. *Larosa Catania* 2012, p. 299-310

Driessen, J. Fiasse, H. Devolder, M. Haciguzeller, P. and Letesson, Q. (2008) Recherches spatiales au Quartier Nu à Malia (MR III). *Creta Antica* Vol.9, pp.93- 110.

Driessen, J. (2007) Spirit of place : minoan houses as major actors. *Langford Conference : Daniel J. Pullen, Political Economies of the Aegean Bronze Age*, 2010, Talahassee, February 2007). pp. 35-65 http://hdl.handle.net/2078.1/83026

Dupre-Moretti, E. (2019). Contribution à l'histoire rurale des pyrénées basques : en pays de cize, anthropisation et dynamique spatiale des environnements humains sur le massif d'urkulu-orion (saint-michel, basse-navarre, iparralde), le quartier d'etxolak de peko elurzaro. *IKUSKA. Nouvelle collection* – 2nd term. N° 42.

Durgun Şahin, Y. Gülşen, F. and Altunkasa, F. (2021) Computer applications and quantitative methods in archaeology: The case of Anazarbos, *Scientific Culture*, Vol. 7, N° 1, pp. 79-91, DOI: 10.5281/zenodo.4261746

Duval, N. (1995) *Djémila*, Encyclopédie berbère [on line], 16, document D69, posted on june 01 2011, consulted on september 25 2020. URL : http://journals.openedition.org/encyclopedieberbere/2185

Eeckhout, P. (2013), Dans les pas des incas. Architecture précolombienne et syntaxe de l'espace. *CLARA* Vol.1, N°1 | pp.61-79, Éditions de la Faculté d'Architecture La Cambre Horta. Mis en ligne sur Cairn.info le 03/06/2018, https://doi.org/10.3917/clara.001.0061.

Ennabli, A. (2000) L'art romain en Afrique du nord. Son avenir. *La revue du patrimoine mondial* No. 16 Septembre 2000, pp.18-29 http://whc.unesco.org/fr/revue

Fevrier P.A, Blanchard-lemé M. (2019) *L'édifice appelé « Maison de Bacchus » à Djemila*. Paris, CNRS, Études d'antiquités africaines, 235p

Grahame M. (2014), Reading Space: Social Interaction and Identity in the Houses of Roman Pompeii. *British Archaeological Reports*. 205 p

Guilhembet, J. P. (2007) Résidences urbaines et différenciation sociale : à propos de quelques publications récentes", *Sources historiques, sources archéologiques : apports réciproques ,* Collège de France, 3/5/2007, URL : http://www.college-de-france.fr/media/john-scheid/UPL40663_UPL48487_S_minaire.pdf

Hamouda, A. (2018) Syntaxe spatiale comme outil d'analyse de l'espace architectural. *International Journal of Innovative Technical and Applied Sciences* Vol 2. No.1), pp. 022–030

Hanson, J. (1998) *Decoding Homes and Houses*. Cambridge University Press, Cambridge

Hewitt S. (2000), *The urban domestic baths of roman Africa*, Doctorat Thesis, Mc master university Hamilton Ontario USA, 420p.

Hillier B., Penn A., Hanson J., Grajewski T. and Xu J. (1993) Natural movement : or, configuration and attraction in urban pedestrian movement. *Environment & Planning B, Planning & Design*, No. 20, pp.29-66.

Hillier, B. (2007*), Space is the machine: A configurational theory of architecture*. Electronic edition published by: Space Syntax, London E1 5LN, United Kingdom, www.spacesyntax.com.

Hillier, B. and Hanson, J. (1984) *The social logic of space*, Cambridge university press, UK.

Hillier, B. Hanson, J. and Graham, H. (1987) Ideas are in things: an application of the space syntax method to discovering house genotypes. *Environment and Planing B: Planing and Design*, Vol. 14, pp.363-385.

Huemer, M. (2021), *The Punic House in Context: Domestic Architecture and Urban Planning in the Central Mediterranean.* Dissertation submitted to the faculty of the Graduate School of the University at Buffalo, The State University of New York in partial fulfillment of the requirements for the degree of Doctor of Philosophy Department of Classics

Kent, S. (1990) A Cross-Cultural Study of Segmentation, Architecture, and the Use of Space. *Domestic Architecture and the Use of Space: An Interdisciplinary Cross- Cultural Study*, edited by S. Kent, pp.127–152. New Directions in Archaeology. Cambridge: Cambridge University Press.

