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The water management in an ancient Greek-Roman city (I): An example in the north-east of Spain

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Summary. The city of Empúries (Girona, Spain) is a mirror, with all its achievements and all that it lacks, where we can see how the hydraulic structures in the ancient city work. From an archaeological approach, all the water related aspects of the city have been drawn together in one global perspective. This means that in some respects the work has been innovative: an interest in a city that does not have an aqueduct the same global perspective, and accurate and detailed treatment of all the aspect of the city, including the most modest.

Keywords. Management water – Hydraulic structures – Ancient city – Empúries.

La gestion de l'eau dans une ancienne ville grècque romaine (I): un exemple du nord-est de l'Espagne

Résumé. La cité d'Empúries (Girona, Espagne) est un miroir - avec ses réalisations et ses absences, où nous pouvons observer le fonctionnement des structures hydrauliques d'une cité antique. D'un point de vue archéologique, le travail décrit tous les aspects hydriques d'une cité dans une perspective globale. Ce qui veut dire, d'une certaine façon, que ce travail est innovant : pour l'intérêt porté à une Cité qui ne dispose pas d'aqueduc et par un traitement précis et détaillé de tous les aspects de cette Cité - en incluant les plus modestes.

Mots-clés. Gestion de l'eau – Structures hydrauliques – Cité ancienne – Empúries.

I – Introduction

Even though Empúries (Girona, Spain) is an ancient city which has been under investigation since the beginning of this century, and even though the importance of the remains of the hydraulic structures had attracted the attention of numerous investigators and information about them appears in many publications.

The city of Empúries is a mirror, with all its achievements and all that it lacks, where we can see how the hydraulic structures in the ancient city work. For this reason, the study stems from the wish to carry out a global study, which looks at not only the water supply to the city, but also its distribution and use (Burés, 1998).

This focus has not been easy because the present state of investigation into themes related to the water in the city has developed along other paths. Traditionally these have been from three different points of view: from that of hydraulic engineering, that of the study of the fountains and from the archaeological point of view. However, in all these fields the favourite object of study, and ever has had the mass of studies about water done on it, has been almost exclusively the aqueducts.

This does not mean that, especially over the last few years, there has not been any interest in the other aspects of water usage, but that up till now they have been secondary to the general surroundings. Some authors (Crouch, 1993) have defended the need to understand the city as a relationship of systems, within which the water system plays an essential part. This is the

theoretical framework for this study. From an archaeological approach, all the water related aspects of the city have been drawn together in one global perspective. This means that in some respects the work has been innovative: an interest in a city that does not have an aqueduct the same global perspective, and accurate and detailed treatment of all the aspect of the city, including the most modest.

II – The choice of the settlement and the supply

To start with the analysis of the relationship between the city and water, the first aspect in which water played an important role was the choice of the settlement. Traditionally other aspects were valued, maybe taking for granted the importance for this element. A whole series of elements related to the characteristics of the Phocaea emporia have been considered: Its easy defense, its access to the commercial routes normally by means of a river and in the case of Empúries the protection afforded to it by the Gulf of Roses before reaching the fearful Gulf of Leon.

From the analysis of the need for water, working along the Greek colonies of the Magna Graecia one is able to discover that many of these great cities, like those of Greece itself, were built in areas of karstic characteristics (Crouch, 1993). Crouch, who brought this coincidence to light, believes that it was not a coincidence at all but totally premeditated. The Greeks in their colonies would seek out karstic locations, easily recognizable as they have very pronounced characteristics, and in which they were quite sure of the presence of water and the way of extracting it.

Thus, it is revealing that Empúries is situated in one of the karstic areas of the coast, fighting in with this conditioning feature of the Greek cities. The characteristics of the land without doubt would have been very important when choosing the place for the settlement, not so much for the future of the city, but to ensure that the initial needs of the city were catered for right from the beginning, as a water supply based on cisterns, a technique which they already knew, would take a time to get working. This choice of the appropriate land required some previous knowledge about land before developing the settlement.

