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Marco Giorgio BEVILACQUA, Denise ULIVIERI (Eds.)



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Vol. XV

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Marco Giorgio Bevilacqua, Denise Olivieri
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Taranto underground: digital survey and virtual exploration of the hypogea along the Aragonese walls

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Abstract

The downtown of Taranto (commonly indicated as ‘Città Vecchia’, Old City) reserves traces of its millennia-old history. A highly fascinating system of these traces can be found in the underground of this downtown, with countless cave-built spaces. In time inhabitants have used to dig into the calcarenite embankment, which was easy to quarry and process. In general, it can be noticed that there are various spaces related to religious functions and burial hypogea all along the Northern side of the settlement, while along the ‘Mar Grande’ (The ‘Large Sea’) side the uses are mainly related to work and market activities, with storerooms, oil mills, grain pits and manufacturing or commercial spaces. This concentration of trade-related functions is due to the presence of aristocratic mansions above the walls and of the harbor. In time the border of the town center was well defined by the city walls, apparently emerging from the surface of the water, but based on bank and on the cliffs. The appearance of the walls came from a series of interventions, aimed to improve the military response wanted by Ferdinando D’Aragona. The walls were made delimiting the emerging cliffs and various materials filled the empty spaces between the walls, the natural rock, and the existing constructions. Buildings for any functions rose over this natural/artificial soil before and after the presence of the new walls, incorporating, transforming or bringing the presence of the (so called) hypogean cavities. Despite the completion of the work with the addition of bastions, in XVII century there was a progressive loss of military value of the fortifications. The need for a direct access to the sea from the commercial ‘underground’ activities brought the opening of various passages breaking through the walls. The subject of this study is the section close to the Aragonese walls, where various chambers beneath the buildings have access to the sea. The remarkable number of cavities and galleries are at different levels below the surface, very often they intersect and influence each other, forming what may be perceived like ‘another city’. The present research, proposes the results coming from the digital survey of this system, where lasergrammetry and photogrammetry were essential tools to improve the knowledge about historical stratigraphy and also defining better the relationship between the city and its subsoil. The survey was mainly conducted using 3D laser scanner technology, which has allowed to define a specific interpretation using a specific digital 3D model of the current state of hypogea and the following development of an interactive virtual exhibition.

Keywords: Taranto, digital survey, hypogeum, stratigraphy.

1. Introduction

Maybe the more proper words to open this subject come from the book by Cataldo Nitti, published at the end of the XIX century: “Figli di Archita destatevi dal lungo sonno e sorgete; non vedete

voi che l’astro della libertà un’altra volta splende su questo bel cielo? Mercè la sua non peritura luce non vedete voi ch’è schiuso nuovamente il varco alla vostra antica grandezza? I padri

vostrî furono grandi e potenti, non tanto perché seppero con le armi dominare le vicine terre e città; ma molto più perché seppero coltivare le arti della pace, e perché seppero giovare della posizione in che giaceva questa fortunata città. E con ardimento pari alla saggezza giunsero per le vie dei commerci, e col perfezionamento delle arti a procacciarle tanta grandezza” (Nitti, 1861), that can be translated in “Sons of Archita awake yourselves from this long sleep and arise; don’t you see that the star of freedom shines again on this beautiful sky? Thanks to its never-ending light, don’t you see that the passage to your ancient greatness has opened again? Your fathers were great and mighty”. With this propaganda speech, the senator Cataldo Nitti was the first to launch the idea of a large naval base in Taranto for the recently born Kingdom of Italy. He exalts the topographical situation of a city so much disputed between different civilizations in the previous centuries, from Spartans to Aragonese passing through Byzantines, Longobards and Angevins. Despite these qualities, Taranto had suffered the years of abandonment and neglect during the just finished Bourbon domination (Blandino, 1974). That sense of loss of memory in a sort of long sleep cyclically affects the city, even in recent years (Montalbano, 2018). This is why it is important to investigate into city roots, the most hidden and deepest ones, especially underground. Roots that paradoxically, not assuming archaeological or monumental value, have not been properly explored, documented, cataloged and protected yet.

