Corals in the Desert

Recent Discoveries of Red Sea Corals in Byzantine and Early Islamic Sites in the Negev Desert

Guy Bar-Oz, Yotam Tepper, and Roee Shafir

General view of the the southern church and the adjacent pool of Shivta on a winter morning. Photograph by Guy Bar-Oz.

Corals have been commercially exploited for many centuries all over the world (Jiménez and Orejas 2017). Traditionally, they have been regarded as mystical objects and hybrid organisms. Their skeletons have commonly been used as remedies and as amulets or jewelry, and they have represented an exotic and valuable resource throughout human history. In the Greco-Roman literature a number of classical authors, such as Aristotle (fourth century BCE, History of Animals *5.16; Ogle 1882) and Pliny (first century CE), referred to the natural history of corals and classified them as enigmatic creatures. Since corals are animals that lack locomotion or perception, Theophrastus also classified them as hybrids of plants and stones (*On Stones *53:38; Caley and Richards 1956).*

Other ancient scholars (like many people today) debate whether or not corals belong to the animal kingdom. Pliny provides a fascinating description of corals in chapter 11 of book 32 of his *Natural History*, which is devoted to the forty-three remedies and observations of corals (*HN* 32.11; all translations from Perseus):

> Its form is that of a shrub, and its color green: Its berries are white and soft while under water, but the moment they are removed from it, they become hard and red, resembling the berries of cultivated cornel in size and appearance.

Following the description of its unique anatomy Pliny lists the natural remedies that corals offered for a variety of illnesses:

> Calcined, pulverized, and taken in water, coral gives relief to patients suffering from griping pains in the bowels, affections of the bladder, and urinary calculi…. Powdered coral, too, is an excellent remedy for patients who bring up or spit blood. Calcined coral is used as an ingredient in compositions for the eyes, being productive of certain astringent and cooling effects.

The unique shape of corals also played a significant role in their use as amulets carried either as necklaces or as pendants:

> Diviners look upon coral as an amulet endowed with sacred properties, and a sure preservative against all dangers: Hence it is that they equally value it as an ornament and as an object of devotion.

Later historical records continuously recommend the use of corals for their apotropaic powers, such as against the evil eye, and as a highly valued medicine for multiple diseases. The second-century CE Greek physician and anatomist Galen (*Method of Medicine*; Jiménez and Orejas 2017) used several recipes against blood loss that included exotic corals. Galen's medical doctrine dominated and inspired late antique theory and practice into the Middle Ages in the Byzantine and Arabic worlds for close to 1500 years (Bouras-Vallianatos and Zipser 2019). The imaginary natural history of the coral that represented a creature that was transformed from an animal and plant into stone fueled increasing demand for these exotic natural products among wide populations across the ancient world. Its demand reached its peak in the Middle Ages when it was listed as one of the major substances in medicinal and traditional healings (Lev 2003). Many of these beliefs continue in traditional societies to the present day (reviewed in Jiménez and Orejas 2017).

Despite their broad traditional historical uses as healing and magical entities, corals are not frequently encountered in the archaeological record, and most of the published specimens in the eastern parts of the Mediterranean Sea were red corals (*Corallium rubrum*) that originated mainly from the western parts of the

Mediterranean Sea (Tsounis et al. 2010). Those corals were imported and traded from Neolithic times throughout Europe, the Levant, and Egypt, and were widely used as beads or as natural pieces (Skeates 1993; Jiménez and Orejas 2017). This includes a large assemblage from Roman-period Alexandria on the southeastern part of the Mediterranean coast, which served as a major hub of trade and commerce with the Red Sea (Morand 2020). Several dozen Mediterranean red corals found at the Roman site of Adulis on the western shore of the southern Red Sea in Eritrea (Carannante et al. 2015) further attest to the importance of coral exchange between the two seas.

Figure 1. Location map of sites between the Red and the Mediterranean Seas.

Unlike Mediterranean red corals, Red Sea corals, which are usually white branching, are rarely reported at Levantine sites. Several pieces were found along Neolithic pathways in the Judean desert and the Jordan Rift and later in the fifth to fourth millennia BCE in Upper Egypt, mostly in elite funerary contexts (Meeks 2000). In addition, two small fragments of Red Sea corals (*Stylophora sp.*) were found in Roman Jerusalem (Ktalav pers. comm.). Another piece of *Stylophora* was found in Early Islamic Yotvata, ca. 40 km north of the Gulf of Aqaba (Erickson-Gini 2019). The latter is the only example of a specimen found along a definite trade route that connected the Red Sea with northern and western realms.