III – Cisterns, wells, fountains and aqueducts

Once the settlement was installed, as it grew and developed, the main concern would still be the supply. This could be resolved in many different ways which can be divided into two main groups: structures which take advantage of rainwater and those which make use of underground water.

In the first group we find exclusively the cisterns (i). This type of structure has been widely documented all over the Mediterranean, but we would like to make a few points. In the first place we must differentiate between cisterns or pools. A cistern is always covered and is under the ground, whilst in the other cases the water is in the open air. This means that the water in the cisterns does not evaporate and it remains at a cool temperature and is not submitted to the exterior changes of temperature. In this way we can appreciate a special concern with its treatment showing us one of its possible uses. Despite the fact, according the classical texts, the Romans and the Greeks preferred running water for drinking and they distrusted stagnant water, they accepted the use of water cisterns for human consumption.

From the analysis of these cisterns one of the most surprising aspects is the great difference between the Greek and the Roman cities, which affects many of the aspects of their characteristics. In any case, the cisterns of Empúries have a series of general characteristics in common which affect the most basic elements. There is no documentation of any large tank (which could be called a reservoir) and all the structures which have been documented are strictly cisterns, all of them underground and all of them covered. Another of the most distinguishing features is the way

in which most of them are built, often painstakingly, rather than a small group of simply excavated cisterns.

The differences are abundant. The general features of cisterns in the Neapolis (the Greek city) are the use of mainly sandstone and their elliptical shape. Two strongly related characteristics, to the point that there is no mention of any elliptical cistern made of calcareous stone in the Greek city, they are all made of sandstone. The other distinctive features are the abundance of cisterns with a flat lid, the massive use of a type of preparation (known as Tp 5) which is characterized by not giving any visible intrusion in a macroscopic analysis, neither pottery nor ashes, and finally the presence of different systems used to improve the adherence of the lining.

In contrast, the establishing of the building characteristics of the cisterns in the Roman city is not easy due to a large number of undetermined factors. As such it would be more correct to talk about the tendencies that seem to be indicated by the available data. In any case, we can observe features which are very different from those present in the Greek city. Thus, in the Roman city we can document a clear preponderance of the use of calcareous stone, but also, one of the defining features is its diversity, as there are other cisterns which are documented as having been cut straight from the rock face. With regard to the shape, there are as many rectangular cisterns as there are elliptical ones. There are also others, as in the case of the use of different types of stone. The other factor, the type of lid used, is determined by the total mastery of vaulted lids, the flat lid being almost totally absent. In fact it is not demonstrated, but they could only have used it to cover the cisterns of the *praesidium*. With reference to the linings there is no documentation in the Roman city about any of the preparations of the group that was most abundant in the Greek city, and there is only mention of the systems which improved the adherence of the lining.

In the Greek area the first cisterns that are dated to the 4th century BC, are cut directly into the rock and are bottle shaped. They can be found in many settlements in Greece itself, for example in Athens (Camp, 1977), in Asia Minor, for example Pergamum (Brinker, 1990), and in Magna Graecia, for example Syracuse. This shape seems to have been used in the early days of the settlement at Carthage (Vann, 1981). In Empúries there are no cisterns with this shape documented, although we cannot completely rule out their use as we do not have information about the urban areas that were occupied during the early days of the city.

After the bottle-shaped cisterns, during the 3rd and 2nd centuries BC, the cisterns in the Mediterranean area take on two main shapes; elliptical cisterns and rectangular ones. With the regard to the elliptical ones, when we refer to them we are talking about some common characteristics, they are very long and narrow, built with a flat cover. This type has been documented in the north of Africa in cities such as Carthage (Lancel, 1982), Berenice (Lloyd *et al.*, 1981), Sabratha (Kenrick, 1986) or Utica (Lezine, 1986) amongst others, and its use also extends to all the areas with Carthaginian influence: to Sardinia in cities such as Tarros (Acquaro, 1981), Nora (Chiera, 1978), to Sicily in Mozia for example (Brancoli *et al.*, 1967). In addition, this type of cistern is found in abundance in the south of the peninsula in sites such as Cerro de la Cruz (Vaquerizo, 1985), Lacipo (Puertas, 1982), Castulo (Blazquez *et al.*, 1984) amongst others. The northern boundary is the area of influence of Empúries, a Greek city, is found within this group of Punic settlements or those with a Punic influence.