2. Taranto underground, how it started

The subsoil of Taranto has been the beating heart of the city for centuries. Such as a living organism

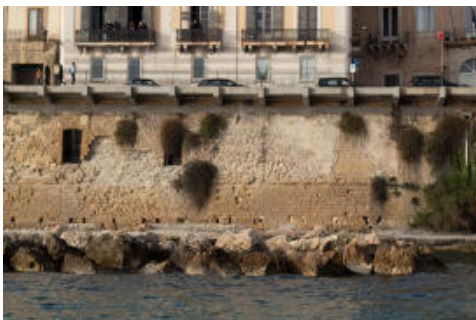


Fig. 1- Two openings of the hypogeum under Palazzo Stola passing through the Aragonese walls (Giada Germanà, 2022)

it contracts and closes itself towards the external environment. From the beginning it provided the raw material necessary for the construction of the buildings and defensive walls of the city. After the Saracens razed the Spartan city to the ground in 961 A.C., the emperor of Constantinople Niceforo Foca rebuilt it from the foundations to the walls. Furthermore, his successor enlarged the building land by creating an embankment towards the ‘Mar Piccolo’ (The ‘Small Sea’) (De Vincentis, 1878) using the debris resulting from the excavation of the surface layer of the Greek acropolis (De Vitis, 2015). At the same time the inhabitants have used to dig into the calcarenite embankment, which was easy to quarry and process to create cave-built spaces for funerary use, storerooms, oil mills, grain pits, connecting galleries and manufacturing or commercial spaces as has been common for millennia all across the Mediterranean *Koinè* (Caprara & Dell’Aquila, 2005). Archaeological excavations confirm that the reconstruction of the medieval city had to follow a unitary and complex project which included both high and underground city. Moreover it is worth keeping in mind that the Emperor Niceforo II was originally from Cappadocia, the cradle of Mediterranean hypogeism. For this it was possible to suppose some connection between the behaviours in creating carved spaces influencing the way Taranto was going to be rebuilt, in the shape of a modern fortress, but at the same time using older solutions with all the places for hiding, fleeing or storing goods and products. A system laying or integrated just beneath the building basements, and often independent from the urban pattern defining the surface of the neighbourhoods. An ancient tradition connecting mediterranean cultures, most of all showing a very practical approach to the relationship between urban settlement and soil and linked to the specific workability of the materials. A system of choices producing an underground series of spaces which are able to resist quite well in time and now capable of evoking suggestions and stimulating imagination about the most various and amazing stories and legends, even when their real use and story is most of the time extremely interesting and fascinating.

3. Aragonese walls, brief historical overview

In general, it can be noticed that there are various spaces related to religious functions and

burial hypogea all along the northern side of the settlement, while along the ‘Mar Grande’ (The ‘Large Sea’) side the uses are mainly related to work and market activities, with storerooms, oil mills, grain pits and manufacturing or commercial spaces. This concentration of trade-related functions is due to the presence of aristocratic mansions above the walls and of the harbor. In time the border of the town center was well defined by the city walls, apparently emerging from the surface of the water, but based on banks and cliffs. The appearance of the walls came from a series of interventions, aimed to improve the military response accordingly to the will of Ferdinando D’Aragona. The wall curtain is about 500 meters long. It was raised on a path with broken lines to obtain salient and receding angles that allowed the mutual defense of the walls. To break its rhythm, in the middle, there was the ‘Marrese bastion’, designed in a pentagonal shape and about fifteen meters high. The appearance of the walls remained unchanged even during the French occupation, during which more importance was given to the island of St. Paolo. The island became the base of the stronghold observatory on the Mediterranean Sea. Meanwhile, Taranto passed under the Bourbon domination, returning to the anachronistic medieval conception of a towered city, which, despite the reduction of habitable houses due to the increasing convents, was

never allowed to expand outside the island. This encouraged the inhabitants to extend their homes vertically, moving the most practical activities to the subsoil. At the end of the XIX century, in the same time as the construction of the new arsenal in the ‘Mar Piccolo’, the southern front of the walls lost more and more military value. The demolition works began in 1889, with the cut of some fronts on the sea of the aristocratic palaces. In place of the current sidewalk overlooking the sea alongside *Corso Vittorio Emanuele* (the old ‘Via delle Mura’), a wall from five to six meters high stood with a patrol walk behind the parapet. (Speziale, 1930). The last interventions that affected this portion of the walls dates back to the early 1920s, with the addition of a rolling road, and with the extension along its entire length in the 1950s. This last intervention was done placing a reinforced concrete slab bearing over the top part of the walls and even creating various concrete overhung elements with brackets at need.