Conversely, Red Sea corals were usually found near their place of provenance. They were popularly exploited in Roman-Byzantine sites along the Red Sea shores, where they have been used for multiple mundane purposes. Large specimens of corals have frequently been used as building material. For example, Late Roman structures at Aila on the Gulf of Aqaba were composed of fieldstones, dried mudbrick, and chunks of coral (Retzleff 2003: 54). Similarly, the Byzantine city wall has occasional chunks of coral in it (Parker 1998: 385). At southern Egypt's Red Sea seaport site of Berenike most of the walls were built with pieces of corals, seemingly unworked but possibly broken down to the appropriate size range for construction (Sidebotham and Wendrich 1996: 106).

In this paper we present the recently found Red Sea corals in sites in the Negev desert, located over 200 km from where they were originally collected. Most of them were found in the landfills of the Byzantine (fifth to seventh centuries CE) and Early Islamic (seventh to ninth centuries CE) sites of Elusa, Nessana, and Shivta. The first was the capital of the province *Palaestina Tertia*, located along the trade routes that linked the Red Sea to the Mediterranean Sea. Similarly, Nessana was an important trade post on the road to Sinai and Egypt. Finally, Shivta is situated ca. 10 km south off the main road. All sites were located 30–60 km from the

Figure 2. (1) *Favites abdita*. Photograph by Larry Basch, distributed under a CC-BY 2.0 license. (2) *Stylophora pistillata*. Photograph by Scott Mills, distributed under a CC-BY 2.0 license.

Mediterranean Sea and served as gateways to lucrative commercial commodities brought from the Red Sea (fig. 1). Like other exotic Red Sea goods, which include dried parrotfish (Scaridae; Gambash et al. 2019; Blevis et al. 2021) and shellfish (*Lambis truncata*; Ktalav et al. 2021), their presence at the Negev sites indicates that they were among the natural long-distance-traded merchandise of the time.

The attractiveness of corals would have been very relevant for past traders. Like spices and aromatics, such as frankincense and myrrh, corals were used and predominantly exported as small products, and all had sacred and healing properties. In addition, they could have been transported over long distances and still preserve their tremendous effectiveness for multiple purposes. Like other imported exotic goods, corals could have enjoyed "marketing through storytelling," which no doubt mythologized the products and increased the legendary and spiritual dimension of these items as precious commodities. Therefore, our second goal is to increase awareness of the significance of corals in early economies with the hope that further archaeological examples will be found through careful excavations and documentation.

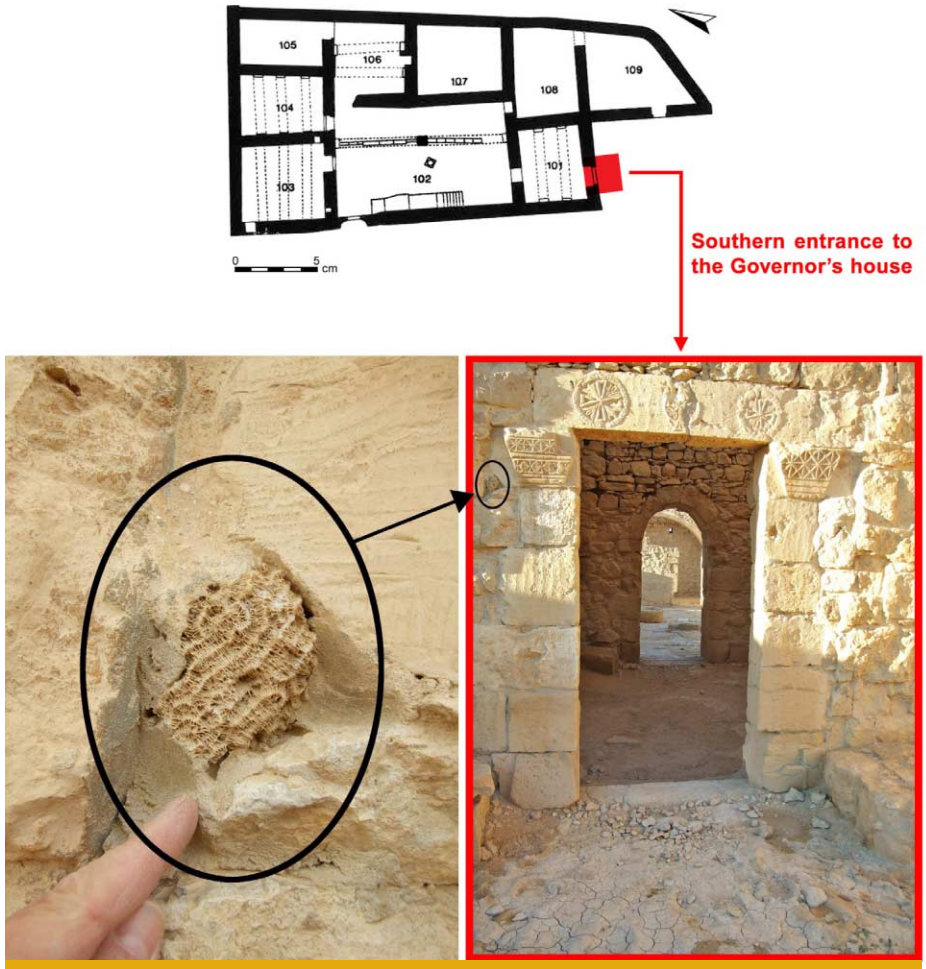


Figure 3. Embedded coral in the lintel of the Governor's house in Shivta. Photographs by Yotam Tepper.

