H38 The Effects of Varying pH on Bone in Aquatic Environments

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After attending this presentation, attendees will learn the results of an experiment investigating the effects of varying pH solutions on bone segments submerged for a one-year period. Attendees will also learn some of the capabilities of the FBI's Underwater Search and Evidence Response Team.

This presentation will impact the forensic science community by providing empirical data on postmortem aquatic changes which may be extremely useful in forensic contexts for both improving time since death estimates, and also for providing better information to underwater recovery experts thereby potentially increasing the quantity and quality of remains recovery.

In the summer of 2007, the FBI Laboratory's Forensic Anthropology Program received an inquiry from a member of the FBI's Underwater Search and Evidence Response Team (USERT) regarding the possible condition of missing human remains. The USERT assists in water-based searches for evidence, and divers are specially trained to locate and recover items of evidence that are believed to be underwater. The USERT also utilizes the most advanced underwater technology to assist in its searches, including side-scan sonar, sector scan sonar, and remotely operated vehicles (ROVs). While the USERT has been involved in several high-profile dive operations, the majority of USERT operations involve searches for handguns, knives, bodies, vehicles and similar items. The USERT also is capable of conducting hull and pier searches in support of counter-terrorism and counter-intelligence operations. FBI USERT also may be contacted for assistance in state and local police matters when there is a need for underwater evidence recovery.

The question posed by the USERT diver in this case was: How well preserved would you expect a body to be after twenty years in a slightly acidic lake? Divers were curious whether, because of the acidity of the water, there would be enough of a skeleton remaining to warrant an underwater search. A review of the literature revealed that little is known about the decomposition of remains in aquatic environments of varying pH, and even less is known about the specific effects of these environments on bone. Documentation of postmortem changes in aquatic environments has been scant and consists primarily of general overviews, a few empirical studies, and case reports. Other reports emphasize the formation and preservation of adipocere, algae formation, invertebrate colonization, or fluvial transport, but little research has been done specifically on bone preservation in various aquatic environments. This discovery prompted the following pilot study.

Bovine remains were obtained from a meat processing facility, and cut into approximately 3-5cm thick cylindrical discs using a table saw. Solutions were prepared to represent aquatic environments of pH1, pH4, pH7, pH10 and pH14 using nitric acid and sodium hydroxide. The specimens were placed into glass beakers and the solutions were added until the bones were completely submerged. The specimens were periodically removed from their solutions and photographed. After one year, the specimens were removed from the solutions, rinsed, photographed, and examined visually and microscopically.

The pH7 and pH10 solutions had little effect on the bone, but all other solutions affected the bone to some degree. Extreme pH levels significantly affected the integrity and physical appearance of the bone, completely dissolving it in six days in the case of pH1, and degrading it considerably over one year in the case of pH14. Good to excellent preservation was observed in the solutions of pH4, pH7 and pH10, with the pH10 solution showing somewhat better preservation than the pH4 solution. Given that the range for pH of water in the U.S. is around pH4.3-pH10, one would therefore expect the pH of the water to have little effect on bone preservation (at least over a period of one year or less). More information on the effects of pH levels on fully-fleshed remains would be needed to improve estimates of time since death, but the results observed here may be useful in making statements regarding time since skeletonization.

Empirical data on postmortem aquatic changes may be extremely useful in forensic contexts for both improving time since death estimates, and also for providing better information to underwater recovery experts thereby potentially increasing the quantity and quality of remains recovery. While this study was rather small-scale and included pH extremes unlikely to be encountered in forensic contexts, it serves as one of the first controlled studies of its kind. It is hoped that results will prompt larger empirical studies to be conducted including the use of, for example, larger biological specimens, less extreme pH levels, and varying temperature and salinity.

Water pH, Bone Preservation, USERT

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