Early Byzantine reservoir of Caesarea - A new high resolution environmental study from the Carmel coast of Israel

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Introduction

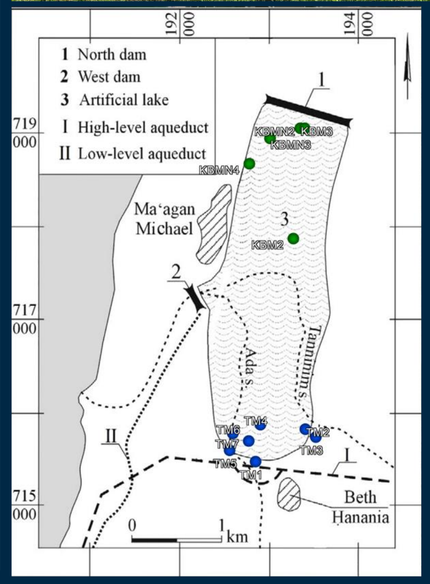
Caesarea Maritima was a major port city built by Herod the Great on Israel's Carmel Coast between 21 to 10 BCE. By the early Byzantine period the city had grown to an estimated population of at least 50,000, leading to increasing demand for resources. In the fourth century CE, the Tanninim Reservoir was created by building two dams: the Nahal Tanninim Dam, which blocked the area's streams, and the Northern Dam, which spanned 900 meters and prevented overflow from the reservoir. The result was a 600-hectare artificial lake that raised water levels by ~4 – 6 meters. This provided the elevation necessary to allow the Low-Level Aqueduct to convey water to Caesarea.

The dams were also used to power grain mills. At the time the reservoir was created, it appears this was a secondary priority, with most of the water going to the city. Over time, more mills were built, and this became the primary use for the reservoir water. It is not clear why this shift occurred, nor is it known what exactly the water was used for in the city. It is unlikely to have been used for drinking water, as the water is thought to have likely been brackish. High quality drinking water from springs on Mt. Carmel was already being brought to the city by the High-Level Aqueduct, likely built around 50 CE. No evidence has been unearthed suggesting the water was used for irrigation. Proposed uses include industrial activities or waste-management.

The goal of this research is to use sedimentological and micropaleontological evidence to understand how environmental parameters in the reservoir changed over time and how this relates to Caesarea's water management decisions.

Methods

Sediment cores were extracted from the area once covered by the Tanninim Reservoir using a Geoprobe corer during expeditions between 2019 and 2022. The cores were split, imaged, and elemental abundance data was collected with the X-Ray Fluorescence core scanner at the Scripps Geological Collections. Samples were analyzed for grain size and organic carbon content, and wet-sieved to extract microfossils. Chronology for the cores was obtained from a combination of Optically Stimulated Luminescence (OSL) and radiocarbon dates. Microfossils, primarily consisting of ostracods and gastropods, were isolated and identified to genus or species level.



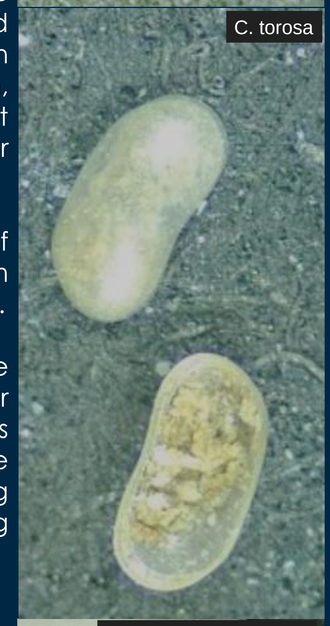
Top: Geoprobe coring in the Kebara Swamp, Israel, in 2019. Left: Core locations superimposed on map showing approximate perimeter of the Tanninim Dam. (Adapted from Gendelman-Uzi'Ad 2019)

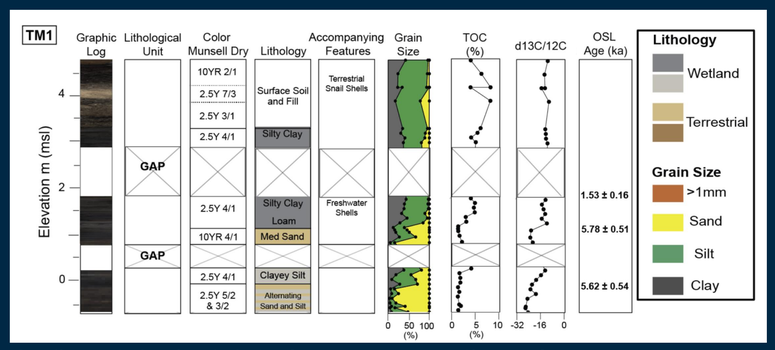
Early Findings

Samples from core TM6, located in the southern portion of the Tanninim Dam perimeter, contain abundant ostracods, sub-centimeter sized gastropods, and Chara sp. gyrogonites and oospores in the uppermost section of the core. The sediment in this unit is silty-clay. The ostracod assemblage consists predominantly of Cyprideis torosa, a euryhaline species which tolerates a wide range of oxygen levels and substrates and up to 150 g/L salinity. Also present in substantial numbers are Heterocypris salina and a Candona species. H. salina is also fairly euryhaline and can tolerate freshwater to salinity of 35 g/L. Gastropod species are dominated by Theodoxus and Melanoides tuberculata, which inhabit freshwater to brackish water. Also present in smaller numbers are Gyralus piscinarum, a freshwater species of gastropod. The microfauna suggest that the reservoir's salinity likely varied seasonally due to lower precipitation and higher evaporation in summer months.

Immediately below this unit the sediments contain a mix of sand and silt, and few if any fossils. This shows that pre-dam construction, the southern portion of the reservoir was dry land.

Next steps will include a higher resolution analysis of the microfaunal assemblage to investigate whether water conditions changed over the time the reservoir existed. Cores KBMN3 and TM1 will also be included in this analysis, and the chronology of the entire dataset will be improved by obtaining several additional radiocarbon dates to complement existing radiocarbon dates from deeper sections of the cores.





Sedimentological data from upper sections of core TM1

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