Corals in the Red Sea

Coral (Phylum: Cnidaria, Class: Anthozoa) is a calcium carbonate substance that is secreted by compact colonies of marine invertebrates to form the hard exoskeleton that comprises the framework of the reef. They are typically found in tropical waters, and corals are slow-growing, long-lived organisms. Their natural annual growth encapsulates unique environmental proxy in their skeleton and they are very sensitive to climate change. High resolution global climatic parameters (sea-surface temperature, salinity, amount of available nutrients in the water) are now frequently extracted from modern and fossil corals (Watanabe et al. 2019).

The reef is an extremely diverse marine ecosystem and comprises a wide range of coral communities along a cross-shelf gradient. Among them the offshore and midshore communities are relatively homogenous and include diverse species in various forms and shapes. Many are found mainly in shallow waters of tropical and subtropical seas, including the Red Sea, which is the northernmost tropical sea (Veron 2000; Berumen et al. 2019).

The Red Sea's reef is one of the longest continuous living reefs in the world. It extends along 4,000 km of the Red Sea's shorelines and serves as the habitat for more than 200 species of stony coral. The most common genera are: *Acropora*, *Stylophora*, *Pacillopora*, *Favia*, and *Porites*. Among them, the columnar *Favites* and the tree-like branching *Stylophora* are among the most dominant species on exposed reef fronts (fig. 2). Those taxa are represented by several species, most of which are easily distinguishable by the general structure of the polyp skeletal elements (corralite). They form large colonies that inhabit shallow water, generally at a depth less than 5 m and up to 30 m deep and provide the structural framework of the reef (Veron 2000). They are also among the most commonly collected of Red Sea corals and their morphological traits allow easy identification.

Shallow water corals can be easily harvested fresh by freediving from the reef. They can also be collected dried on the beach, or along exposed dead and fossilized reefs. They can then either be designed as pieces of jewelry or left and distributed as natural pieces.

Corals have many colors, each species receiving its unique coloring from the zooxanthella, the symbiotic photosynthetic algae that live inside it. White or bleached corals are corals that have lost their algae. This normally happens to most of the tropical corals soon after they are collected and exposed to sunlight. Therefore, these corals must have been exported as white corals.

The Byzantine Negev Sites

Corals were found in landfills of three Byzantine and Early Islamic sites, all of which were part of municipal trade centers in the Negev Desert (fig. 1). This includes the ancient economic and administrative Byzantine city of Elusa with its large church and cathedral, theater, and chain of three to four high towers (portrayed on the Madaba map; Negev 1976); the desert agro-village of Shivta that includes public buildings, including three churches and a mosque; and Nessana which also contained three churches and served as another major caravan and pilgrimage post of Byzantine and Early Islamic administration. Two major roads crossed the region: One was the historical incense trade route with its plexus of paths that crossed the Negev along which traders transported cargoes from the south and the east to Gaza and the Mediterranean Sea, and another one that led southwest to Sinai and served Christian pilgrims to St. Catherine's in Sinai (Hirschfeld 2004).

Those sites, which were established in Roman times, flourished both from commercial trade and sustainable agricultural production of cash crops in periods that reached their peak in the Byzantine era between the fifth to sixth centuries CE. The rapid, successful processes of settlement expansion were followed by a rapid decline in the following Early Islamic (seventh to ninth centuries CE) period. Intensive, recent multidisciplinary excavation of trenches in trash deposits both inside and outside of the sites reveal a complex picture of the fate of the Byzantine settlements in the Negev (Bar-Oz et al. 2019; Marom et al. 2019; Tepper et al. 2018; 2020a; Fuks et al. 2020).

Removal of trash to external dump heaps at the outskirts of sites continued throughout the Byzantine period in all settlements. Elusa's urban decline occurred in the mid-sixth century CE, almost a century before Islam entered the area, during the peak of the Byzantine era (Bar-Oz et al. 2019). Conversely, the succeeding Early Islamic trash was deposited primarily inside the sites, within deserted structures, as evidenced in Shivta (Tepper et al. 2018) and Nessana (Tepper et al. 2020b). Such trash management routines, together with the possibly partial abandonment of Shivta evidenced from the sealing of entrances of households (Tepper, Weissbrod, and Bar-Oz 2015), represent a reduced intensity of human occupation. This long and slow decline may have continued to as late as the eighth or ninth century CE in Shivta and ninth to tenth century in Nessana.