On the other hand, Empúries also used other resources to improve its water supply, to be precise, the use of underground water (ii). Nevertheless, in order to analyse the role that this resource played in the development of the city, first of all we have to look at the possibilities of the areas. As we have already mentioned, the city of Empúries is in a coastal karstic area which is characterized by the presence of underground water which develop as the calcium carbon dissolves. This aquifer that covers the whole of the area of the Montgrí is not very large and is easily intruded upon by sea water. Near Empúries we also find the aquifer of the delta of the Rivers Fluvia and Muga, which is very abundant and which probably covered the whole of the area which in past times were marshes.

The underground water could be used in different ways; wells, fountains and aqueducts, each of which had its own set of problems. First of all it is noteworthy that there are only nine wells at Empúries. To understand why there are so few we cannot blame their depth as the majority around 9 or 10 meters deep, which is not an excessive distance if we take into consideration the 90 meters which were documented in some examples of the Mediterranean of a similar age. Thus the only explanation would seem to be that either there was not enough water or that the quality was not very good. These two characteristics were able to be contrasted when well 101 was excavated and also using data available about the aquifer of Montgrí.

The wells are not a vital element in the Emporitan water supply, as the great majority of the private structures did not have them and the only one with public access that is documented, is in the agora. Thus wells must have been just a backup in places where they required a lot of water: the public baths, the *Asklepeion* and the very well documented industries such as the metallurgist ones.

As mentioned above, another resource that can be used to supply water to a city is fountains: as it could refer to natural waterspouts or to fountains as a built structure.

As far as the first definition is concerned these fountains constitute a place where underground water spurts to the surface and it occurs when an impermeable layer begins to show and allows water from an underground layer to pass through.

The other use of the word fountain is that of a built structure, which may or may not be related to a place where water springs naturally. In the Greek era two types of structures are documented, a simple type with a small quadrangular deposit and another more complex type which tend to become monuments as centuries go by. Both types can provide water which is transported by means of aqueducts. This system is the one which we know in Roman cities such as Pompeii or Cordoba in the Iberian Peninsula.

Finally, within the group of resources that make use of underground water, we can include aqueducts, because although not exclusively, they tend to use water from fountains as their supply. In this case, to date, no element that allows us to talk about the existence of this type of neither structure nor about material remains or about the organizational system of the water supply that this would require has been documented.

IV – The water from rivers

The last element that is left as usable for the water supply is the water from rivers. Empúries is flanked by the mouths of two rivers, the Ter to the south and the Fluvià to the north. All the sources show us that in ancient times the Greeks were not very keen on using water from rivers for their consumption, especially if they were in the final part of the river course as often, and is the case in Empúries, they flow into the sea going through a marshy area and quickly become salty.

V – The water supply

The main problem with a system based on cisterns is the question of water balance, in other words up to which point the water stored was sufficient to serve the whole population of the city. To carry out these calculations we need to know different data about the city; the total capacity of water storage, the size of the city, details of the rainfall and the number of inhabitants. This element, which is to date the most difficult to calculate, could be considered the unknown dimension of the equation, as if we were to know the other details we could work out how many people the water system of the city could support. The last detail that we need in order to be able to do the calculations is to decide between the data offered by researches and specialists on the daily water necessities for one person. Although if we decide on the number of people who lived in the

city, we will also obtain the quantity of water to which they had access, according to the natural resources of the area and the provisions made for its storage.

