An Effective Diver-Operated Coring Device for Underwater Archaeology

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ABSTRACT

A simple, cost-effective diver-operated coring device for underwater archaeological sites is based on a modified design of a previously published device (Cawley and Parker 2001). The utility of this corer is demonstrated, and examples and advice from field testing the device are provided.

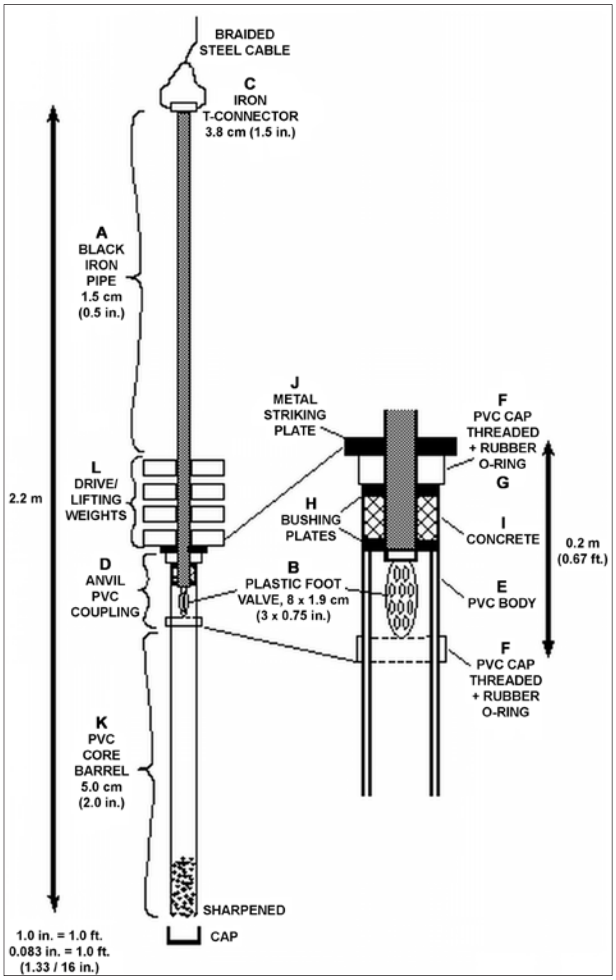
Introduction

Underwater archaeologists have struggled to find an effective, efficient, and inexpensive diver-operated coring device for decades. Some projects have been able to utilize various non-diver operated coring devices such as those employed by Ballard (Webster 2008) in deep-sea archaeological expeditions, and Stanley et al. (2007) in investigations of ancient Alexandria. Others have made use of commercially produced diver-operated corers, including Faught (2004:278) in paleolandscape research, and Trembanis and McNinch (2003:4–5) on the purported *Queen Anne's Revenge* shipwreck site. Other projects, however, are not able to afford complex corers and must rely on those that can be operated by divers on-site. Problems with diver-operated underwater coring usually relate to the difficulty of getting enough pressure or leverage underwater to drive the corer deeply enough into the sediment, almost regardless of the length of the coring tool or of the matrix itself. An equally difficult task involves the extraction of an intact sample from most sediments, as there is often insufficient suction in a coring tool to hold the weight of the sediments.

Regardless of the device or technique used, coring on underwater sites is generally a challenging and awkward job (Dean et al. 1995:204–205; Gorham and Bryant 2001:286; Martens and McNichol 2001:32), and unfortunately it is a technique that is often abandoned or not attempted. Researchers are usually left to explore other avenues of data acquisition, generally consisting of either an emphasis primarily on remote sensing data, or on more invasive and time-consuming techniques such as test units or full excavations. It is possible that sediment coring may be a less useful tool for some sites; for example, sites that are wholly exposed, or on which there is no intent of research beyond mapping the site (in this instance, however, coring could provide information on site stability). For sites which are in less-conducive working environments, for projects working with minimal resources, or under extreme time limits, or simply for sites where more information is necessary, successful sediment core data may substantially add to the knowledge obtained from site investigation.