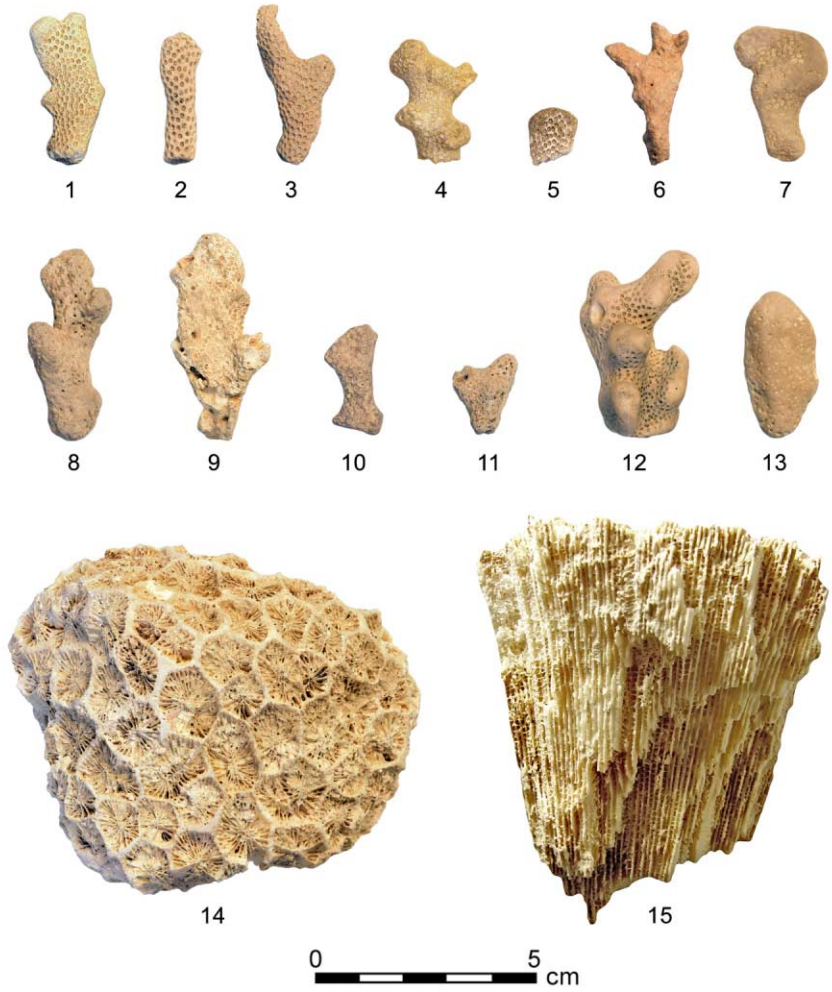
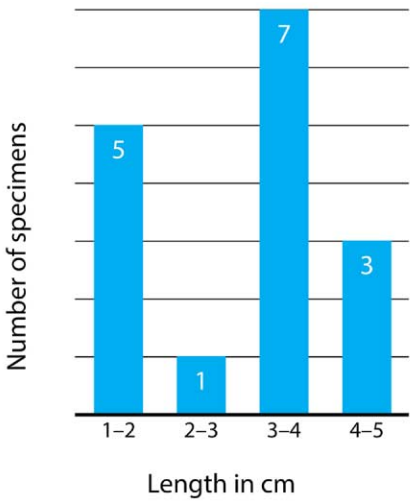


Figure 4. Corals from Elusa (1–2), Nessana (3–8), Shivta (9–15). Photographs by Roee Shafie.

Systematic excavation and sieving of material from the different trash mounds revealed a high abundance of zoological finds, as well as rich and varied material culture. Like other faunal remains comprised predominantly of bones and teeth as well as the shells of mollusks, the corals were found in ashy layers that derived from household activities (Butler et al. 2020).

Methods

Corals were retrieved through systematic and expansive field survey of surface trash mounds in each of the sites, which is where the majority of specimens were found. The terminal date of each mound was determined through analysis of large quantities of surface survey artifacts, including ceramics, glass, and coins (Elusa: Bar-Oz et al. 2019; Shivta: Tepper et al. 2018; Nessana: Tepper et al. 2020b). Additional pieces were found through probe excavations in the mounds of sites. All excavated material was dry sifted through five millimeter mesh. This allowed discovery of small faunal remains, including small coral fragments. Two other pieces were found in Shivta: One was found during excavation of the floor of a Byzantine house and another was embedded in the doorway of the "Governor's house" (fig. 3).