4. Case studies

Till now the documentation of Taranto’s underground spaces has count about sixty entrances to hypogea, although many are probably still to be discovered (Montalbano, 2018). From a visual study of those reported ones, it is possible to see a rich variety of spaces that differ in position



Fig. 2- Plan of the Old City with red profiles of the three underground case studies (Giada Germanà, 2022)

and shape. Their morphology and articulation may vary in significant ways, with multiple interventions in time (Farella, 1988). They can be totally immersed and completely excavated or embedded in the ground for few meters and closed horizontally with vaults that make up the basement floors of urban buildings. The sizes vary according to the functions they hosted, but in general there is a structural correspondence between what is above and below the ground line, which here assumes the function of threshold and not just of supporting surface. They also change in access, that can be direct from the streets or courtyards and from the rooms of the buildings above. Immediately after the entrances, the stairs can be gradual (if the underground rooms were stables or animal traction mills) or steep and difficult. Finally almost all of them needed access to street level for the placing of goods or raw materials from above. They work both as depots, connections, and passages, even if the functions tend to sum up in time toward a generic 'warehouse' use. A certain number of these spaces were abandoned in recent times and left as they were after the last usage. This allows a quite clear interpretation of the most recent functions and a first step towards the reading of their transformation in time. The subject of this study is the section close to the Aragonese walls, where various chambers beneath the buildings have another peculiar characteristic: the access to the sea. The remarkable number of cavities and galleries are at different levels below the surface, very often they intersect and influence each other, forming what may be perceived like 'another city'. A system that may be inspiring and may be a part of a possible recovering of such a complex and suffered urban landscape (Rizzetto & Hooimeijer, 2022). These are structures in 'negative', low and dug into the rock and often showing signs of ongoing processing on the walls, such as those of the pickaxe, just left interrupted in an undefined time. In the apparently casual orientation of the galleries found at the deepest level of Palazzo Baffi, is it possible to imagine the difficulty encountered in the excavation, which often, as it happened in other context, like in the vast rupestrian settlements in Cappadocia, Turkey, continued even through 'blind' attempts. As regards the dating of the three hypogea examined, it can be assumed that they were built in conjunction with the buildings above in the XVII century. The one under Palazzo Baffi consists of two large vaulted rooms which, according to the traces found on

the walls, could have been a charcoal pit and a water cistern. The two large arches created as substructures of the building, which were made using bare materials from probably earlier periods and/or previous structures, are also quite specific and show original aspects. The other hypogea, not far from Palazzo Baffi, takes place under Palazzo Stola, its previous use was being a huge oil mill. The last hypogea detected is the largest in the whole Old City and also the most complex, because probably different functions took place over the years. The sources testify of the ancient Church of *Santa Maria del Porto* (St. Mary of the Harbour), mentioned in the holy pastoral visit of monsignor Brancaccio in 1578. In the following century the Olivetan priests settled there, leaving traces of an environment shrouded in mystery, today commonly recognized as the *putridarium*, a space dedicated to the temporary burial of deaths and organized to allow the progressive decay of the bodies according to a specific rite of trespassing, once the bodies were properly consumed, the bones were collected and moved to an ossuary (Fornaciari, 2008). Then in the XIX century the building was bought by the Cordiglia family (who were coming from Liguria) who used the underground areas as storage warehouses.