Lafon, X. (2001) *Villa Maritima : recherches sur les villas littorales de l'Italie romaine*. Rome, Bibliothèque des Ecoles francaises d'Athènes et de Rome, 307p.

Lamare, N. (2016) Architecture et motif littéraire de la fontaine, Orient-Occident. *Parure monumentale et paysage dans la poésie épigraphique de l'Afrique romaine*. Recueil de carmina latina epigraphica, Ausonius, pp.263-273.

Manum, B. (1999). Spatial themes among the traditional houses of Turkey. *Proceedings of the second International Space Syntax Symposium,* Brasilia, Vol. 1, pp.40.1-40.12.

Morvillez, É. (2004) L'architecture domestique à Antioche dans l'Antiquité tardive : conservatisme ou modernité ?. *Topoi. Orient Occident*. Supplément 5. Antioche de Syrie. Histoires, images et traces de la ville antique; https://www.persee.fr/doc/topoi_1764-0733_2004_act_5_1_2901

Mustafa, F. A., Hassan, A. S. and Baper, S. Y. (2010) Using space syntax analysis in detecting privacy: a comparative study of traditional and modern house layouts in Erbil city, Iraq. *Asian Social Science* vol.6 No.8. pp.157-166 DOI:10.5539/ass.v6n8p157

Nevett, L. 2007, Greek houses as a source of evidence for social relations. *British School at Athens Studies* Vol. 15, BUILDING COMMUNITIES: House, Settlement and Society in the Aegean and Beyond, pp. 5-10. https://www.jstor.org/stable/40960568

Rapoport, A. (1972), *Pour une anthropologie de la maison*, Paris, Dunod.

Rebuffat, R. (1980) Cuicul. *Antiquités africaines*, No.15 pp. 309-328; doi : https://doi.org/10.3406/antaf.1980.1051 https://www.persee.fr/doc/antaf_0066-4871_1980_num_15_1_1051

Stöger, H. (2014). The spatial signature of an Insula neighbourhood of Roman Ostia. *Spatial analysis and social spaces* (pp. 297-316). In E. Paliou, U. Lieberwirth & S. Polla (Ed.), Berlin, Boston: De Gruyter. https://doi.org/10.1515/9783110266436.297

Stöger, H. (2015), Roman neighbourhoods by the numbers: A space syntax view on ancient city quarters and their social life. *The Journal of Space Syntax*, Vol. 6, No. 1 Online Publication Date: 26 October 2015 http://joss.bartlett.ucl.ac.uk/

Sweetman R. J. (2011) Domus, Villa, and Farmstead: The Globalization of Crete, ΣΤΕΓΑ: The Archaeology of Houses and Households in Ancient Crete. *The American School of Classical Studies at Athens*. DOI: https://doi.org/10.4000/encyclopedieberbere.2185.

Thébert, Y. (1985) Vie privée et architecture domestique en Afrique romaine. *Paul VEYNE*, pp. 301-398.

Twaissi, S. (2017) The source of inspiration of the plan of the nabataean mansion at Az-Zantur IV in Petra: a space syntax approach. *Mediterranean Archaeology and Archaeometry*, Vol. 17, No 3, pp. 97-119.

Van Nes, A. (2009) Measuring the degree of street vitality in excavated towns: How can macro and micro spatial analyses tools contribute to understandings on the spatial organization of urban life in Pompeii? *Proceedings of the 7th International Space Syntax Symposium,* Stockholm, Sweden, June 8-10, 2009. Eds.: Koch, D., Marcus, L., Steen, J. Trita-ARK. Forskningspublikationer, 2009:1 http://resolver.tudelft.nl/uuid:e5a67714-8ec2-4075-ada4-a9f097953b7e

Von Hesberg, H. and Lipps, J. (2013) L'architecture romaine, évolution d'un champ d'études depuis les années 1950, *Perspective* [on line], 2 | 2010, posted on august 13 2013, consulted on October 01 2020. DOI : https://doi.org/10.4000/ perspective.1098.

Wallace-Hadrill, A. (1988) The Social Structure of the Roman House, *Papers of the British School at Rome*, No.56, pp. 43-97.