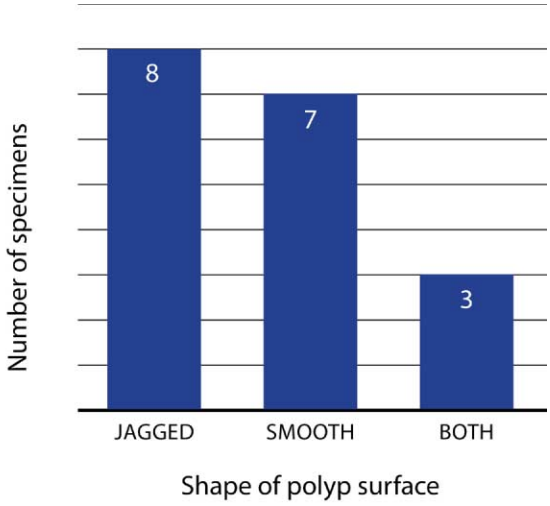


Figure 5. Size (a) and surface texture (b) of *Stylophora pistillata* specimens

All coral items were collected during survey and excavation and were identified taxonomically using Veron's *Corals of the World* (2000) atlas. Identification was based on morphological parameters. First, the shape of the coral was used to separate between round and cylindrical-body corals and tree-like branch corals. Species identification was based on the structure, size, and shape of the coral's polyps (corralite). This was also facilitated by examining the thickness of the wall between polyps. Some have a combined wall while others have a distinct and thick septum. The septum thickness, which is the radiating vertical plates, served to differentiate between closely related species.

In addition, we documented the thickness of each of the corals. This enabled us to provide a rough estimate for the age of the round corals. This same procedure was also applied to the branch corals. For them the thickness reflects where they were grown on the reef. On a flat, off-shore reef that is exposed to strong waves, branches are thick and sturdy; on the reef slope in the midshore branches are moderately thick; finely branched colonies will be formed in sheltered reef slope and in the deeper parts of the reef.

We examined the texture of the coral of each specimen and coded whether its surface is smooth or jagged. Eroded specimens were those with their polyps worn down and their surface smooth. By contrast, the surface of fresh specimens remained jagged. This might enable us to reconstruct the depositional history of different items. Those with jagged surfaces indicate that they were collected while the corals were fresh (live specimens) and they were kept protected over time. Alternatively, eroded specimens could indicate a more complex story. They could have been collected dry and desiccated (dead specimens that could have been collected on the shore) or eroded over time due to lengthy aerial exposure and weathering deterioration. It is also possible that erosion resulted from rubbing of the surface due to frequent use. Unfortunately, we could not differentiate between natural and cultural erosion of corals. In addition, we measured the longest length of the branch corals and diameter of the round corals. Each of the coral specimens was then examined under a five-power magnifying lamp to determine if any had been worked or undergone modification.

The Corals

A total of 18 stony coral fragments was found (fig. 4). Of them 16 were identified as *Stylophora pistillata* and 1 specimen belonged to *Favites sp.* (most probably *Favites abdita*). Both taxa are among the most common corals in the Red Sea. They are mostly abundant in the shallow water and close to the coastline fringing reef.

The distribution of stony corals in each of the sites is provided in table 1. Five excavated pieces of *Stylophora* were found in Late Byzantine dumps. Another fragment of *Favites* was exposed in a Late Byzantine–Early Islamic domestic context. In addition, three other *Stylophora* pieces were found on the surface of the dumps and were tentatively dated to Late Byzantine–Early Islamic periods. In Nessana we excavated four pieces of *Stylphora* in an Early Islamic trash mound and another two that were collected on the surface during survey. The latter pieces are tentatively dated to the Late Byzantine–Early Islamic period. In Elusa we collected another two *Stylophora* specimens on Late Byzantine trash mounds. Finally, another piece of coral was found in Shivta embedded in the doorway of the "Governor's house" (fig. 3). This piece seems to belong to *Favites*. However, the context of the find is not clear and we could not determine if this find is in situ or was placed there during conservation works at the site (Biton, pers. comm.)

The diameter of the second *Favites* piece found in situ in the domestic structure is 8.8 cm, suggesting that it derived from a ca. ten-year-old coral. The *Stylophora* specimens are small, all within the range of 1–5 cm (fig. 5a), and usually do not contain more than a single branch. Some of these pieces are relatively thick, indicating that they originated from colonies grown on the fringe of the reef in areas with strong waves. One irregular piece suggests that it derived from a colony exposed to turbulence. All of the specimens are unworked fragments and bore no sign of deliberate surface modification like polishing, cutting, or drilling.

By examining the shape of the polyp surface we found that about half of the specimens had jagged and sharp surfaces while the other half were smooth and blurred. Interestingly, the

Table 1. Distribution of coral items in the Negev sites (found in survey or excavation) and their surface structure (jagged or smooth).