5. The digital survey campaign

For any purposes of knowledge, intervention and enhancement of an underground system like the one that characterizes the Old City in Taranto a full digital coverage results in a mandatory and necessary operation. The main tasks are mostly two: positioning with extreme accuracy all the elements, spaces and cavities of the underground, while at the same time measuring all the structures, details, architectural components, obstacle and added elements with a metrically sharp procedure. Such an operation, is done in order to understand all the dimensional aspects and all the morphological specific conditions of the carved spaces, so to help properly define their story and evaluate the relationship with the structures around and above. The survey was carried out with a 3D laser scanner unit, a Cam/2 Faro Focus3D, 70s model, with the capacity of gathering points up to 70 metres and with an accuracy of about one millimetre at ten metres of distance on standard reflective surface. Such features turned out more than efficient for recording the geometry of the tunnels and rooms, documenting all the details and elements of decay. About 260 scans were taken from different points

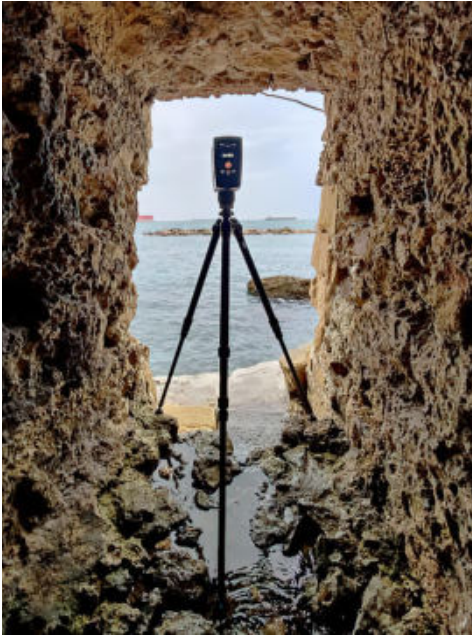


Fig. 3- The 3D laser scanner unit at the end of the gallery of the hypogeum from Palazzo Baffi, passing through the Aragonese walls (Giorgio Verdiani, 2021)

of view in order to reduce to the minimum the occlusion spaces, avoiding any possible lack of data in the documentation of the spaces. The scanner unit operated well in all the conditions, with no significant difficulties neither when the surfaces were extremely wet or even is flooded tunnels. Obviously the pools turned out as ‘holes’ in the resulting point cloud, thus the measuring of elements surfacing from the water and the level emerging from it allowed a reasonable coverage also for these situations.

The scanning work was done without placing any targets, the high level of details of all the surfaces, with spots, holes, nails, wires, cracks, hanged objects and writes, was enough to garrantee an accurate alignment of each single scan, the use of scanning settings from medium density resolution (the value of $\frac{1}{8}$ according to the scanner menu with the production of a point cloud counting up to 11 milions points, with a density of one point each 12,3 millimetres at ten meters of distance) to medium-high density resolution (the value of $\frac{1}{8}$ and $\frac{1}{4}$ according to the scanner menu with the production of a point cloud counting up to 28 and 37 milions points, with a density of one point each

7,7 and 6,1 millimetres at ten meters of distance), turned out more than enough for the creation of a well detailed and not overmeasured dataset. The higher resolution settings were adopted for all the larger spaces and for the external areas, while the medium resolution setting was adopted for all the tunnels, small rooms and staircases. The overlapping of the scans was calibrated according to the shape and articulation of each space. All the scans were taken in greyscale, deriving the colorscale from the reflectance values and without using the photographic features of the scanner unit. This choice was done to speedup the survey and to avoid weird colouring results due to the missing of an adequate lighting in most of the spaces combined with very difficult shapes in terms of photographic coverage and natural/artificial lighting. The excavated spaces have in most of the cases very omogeneous colours, just the natural one of the material, so it was preferred to keep all the scans in basic grayscale, programming specific SfM/IM (Structure from Motion Image Matching) photogrammetric and/or photographic interventions only where the quality of the element was worth and significant for documentation purposes. The overall survey



Fig. 4- The 3D laser scanner unit in front of the Putridarium beneath Palazzo Stola (Giorgio Verdiani, 2021)