The Cawley-Parker Diver-Assisted Percussion Coring Device

In 2001, Jon Cawley and Bruce Parker (2001) published a short technical article in the *Journal of Sedimentary Research* describing a diver-operated percussion coring device which is versatile and inexpensive, unlike many other coring devices employed by scientists that work in underwater environments. The article provided a detailed schematic of the device (Cawley and Parker 2001:863–864), including vital and important details such as model and part numbers and even places of manufacture for most of the parts. Cawley and Parker's original schematic is depicted in Figure 1, and the modified corer is shown in comparison (Figure 2). Most of the recommended parts are listed in Table 1. The device, as envisioned by Cawley and Parker, is approximately 1.5 m (5 ft.) long without the PVC tube or core barrel inserted. It is comprised of a hollow black iron pipe shank connected to a simple platform or anvil (the strike plate and compression coupling), which in turn holds the PVC tube that collects the sample. The drive weights are placed around the iron pipe and are used to pound or drive the corer into the sedi-



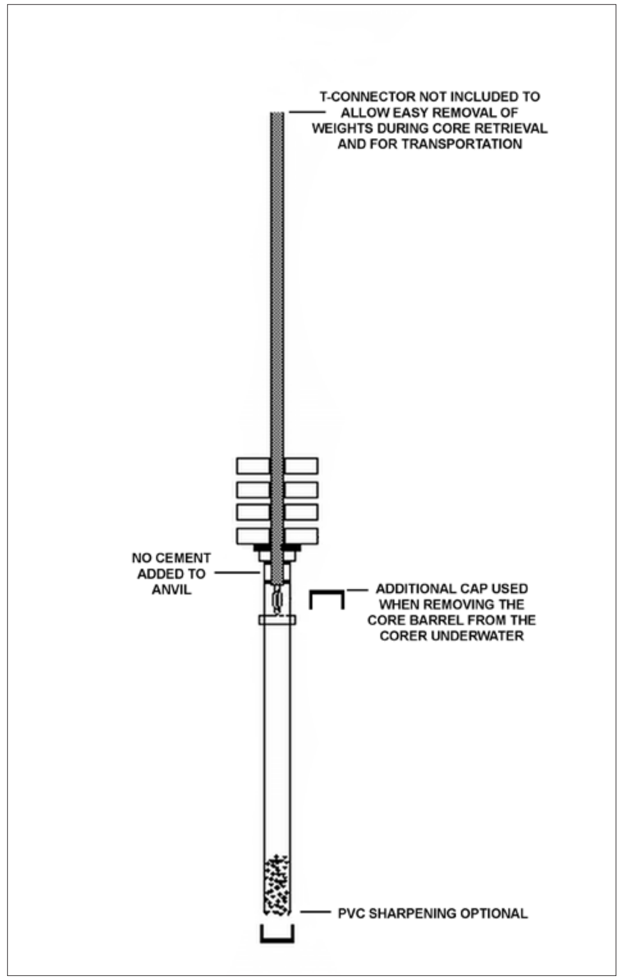


Figure 1. Cawley and Parker's 2001 design for a diver-assisted percussion coring device, after Cawley and Parker (2001). (Drawing by author, 2007.)

Figure 2. The author's modifications to the coring device are simple, and yet allow the device to be more versatile and effective in the marine environment. (Drawing by author, 2007.)

Table 1. Parts List For The Percussion Coring Device.

Part	Description
A	1 black iron pipe: 48 × 0.6 in. (lathe-threaded 22 cm on one end, normal thread on the other)
B	1 plastic foot-valve: SFV-75, 0.75 in., Brady Products, Clearwater, FL. 1 metal hex bushing: 0.75 in. male × 0.5 in. female, G241-2015, Aquasource, Willsboro, NC
C	Iron T-connector (not used in modified corer)
D, E, F, G	1, 2 in. PVC compression coupling: FPURCC-2 160-108LG 2 in., B & K Industries, Inc., Elk Grove Village, IL.
H	2, 2 × 0.75 in. PVC bushing plates: Schedule 40, Model 430-24, Lasco Fluid Distribution Products, Kent, WA.
I	Concrete (not used in modified corer)
J	1, 1.25 in. metal striking plate (this may also be a large and thick washer—whatever is locally available)
K	5 ft. × 2 in. PVC tube or casing
L	4 drive weights, 2 kg (4.4 lb.) concrete/plastic doughnut athletic lifting weights (larger or heavier weights are recommended for turbulent environments and heavier-duty coring)
Unlabeled	2 in. PVC slip caps, Schedule 40 (extra caps recommended).

ments after the PVC tube is positioned on the seafloor. PVC tubes for the corer may be any manageable length desired.