Site	Period	N	Survey	Excavation	Other	Stylophora	Favites	UnID	Jagged	Smooth	Both
Elusa	Middle Byzantine	2	2			2				1	1
Nessana	Late Byzantine–Early Islamic	2	2			2			1	1	
Nessana	Early Islamic	4		4		4			2	2	
Shivta	Late Byzantine	9	2	3	1	8	1	1	3	2	2
Shivta	Late Byzantine–Early Islamic	1	2	1		3	1		2	1	
Total		18				16	2	1			

majority of smoothed items (six out of seven) are the ones that were found during survey on the surface of the mounds. Correspondingly, most jagged coral items (six out of eight) were found in excavation. The remaining three pieces were difficult to differentiate and had both jagged and smooth surface textures (fig. 5b). This observation suggests that the smooth surface of corals most probably resulted from postdepositional rubbing of the surface of the coral with the sediment. It also indicates that fresh corals are represented.

Discussion

The value and exchange of Red Sea corals are now well demonstrated along the historical trade routes that connected the Red and Mediterranean Seas via the Negev Desert. Corals in the Negev sites indicate that they were among the natural, traded commodities in the Byzantine and Early Islamic periods. Discovery of their cultural trajectory in the Negev Desert provides new means to reconstruct the economic structure that connected the regions. As such, their presence is a flagship that signifies their iconic importance for reconstructing ancient, panregional, long-distance trade routes.

Here we have reported on several white corals that have been found in domestic trash mound deposits of settlements more than 200 km from their place of origin. Their contexts in household deposits, together with other Red Sea finds (fish and shells) further demonstrate the infrastructure of long-distance international networks in the Late Antique of the southern Levant. What was their role for the Byzantine–Early Islamic people of the sites of the Negev? Do any of their specific characteristics provide any clues for their potential use?

Most of the Negev corals are small branches of the widespread and common *Stylophora* coral that were exclusively chosen out of the full range of potentially available Red Sea corals. Mediterranean corals uncovered in parallel contexts in Alexandria (Morand 2020) were not found in the Negev. *Stylophora* coral becomes bleached soon after it is removed from the reef and therefore it must have been exported as a white coral. In addition, it is plausible that some of the corals were collected dried on the beach. Their context in household deposits or in trash mounds that are characterized by domestic refuse accumulations, together with the fact that none were found perforated or worked, suggest that they were not used as jewelry or ornaments. In addition, they do not derive from precious and rare corals, or ones that would symbolize greater beauty when worn (as opposed to Mediterranean red coral). Thus, it appears that they also were not worn and used as amulets. We might suppose, then, that their use must have been more ordinary and mundane than previously thought and we have to search for alternative reasons to explain their commercial value.

Another reasonable scenario is that these corals were attractive due to their healing properties. Over time, the unique medicinal properties of corals were repeatedly recognized by various healers, and they occur in a wide array of medical recipes. Lev and Amar (2008) list corals as one of the seven main animal sources that have been exploited in the Levant for traditional healing from antiquity to medieval times and some even to the present day. Some of these corals continue to be important and are at the focus of research, as they produce anticancer chemicals (Bruckner 2002).

Some of the reputations of corals to cure various maladies, many of which have their roots in Roman times, continue to be in high demand to treat a wide range of ailments, including respiratory and circulatory problems, kidney and liver diseases, skin ailments, and pain. Described by classical writers including Galen and Pliny, corals were endowed with various medicinal qualities, encouraging their transport throughout the imperial territories. The various remedial prescriptions use oral consumption of powdered corals. This tradition continues throughout Late Antique medical authors to the Middle Ages and modern history. For example, the late sixth-century CE Alexander of Tralles, who combined his own extensive clinical experience with earlier medical theories, used various natural remedies including corals as an ingredient for an antidote and as a drug for blood spiting. He also recommended them as an amulet for epilepsy (Bouras-Vallianatos 2014). Similarly, twelfth-century Arabic writers recommend a dose of powdered corals as a remedy for all internal bleedings (Lev 2003). Powder of white corals mixed with several other ingredients was prescribed as remedy for plague in medieval Europe, part of it derived from ancient Greek recipes for preparing *theriac*—the ancient antidote to cure the poisonous bites of serpents, mad dogs, and wild beasts (Fabbri 2007). The

use of corals continued among Late Antique medical authors. Some seventeenth-century European accounts mention cures from dangerous fever by taking six drops of powdered coral solution. Another account prescribes ten grains of coral for infants to treat epilepsy (Merrill 1922: 168).

The domestic contexts of the Red Sea corals in the trash mounds of the Negev settlements together with the historical recipes lead us to favor the explanation that they were used mainly for their curative value. Given that coral powder was also used to repel the plague in medieval Europe (Fabbri 2007) it is tempting to speculate that their presence at the sites is related to the enigmatic demise of the Negev community, which occurred in the decades that follow the Justinian Plague. As such, their appearance in the Negev might reflect traditional medicine alongside some of the superstition and beliefs that characterize this period.

Acknowledgments

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References

Aristotle. *History of Animals*, trans. William Ogle. London: Kegan Paul, 1882.