There are different elements which are noteworthy in the analysis of the water supply to the Neapolis. In the first place, we are looking at a small city with few inhabitants where, without using the resources to their limit, a maximum of about 500 people could have lived, based on the surface that has been excavated to date. Secondly, we can also see a clear relationship between the size of the houses and the capacity of the cistern from which we have found a relationship with the inhabitants. Thirdly, another notable element is the fact that despite having found many cisterns there is no great density of them, as for example documented in Byrsa quarter (Lancel, 1982) or in the *insula* 3 of the Roman city, places where everything would seem to point to having been houses of two storeys. Thus, based on their hydraulic resources we cannot say that in the Greek city there were two storeys as a generalization. Finally we have to mention the importance of the public element in the sustenance of the city. A good number of inhabitants, especially those who lived in the more modest homes, counted exclusively on the public water supply for their subsistence.

The Roman city is a completely different case, first of all because we do not have the same elements to be able to make calculations with as we did in the Greek city and therefore it is very risk to draw conclusions. In the group of the domestic structures we can differentiate between the great *domus* and the area of the *insula* 3 where the dwellings there more modest. Unlike the Greek city the areas with the highest density of cisterns are not richer ones but the more humble ones. Both in their dimensions and in the number of cisterns, as well as in the total quantity of water that could be stored, they are much higher than in the Greek city. Thus the relationship established between the quantity of usable water and the capacity of the cisterns changes from that of the Neapolis, going from being filled 4 times a year to between 3 in the highest case and 5 in the *insula* 3.

The explanations for this phenomenon may be diverse. Firstly, the reason could be in the absence of wells, the lack of this element of support obliges the city to rely exclusively on the cisterns and therefore they insure their viability by increasing the number of them. Another explanation, particularly bearing in mind the *insula* 3, is that in the Roman city there may have been a change in the public interest in the water supply and it may have been left exclusively in the hands of the private sector, because in the area of the forum the only documented cisterns are the big ones of the old *praesidium*. A final possible explanation could be the better building techniques used for the construction of the Roman city meaning that it was easier to increase the capacity of the cisterns and as such to improve the relationship between the surface and the capacity. In any case with the information that we have it is not possible to define which idea is the strongest, although probably all of them would lead in the same direction.

VI – The distribution of water

Another aspect of the management of the water in the entire ancient city is its distribution. In this section we will talk about three aspects: the conduits, the supply and the drains. As far as the conduits are concerned, they represent the element by means of which the distribution took place.

When we talk about conduits we must differentiate between conduits and pipes. The typology of each is very different and in Empúries we can find a large sample of different materials and building techniques used. The most notable as far as the pipes are concerned is the documentation of especially made pottery pipes, of pipes taking advantage of amphorae and of the well known lead pipes. As far as the conduits are concerned the variety of sizes, techniques and materials used is great, even though they mainly used stone rather than other material such as pottery or mortar. The use of plenty of sandstone is also notable, in keeping with the other hydraulic structures.

As far as the supply is concerned, in this section it has a different meaning from that used above, as we are looking exclusively at the distribution. Thus, it is important to distinguish between cities with aqueducts and those without, because the presence of an aqueduct lays down the way in which the water is distributed. In Empúries there is no documentation of any of the elements which characterize this type of distribution, there are no *castellum aquae* or secondary towers or lead pipes to take the pressure. Therefore, when studying the water supply with reference to the distribution, we have to analyze it by looking at how they organized the arrival of the rainwater to the main part of *Emporitana* system, in other words the cisterns. It is clear that this function is closely related to the architectonic organisation of the house and its development.

For two architectonic systems that were best developed for collecting rain water are extensively documented in Empúries: the *perystyle* houses and the atrium houses. However, these are not only the combination because a large part of the urban area is occupied by public buildings of by other structures for living in which are not in either of above styles. So, on one hand we have to make an initial division between public buildings and homes, and on the other hand these can then be subdivided into the different types of houses that can be found in Empúries.

Concerning the public buildings, each one is of a different type because of the different organization requiring different characteristics. However in the homes we can observe some similarities and other differences according to the type of construction. Thus, in the atrium houses, apart from the classic scheme in which the water is collected in the *impluvium* from where it goes to a cistern which has a drain, there are also other methods documented in which the position of the conduits and the *impluvium* allow us to deduce that this, by means of a system of blocking up the entrance or just by an accurate disposition of the levels, activated the drain when the cistern was full. On the other hand, the different *peristyle* houses which are to be found in the Roman city and in the Neapolis are not as well documented as the atrium ones, however, they also have a system which basically collects from the porches and takes it to cistern.