Cawley and Parker (2001:864) suggested that the device can be built for approximately $50 from easily accessible parts. Due to its ease of use in the underwater environment, it is an ideal tool for cost-effective and efficient sediment core collection. The authors stated that the device is limited only by the depths accessible to scuba divers, and they demonstrated its utility in lacustrine environments. The article does not address post-processing of the collected sample, or any issues that might arise, likely because the purpose of the article was to disseminate useful technical information to other researchers.

Diver-Operated Percussion Coring Device Field Tests

Field research on shipwrecks from the historic maritime trade with West Africa were conducted in 2007 as part of the Central Region Project (DeCorse 2001) and with the support of the National Science Foundation (MRI 0521121). Work focused on an intense investigation of a shipwreck previously discovered by Greg Cook (currently of the University of West Florida) in 2003, and mapped by Cook and a team of volunteers in 2005 (Cook and Spiers 2004). The production of the site plan was no small feat as the site is located at a depth of 11.5 m (38 ft.) in a turbulent and generally black water environment for much of the year; conditions that unfortunately also existed during the most recent research period.

A cross-section of the wreck site was excavated as a means of building an in-depth understanding of the wreck and its social and historical roles in the international maritime trade in Ghana. In addition to excavation, sediment core samples were collected from within and around the wreck site. Cawley and Parker's coring device was selected for its apparent simplicity of construction and low-budget design. Some of the parts necessary for constructing the coring device were purchased in the United States, specifically the compression coupling and one-way valve. The remaining components were available in Ghana.

The Modified Coring Device

Modifications were made to the Cawley-Parker device during construction. Additional changes were made as more experience was gained using it on-site. As weightlifting weights were not available to use as drive weights, a local fisherman was commissioned to manufacture lead weights for the device. The fisherman designed and manufactured three weights, each approximately 10 kg (22 lb.), expertly formed in a homemade mold. Other parts were purchased in local markets. The second major modification eliminated the cement filling in the compression coupling and left it as free space, contrary to the suggestion of Cawley and Parker (2001:863). This was easier to construct and did not appear to have any negative repercussions. The device was joined using an epoxy resin, though the use of PVC cement is strongly recommended. Finally, the T-connector was not placed at the end of the iron pipe. This allowed for easy removal of the weights and made the device less cumbersome to transport over long distances on the seafloor.

Locally available 2 in. gray PVC tubes were used for the coring tool, each separate tube cut to about 1.5 m (5 ft.) in length. Cawley and Parker (2001:863) recommend sharpening the ends of the PVC before using them for the coring tool. While this may be important in some environments, it was not found to be necessary, despite the wide range of matrices in which the corer was used. It is important, however, to be cognizant of the fact that PVC filings may shear off during use, particularly when pushed through coarse or sharp materials. As a result, modern PVC fragments may be accidentally included with the sediment sample and should be removed during sample processing.

Coring

While general coring practices need not be expounded here, there are several things that may be helpful to discuss concerning the use of this corer. It is recommended that the PVC tube and coring device be assembled on the surface to reduce the number of parts carried and assembled underwater. It is also advantageous for the divers to be relatively heavily weighted, particularly in turbulent or dynamic environments, because additional weight provides greater stability on the seafloor and allows more effective driving of the corer. This must be carefully considered in terms of dive safety, however.

The method of sample extraction recommended by Cawley and Parker (2001:865) was also tried. It consisted of pulling the sample and corer up as one unit and capping the PVC as it broke the sediments. Due to rough conditions, it was not possible for surface crew members to pull on the corer while divers rocked the corer in the sediments as Cawley and Parker recommended. Divers instead had to cajole the core without surface assistance, either by rocking or pulling upward until it came free from its hole. This method was variably successful, but in some sediments, such as what appeared to be deep deposits of fine and light silt, the corer would emerge empty. It was also discovered that over time it became increasingly difficult to extract a full sample. This may have resulted from wear in the corer seal, but whatever the cause, it was problematic and ineffective. The solution to this problem was to separate the sample from the corer before extraction, as is discussed below.