Bar-Oz, Guy, Lior Weissbrod, Tali Erickson-Gini, Yotam Tepper, Dan Malkinson, Mordechay Benzaquen, Dafna Langgut, Zachary C. Dunseth, Don H. Butler, Ruth Shahack-Gross, Joel Roskin, Daniel Fuks, Ehud Weiss, Nimrod Marom, Inbar Ktalav, Rachel Blevis, Irit Zohar, Yoav Farhi, Anya Filatova, Yael Goren-Rosin, Xin Yan, and Elisabetta Boaretto. 2019. Ancient Trash Mounds Unravel Urban Collapse a Century before the End of Byzantine Hegemony in the Southern Levant. *Proceeding of the National Academy of Science USA*. DOI: 10.1073/pnas.1900233116.

Berumen, Michael L., Roverto Arrigoni, Jessica Bouwmeester, Tullia I. Terraneo, and Francesca Benzoni. 2019. Corals of the Red Sea. Pp. 123–55 in: *Coral Reefs of the Red Sea*, ed. Christian R. Voolstra and Michael L. Berumen. Cham: Springer.

Blevis, Rachel, Guy Bar-Oz, Yotam Tepper, and Irit Zohar. 2021. Fish in the Desert: Identifying Fish Trade Routes and the Role of Red Sea Parrotfish (Scaridae) during the Byzantine and Early Islamic Periods. *Journal of Archaeological Science Reports* 36. DOI: 10.1016/j.jasrep.2021.102808.

Bouras-Vallianatos, Petros. 2014. Clinical Experience in Late Antiquity: Alexander of Tralles and the Therapy of Epilepsy. *Medical History* 58:337–53. DOI: 10.1017/mdh.2014.27.

Bouras-Vallianatos, Petros, and Barbara Zipser, eds. 2019. *Brill's Companion to the Reception of Galen*. Leiden: Brill.

Bostock, John, and Henry T. Riley. 1855. *The Natural History of Pliny the Elder*. London: Bell.

Bruckner, Andrew W. 2002. Life-saving Products from Coral Reefs. *Issues in Science and Technology* 18.3:39–44.

Butler, Don H., Zachary C. Dunseth, Yotam Tepper, Tali Erickson-Gini, Guy Bar-Oz, and Ruth Shahack-Gross. 2020. Byzantine–Early Islamic Resource Management Detected through Micro-Geoarchaeological Investigations of Trash Mounds (Negev, Israel). *PLOS One*. DOI: 10.1371/journal.pone.0239227.

Carannante, Andria, Chiara Flaux, Christophe Morhange, and Chiara Zazzaro. 2015. Adulis in Its Regional Maritime Context: A Preliminary Report of the 2015 Field Season. *Newsletter di Archeologia CISA* 6:279–94.

Erickson-Gini, Tali. 2019. Yotvata. *Excavations and Surveys in Israel* 131.

Fabbri, Christine Nockels. 2007. Treating Medieval Plague: The Wonderful Virtues of Theriac. *Early Science and Medicine* 12:247–83. DOI: 10.1163/157338207x205115.

Fuks, Daniel, Guy Bar-Oz, Yotam Tepper, Tali Erickson-Gini, Dafna Langgut, Lior Weissbrod, and Ehud Weiss. 2020. The Rise and Fall of Viticulture in the Late Antique Negev Highlands Reconstructed from Archaeobotanical and Ceramic Data. *Proceeding of the National Academy of Science USA*. DOI: 10.1073/pnas.1922200117.

Galen. *Method of Medicine*. 2011. Translated by Ian Johnston and G. H. R. Horsley. Loeb Classical Library. Cambridge: Harvard University Press.

Gambash, Gill, Guy Bar-Oz, Efraim Lev, and Uri Jeremias. 2019. Bygone Fish: Rediscovering the Red-Sea Parrotfish as a Delicacy of Byzantine Negev Cuisine. *Near Eastern Archaeology* 82:216–25.

Hirschfeld, Y. 2004. The Monasteries of Gaza: An Archaeological Review. Pp. 61–88 in *Christian Gaza in Late Antiquity*, ed. Brouria Bitton-Ashkelony and Aryeh Kofsky. Leiden: Brill.

Jiménez, Carlos, and Covadonga Orejas. 2017. The Builders of the Oceans—Part II: Corals from the Past to the Present (The Stone from the Sea). Pp. 657–98 in *Marine Animal Forests: The Ecology of Benthic Biodiversity Hotspots*, ed. Sergio Rossi, Lorenzo Bramanti, Andrea Gori, and Covadonga Orejas, eds. Cham: Springer, pp. 657–697.

Ktalav, Inbar, Yotam Tepper, Gil Gambash, and Guy Bar-Oz. 2021. Long-distance Trade of Mollusks: A View from the Byzantine Negev. *Journal of Archaeological Science Reports* 37:102927. DOI: 10.1016/j.jasrep.2021.102927.

Lev, Efraim. 2003. Traditional Healing with Animals (Zootherapy): Medieval to Present-Day Levantine Practice. *Journal of Ethnopharmacology* 85:107–18.