In the other types of living quarters, the simpler ones, the hydraulic structures are less plentiful but in the structures that are documented, the *tabernae* with their double use as both a house and business premises, the houses with a side patio and those with a passage or hall, the construction for collecting the water to send to the cisterns is fairly similar. Normally conduits can be found that go for the corners of the rooms where the cisterns are located, and are directed towards it. Despite the simplicity of the houses the structures for collecting water are complex, we are not talking about an open area where the water falls to the earth to then go to the cistern, but about structures which show the same care and order as the houses of larger dimensions.

The tendency to collect water from the corners of the rooms is one of the most common elements found in public and private, luxurious and modest buildings in both the Greek and the Roman cities. Often a small tray was found in the corners, probably to collect the dust from the different pipes. This same system was used in places where there were columns such as in the *perystyle* of houses 101 and the Roman house 2b or in the *abaton* of the Asclepius sanctuary. They installed pipes or drainpipes stuck to the columns as can still be seen in Delos (Chamonard 1924). Another aspect that has been documented is the homogeneity of the building techniques of the conduits in the same structure.

The other important element of the distribution is that the drains. This has two very different aspects; the drainage of waste water and that of rain water, this is reflected in the dichotomy that exists between the sewers and the drains. However, there are three elements to be taken into consideration, making the division a little more complex, with the reference to Empúries. These are the problem of waste water, the surplus water in the cisterns and the channeling of the rain water.

VII – The use of the water

The final element that is left of the management of the water is its use. This is particularly difficult aspect to study just from the material remains because often these elements that would allow us to make an interpretation do not still exist. Thus, when talking about the use of the water was obviously its availability, especially in a city like Empúries where there are a limited number of fountains. In any case the latest studies that have been carried out, both from a classic point of view and in the Pompeii study, have shown that in the places with more resources, for example those where water is supplied by means of an aqueduct, the personal culture was to save water. Water was a luxury which was used for fountains and ornaments and not, as we may think, for personal hygiene or for cooking use for use in latrines or areas for washing clothes.

In any case, there are two public buildings with a special relationship with water. These are the public baths and the Sanctuary of Asclepius and of Serapis. With regard to the first, many authors defend the posture that the public baths reflect the developmental level of the water resources of a city. The public bathes of Empúries, which are of small dimensions, really reflect everything that we have been saying up to now. They have two cisterns and a well as the means of supplying the water and all the water that was used was extracted and managed by hand.

Finally, the other use of water that can be documented in Empúries is industrial use. All the areas that are documented as having some kind of industry have a strong connection with the hydraulic structures. Only the pottery industry remains unknown, whilst the relationship of water to the metallurgical industry is well documented such as in the car park area, house 57 or other undetermined ones where the presence of ovens in an area such as the great cistern number 27 is documented.

VIII – Conclusions

The first conclusion about the water supply to the city of Empúries is that they basically counted on their cisterns to provide the drinking water. The scarcity of wells means that cannot give them an important role as part of the water supply to the city, we must think of them as more of a complement. Other possible resources, such as fountains, if they exist, are probably at or below sea level, making it impossible to use them. There is no documented evidence about the use of rivers, although their use cannot be ruled out for certain activities such as for industry.

To sum up, from the data which we have at present, Empúries surprisingly shows an important Punic influence, as far as the characteristics of the cisterns during the 3rd and 2nd centuries BC, are concerned.

Thus, in during the 2nd century BC, new techniques were introduced in Empúries, very probably of Roman influence which would culminate in the use of rectangular cisterns with the vaulted lids made of *caementicium*. Despite these innovations the old systems continued to be used for a long time. This phenomenon is also shown in other sites of similar characteristics both in North Africa and in the peninsula, and coinciding with the advance of the Roman colonization.

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