The Thermal Environment of Roman Baths

For Romans, bathing was considered both a social and a recreational activity, one that was integral to everyday life. And their heating system, an impressive innovation from an earlier Greek hypocaust system, remains a popular topic in the archaeological field today. The general layout and the overall operation of the system is relatively well known, with both aspects corroborated by evidence from ancient textual sources and archaeological records. However, the characteristics of the thermal environment—that is, the properties in an area which affect heat—and how a desired temperature was maintained throughout a bath is relatively uncertain. This uncertainty is mostly due to the fact that the average archaeologist does not possess the necessary skills in order to create simulations of the heated areas of a bath that would have produced a more accurate temperature range for individual bath complexes.

In 1998, Dr. Fikret Yegül set out with his team to build a small but functional replica of a simple Roman bath in Sart, Turkey. Their goal was to better understand the construction process and certain engineering feats involved rather than a focus on the hypocaust and tubulation, though some data regarding the temperature, humidity, and the nature of heat transfer in the bath were recorded. This provided a foundation for late researchers to build off of. It wasn't until the early/mid 2010s that the question about the heating characteristics of the hypocaust's heat transfer in both larger and smaller sized bath complexes piqued the interests of researchers outside of the world of Classics. Dr. Oetelaar, an engineer who specializes in computational fluid dynamics, branched out to combine the research and methods of the two fields. While running 3-D modeled simulations of both the NOVA baths and a portion of the *caldarium* from the Baths of Caracalla, Dr. Oetelaar (2015) was able to answer various questions that have puzzled Classical archaeologists for years. For instance, were the windows in the rooms glazed? The answer is that it seems so and a later simulation by Gagliano in 2017 supports Dr. Oetelaar's conclusion.

The inclusion of engineers with a knowledge of physics also shows that multidisciplinary approaches to questions that arise from the archaeological record are very valuable. Through combining both the archaeological record and the data provided from an outside field, a more robust and realistic image of bathing in the Roman world can be constructed. As mentioned above, scholars had wondered over issues regarding the thermal environment that archaeology alone could not answer whereas a field far removed could produce plausible results rather quickly.

Bringing archaeological mysteries to individuals in other areas could potentially provide very valuable information that in turn will further our understanding of functions of structures and systems while also building a clearer image of life in ancient Rome. Much has been discovered by Dr. Oetelaar's research, but that is limited to two cases, one of a modern experimental project and one based off of the large Baths of Caracalla complex, but more thermal analysis should carried out in the future on more baths of varying sizes and air volumes in order to build an extensive corpus of temperature and heat transfer data. A more extensive corpus would help to provide a more accurate average of temperatures that the baths could reach as well as how powerful hypocaust systems needed to be in relation to the bath complex's size. Analysis of the baths at Pompeii and Herculaneum can provide valuable information, as both *balnea* and *thermae* have been preserved. However, based on current results, it can be assumed that a specific temperature range was reached by each bath type, indicating that the Roman architects and engineers knew what size and potential power the hypocaust systems needed to be in order to produce that ideal range.

Bibliography

Gagliano, A., M. Liuzzo, G. Margani, and W. Pettinato. 2017. "Thermo-hygrometric Behaviour of Roman Thermal Buildings: The “Indirizzo” Baths of Catania (Sicily)." *Energy & Buildings* 138: 704-15.

Oetelaar, Taylor, Wood, David, and Johnston, Clifton. 2015. *An Innovative Investigation of the Thermal Environment inside the Reconstructed Caldaria of Two Ancient Roman Baths Using Computational Fluid Dynamics*: ProQuest Dissertations and Theses.