Lev, Efraim, and Zohar Amar. 2008. *Practical Materia Medica of the Medieval Eastern Mediterranean according to the Cairo Genizah*. Leiden: Brill.

Marom, Nimrod, Meirav Meiri, Lior Weissbrod, Yotam Tepper, Tali Erikson-Gini, Hagar Reshef, and Guy Bar-Oz. 2019. Zooarchaeology of the Social and Economic Upheavals in the Late Antique-Early Islamic Sequence of the Negev Desert. *Scientific Reports* 9:6702. DOI: 10.1038/s41598-019-43169-8.

Meeks, D. 2000. Le corail rouge dans l'Égypte ancienne. Pp. 11–20 in *Corallo di ieri, corallo di oggi*, ed. Jean-Paul Morel, Cecilia Rondi-Costanzo, and Daniela Ugolini. Bari: Edipuglia.

Merrill, George P. 1922. *Handbook and Descriptive Catalogue of the Collections of Gems and Precious Stones in the United States National Museums*. Washington, DC: Smithsonian Institute.

Morand, Nicolas. 2020. The Exploitation of Molluscs and Other Invertebrates in Alexandria (Egypt) from the Hellenistic Period to Late Antiquity: Food, Usage, and Trade. *Anthropozoologica* 55:1–20.

Negev, Avraham. 1976. Survey and Trial Excavations at Ḥaluza (Elusa), 1973. *Israel Exploration Journal* 26:89–95.

Parker, S. Thomas. 1998. The Roman 'Aqaba Project: The 1996 Campaign. *Annual of the Department of Antiquities of Jordan* 42:375–94.

Retzleff, Alexandra. 2003. A Nabataean and Roman Domestic Area at the Red Sea Port of Aila. *Bulletin of the American Schools of Oriental Research* 331:45–65.

Sidebotham, Steven E., and Willemina Wendrich. 1996. *Berenike 1995: Preliminary Report of the 1995 Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert*. Leiden: CNWS.

Skeates, Robin. 1993. Mediterranean Coral: Its Use and Exchange in and around the Alpine Region during the Later Neolithic and Copper Age. *Oxford Journal of Archaeology* 108:281–92.

Tepper, Yotam, Lior Weissbrod, and Guy Bar-Oz. 2015. Behind Sealed Doors: Unraveling Abandonment Dynamics at the Byzantine Site of Shivta in the Negev Desert. *Antiquity* 89.348:1–4.

Tepper, Yotam, Tali Erickson-Gini, Yoav Farhi, and Guy Bar-Oz. 2018. Probing the Byzantine/Early Islamic Transition in the Negev: The Renewed Shivta Excavations, 2015–2016. *Tel Aviv* 45:120–52.

Tepper, Yotam, Naomi Porat, and Guy Bar-Oz. 2020a. Sustainable Farming in the Roman-Byzantine Period: Dating an Advanced Agriculture System near the Site of Shivta, Negev Desert, Israel. *Journal of Arid Environment* 177:104134. DOI: 10.1016/j.jaridenv.2020.104134.

Tepper, Yotam, Lior Weissbrod, Tali Erickson-Gini, and Guy Bar-Oz. 2020b. Nizzana—2017: Preliminary Report. *Excavation and Surveys in Israel* 132.

Theophrastus. *On Stones*, trans. Earle R. Caley and John F. C. Richards. Columbus: Ohio State University Press, 1956.

Tsounis, Gerogios, Sergio Rossi, Richard Grigg, Giovanni Santangelo, Lorenzo Bramanti, and Josep-Maria Gili. 2010. The Exploitation and Conservation of Precious Corals. *Oceanography and Marine Biology: An Annual Review* 48:161–212.

Veron, J. E. N. 2000. *Corals of the World*. Townsville: Australian Institute of Marine Science.

Watanabe, Takaaki K., Tsuyoshi Watanabe, Atsuko Yamazaki, and Miriam Pfeiffer. 2019. Oman Corals Suggest That a Stronger Winter Shamal Season Caused the Akkadian Empire (Mesopotamia) Collapse. *Geology* 47:1141–45.

Guy Bar-Oz is an archaeozoologist. He is the director of the Negev Byzantine Bio-Archaeology Research Program, an ERC project, and head of the Laboratory of Archaeozoology, University of Haifa, Israel.

Yotam Tepper is an academic and professional facilitator at the Israel Antiquities Authority (IAA). He is a field archaeologist and agroarchaeologist who has specialized on the Negev Desert, with a focus on the agricultural systems at the hinterland of Byzantine settlements.

Roee Shafir is an archaeozoologist and the manager of the Laboratory of Archaeozoology, University of Haifa, Israel. He is a PhD candidate at the University of Haifa, Department of Archaeology and has a BA and MA in archaeology, as well as an MA in conservation archaeology from the University of Haifa.