Fig. 5- Axonometry views obtained by cutting the point cloud model from Autodesk Recap at variable heights (Giada Germanà, 2022)

campaign took about three days to be completed, producing three dataset group to be aligned. The alignment/registration work was done using Autodesk Recap Pro, using the automatic align features where possible and completing the alignment with manual procedures where needed. The overall good level of overlapping and the accuracy of the scanner unit turned out in a very efficient result. Once the alignment was completed the resulting three final point cloud projects were created and optimized with the manual removal of some ghostly element created by reflections (an issue quite common in flooded rooms and passages). The resulting model, compliant with the direct use in Autodesk Autocad, provided the reference 3D digital model of the underground, which can be investigated and explored even remotely. As previously mentioned, to integrate the point clouds dataset various photogrammetry intervention were operated, mostly on significant masonry or excavated patterns, and on the main façades of the over ground buildings. The digitalization of the underground system is then a perfect base for starting the analysis of the structure of this system, making clear

with extreme accuracy all the relationships between the fortifications, the buildings in the urban pattern, the operative choices operated by the people who developed this system. Its easy use in standard CAD software makes it possible to work on it both in 3D or 2D modes that may allow a better planning of any further interventions aimed to valorize and communicate and give access to this interesting piece of urban architecture. The resulting drawings, both from the horizontal sections and the vertical sections, allow to interpret, starting from the size and the positioning of the cavities, the sequence of their realization, a process that confirm the articulated use of these hidden architectures, all aimed in making more and more fitting the use of the space to the wanted function.

A logic that leaves no option to removal of elements unless they are a real limit and then capable in preserving a wide range of overlapping traces. The 3D laser scanner acquisition techniques, combined with those of CAD modelling, provide a digital/virtual model of reality, from which useful information can be obtained for the analysis, it

is then possible to perform a complete check of all the alignments, directions and sizes of the various spaces. The main objective related to the use of these technologies was to take a first step in the composition of a useful archive of geometric memory, to support research by other scholars, but also for subsequent purposes of protection, conservation and use by a wider public through a virtual reality tour. The goal is to define a *modus operandi* for the revaluation of the place that could be replicated for the rest of Taranto underground.

6. Conclusions

The hypogean spaces in the Old Town are a clear mix of technical, vernacular, and practical choice, they seem not to develop to any other logic if not those connected to the needs and ideas from the various previous owners. In this they increase their value as a specific heritage collecting a mixed story of religious, industrial, military, and civil phases. Their interaction with the city walls is extremely valuable, it shows own the logic of the walled town once again is seen as a limit when the military use lost his original importance.

The walls opened and excavated enter the use for civil purposes, are not any longer a perfect defence from an attack but remains of some use, a sort of occasional scenario for the activities of an improvised dock for goods and materials, the walls are no longer a limit, a clear border, but the passage is never in evidence, it just responds to minimal needs of passing with the items in hands.

The crossing of the wall border is then underground, where depots and rooms exactly sized to the various specific requirements allows now any kind of fantastic idea about the behaviours from the previous users and about the uses themselves. The presence of complex spaces, probably related to specific and disquieting past procedure of the faith, like the *putridarium*, create a strong emphasis, that should be exploited for its correct value, not in the will of spectacularizing a single aspect, but with the intention of giving a articulated understanding of the evolution of this specific structures, guided by aims and now last witness of a phase in the history of the city were the sea, the work of man, the faith, the need of defence, the need for easy living and then the need for exploiting valuable contents, took one the place of the other in a sequence similar to the one of playing cards in the hands of a gambler.

Digital solutions may bring a great contribution, from the state of the system to the integration of a correct musealization the strategies passing by survey to knowledge are more than ever efficient and suitable for such a situation. The need to update procedures and define a proper approach to the re-discovery of the underground may be then the occasion for a general requalification strategy, including the walls and the access to the waterfront, trying to exploit the old damages caused to the walls, like the openings and the carving to go beyond more recent injuries, like the road passing on them adding badly matched



Fig. 6- Palazzo Stola: Sections of the entrance and of the opening to the sea (Giada Germanà, 2022).

elements (like the concrete brackets and slates). Would this ever be a possible and sustainable strategy for Taranto? The underground system is probably not capable in producing massive tourist attraction, but it can be an effective experience in

the renewal of a town which suffered long years of neglect and abandon. In a logic of the reuse of the spaces that may bring on in most of the positive ways the long tradition of adaptations that this urban area as longly experimented.

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