Some authors (Gorham and Bryant 2001:286; Martens and McNichol 2001:31–32) have suggested a method of digging down to the base of the corer and capping the end while still in the sediment matrix. This method was attempted, but failed for two reasons: the first is that generally the corer was buried far more deeply than could be excavated effectively—the PVC was approximately 1.5 m long (5 ft.) and was generally pushed into the sediments to its full length—and secondly, the sediments in this region are generally unconsolidated and tend to fill any hole as soon as it is excavated.

The most effective method devised for capturing the sediment in the corer was to separate the PVC tube from the corer after it had been driven into the sediments. This was completed by first driving the corer into the sediments as a complete unit, then removing the weights from around the iron pipe or stem for greater handling ease, and separating the coring device from the PVC tube. After the corer was removed, a tight-fitting end cap was placed on the PVC tube (if the cap did not fit tightly enough, plastic bags were fitted over the exposed end of the tube and then capped, which created a slightly tighter seal). After capping, the PVC tube could be carefully extracted from the sediments, and the bottom capped for transport to the surface. It is of course, of utmost importance to label the top and bottom of each PVC tube before use, and this is most easily done by marking them before a dive. Carrying spare end caps is also recommended, as they are easily lost in the process of capping the PVC tube.

It is also important to have a method to keep track of the weights, as they can easily become buried in loose sediments. This problem was solved by tying the weights together and using a permanent tether or leash to attach them to some point on the wreck. This did not seem to interfere with their function. Enough line must be allowed to permit use of the coring device, however, without having so much excess that the line gets caught in tank valves and creates a danger to divers.

It was discovered that in particularly heavy swells, if the corer were not balanced properly before it was driven into the sediment, or if the person controlling the weights were not able to pound them quickly enough, it was possible for the PVC tube to fold or snap, making it impossible to complete the sampling process. There is no easy solution for this, unless it is possible to schedule the research period in calmer weather, in which case this problem should not occur.

Sample Removal

Sample removal methods will vary according to the resources and facilities available. It was necessary on this project to reuse the PVC tubes, so sediments were removed (beginning from the top/surface of the PVC tube using a handmade welded tamping device. There is some concern about sediment compaction using this method, but it did not appear to impact more than approximately 10–15 cm of the surface silt, and as such was not considered to be a concern for this research project. Generally, the sample slid out from the tube relatively easily, with minimal smearing or contamination of successive strata in the sample. The PVC tube should then be thoroughly cleaned before reuse.

Lengths of the collected samples depended on a number of factors, including the nature of the sediments, the seal on the tube before removal, and the technique the divers employed in removing the sample—generally a slower and more methodical approach preserves a greater length of sediment. Sample lengths on this project varied between 30 cm (1 ft.) and nearly 100 cm (3.3 ft.), with the average length being 60 cm (2 ft.) or more. It is undetermined why the samples were not longer, considering that the entire corer tube was driven into the sediments, but this is likely due to either something environment-specific, to compaction, or a combination of both, and will likely change depending on the site. Some sediments proved too heavy to remain in the corer tube, despite a tight seal, but this appeared to be the exception rather than the rule.

Cores collected during field research provide us with a cross-section of the shipwreck site and its environs, and offer insights into the intricacies of site formation processes and underwater site stratigraphy. This method of coring is so effective that the corer could be driven through dense sand and shell layers and even through some buried hull structure. It is at times difficult to judge exactly what the corer encounters, and as a result, on multiple occasions the end of the corer was shattered on buried concretions or solid artifacts. In such cases, it is difficult to recover much of the sediment and material in the corer, as there is often no way to maintain any sort of vacuum or pressure inside the tube during extraction. If only a small portion of the corer were damaged, the damaged part was sawed off and the remaining PVC was reused. One of the benefits of this coring device is that it is simple to operate, even in black water conditions, as everything could be operated by feel. While this is obviously not ideal, it is important, and may be useful for other researchers working in less-than-ideal conditions.

Conclusions

Jon Cawley and Bruce Parker's simple and cost-effective diver-assisted percussion coring device has proven to be far more useful than even the authors anticipated. Minor modifications of their original device have served to increase its value as a research tool by changing the way core removal is managed. Its practicality, versatility, and efficiency in even the most dynamic and variable sediment environments is an advantage to any underwater research project, particularly those operating on limited budgets. Finally, with such a simple and accessible tool, the full potential of sediment coring on underwater archaeological sites can at last be properly explored and utilized to the advantage of all who seek to understand the past.

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