David A. Poirier
and Nicholas F. Bellantoni

Forensic Archeology
A Humanistic Science

A decorative 18th-century coffin lid from Cornwall,CT, is carefully uncovered. Brass tacks were commonly employed to indicate the initials and the age at death of the deceased.Photo by William Keegan.

Archeologists have often been harshly, and perhaps justifiably, criticized by the nation's Native Americans as "grave robbers" for the discipline's callous treatment of their ancestors. Fortunately, the last decade has witnessed a significant transformation of attitude and approach within the archeological community regarding osteological remains. The majority of today's professional archeologists do not focus scientific inquiry upon the explicit discovery and examination of human remains. In concert with the spirit and intent of the Native American Graves Protection and Repatriation Act of 1990, most archeologists acknowledge the critical importance of working in partnership with the descendants of the cultures whose archeological remains they study.

Nevertheless, construction and other land modification activities continue to result in the unforeseen and accidental disturbance of unmarked burials and cemeteries. With increasing frequency, such discoveries date from the 18th and 19th centuries and are abandoned rural family burial grounds or forgotten institutional cemeteries. In most states, legislative mandates provide archeologists with the critical responsibility for the identification of the deceased, coordination with descendants and other interested parties, and the respectful treatment of the remains.

Rarely do archeologists encounter a disinterested public in these cases. Public reaction often ranges from emotional distress to vocal hostility. These unfortunate and sensitive situations demand diplomacy, extreme professionalism, and humanistic compassion. Forensic archeologists serve to provide an important bridge between past and present populations.

On-site and laboratory analysis of the osteological evidence, associated funerary remains, burial accouterments, archival records, family histories, and comparative databases often sheds important light on the identification of the deceased, causes of death, and familial or group relationships. Equally paramount, forensic archeologists can offer emotional closure for descendants, concerned neighbors, related ethnic or cultural groups, and the religious community through their respectful and professional handling of these difficult situations. In this regard, it is imperative that forensic archeologists establish a forthright, face-to-face dialogue with all interested parties. A diversity of spiritual, social, cultural, emotional, and political considerations needs to be explicitly recognized and professionally handled. Archeologists must facilitate the recognition of mutual goals, articulate the unique perspective of forensic archeology, and restore the sanctity of the grave.

Forensic archeologists also are scientific partners within the medico-legal system. From cemetery desecration to horrific crime investigations to natural disasters, the technical training and expertise of the forensic specialist offers significant insights concerning the identification of human remains, interpretation of past cultural actions, and the recognition of taphonomic alterations. Archeological methods and techniques often enhance and complement the data gathering investigations of local, state, and federal police agencies. Remote sensing is frequently employed to locate buried murder victims; interpretations of soil and stratigraphic data provide reliable information on the relative sequence of events. Forensic archeological analysis also may yield important contributions regarding the age, sex, and race of the deceased, and the time of burial as well as the interrelationship between osteological remains, the surrounding natural environment, and pertinent cultural material (i.e., "physical evidence").

Forensic anthropology brings a specialized training in the osteological identification of human remains developed out of studies of archeological samples from mortuary complexes, human growth and development, and evolutionary specimens, to assist modern criminal investigations. Comparative skeletal materials representing various biological populations, pathological conditions, and traumatic injuries provide the necessary

dataset that permits scientific analyses of forensic cases that reflect the best interest of the public.

With increased federal and state legislation providing for the reburial and repatriation of human skeletal collections to their appropriate descendants, archeologists and anthropologists have struggled with the ethical questions of balancing the respect for traditional belief systems of specific peoples toward their dead and the interests of humanity through science. These issues raise emotional and complex questions that have been discussed in the anthropological and native communities for over a decade. As scientists, we recognize the importance of comparative collections and appropriate methodologies for analysis. As anthropologists, we recognize the humanistic nature of our studies—not amoebas under a microscope, or stars throughout a galaxy—but humans analyzing the remains of other humans. We are not callous individuals holding on to the interest of our scientific method at the expense of human emotional feelings toward the dead. Reburial and repatriation are appropriate healing measures in the correction of past insensitivities. However, our science is not merely an esoteric, intellectual investigation of the past, but provides a practical scientific application in dealing with some of the most sensitive human issues in modern societies: identification and recovery of victims of war, mass disasters, criminal activities, and missing persons. As forensic anthropological scientists, we seek to strike a sensitive balance between the importance of research regarding human remains and the application of that research for the recovery and emotional closure of distressful situations.

Forensic scientists contribute their unique training and experience to both the day-to-day osteological-related inquiries that occur in their local communities and state, as well as horrific crimes or large scale disasters which affect the national psyche. Most importantly, forensic archeologists must seek answers to sensitive questions: who is represented by the recovered skeletal remains, what was the probable cause of death, and what is the appropriate post-analysis treatment of these remains. Scientific analysis provides forensic archeologists with a pertinent framework for both rigorous medico-legal testimony and the humanistic comforting of family members and other concerned parties.

Cultural resource managers are only infrequently called upon to assist with forensic archeological investigations as part of site development or project-related mitigation and indeed, may never partake in a criminal or disaster investigation. However, an increasing number of cultural resource management projects involve the professional removal and recording of human burials. As a result, physical anthropologists and osteoarcheologists often provide technical guidance for those sensitive projects which deal with human remains. All cultural resource managers should familiarize themselves with the appropriate state and federal laws that pertain to the professional treatment of unmarked burials and forensic inquiries. Government officials, who are mandated with responsibilities for cemetery protection, should be identified and state-specific procedures for notification understood before a crisis-related situation occurs. State Historic Preservation Offices and Offices of State Archeologists are obvious sources of such information. Cultural resource managers may be asked to participate as part of coordinated teams for investigative purposes. Familiarization with laws and officials can expedite procedures during emergency situations. This thematic issue of *CRM* provides important information concerning those federal agencies with the appropriate expertise in forensic studies, and examines projects where forensic archeological and anthropological techniques have contributed to the respectful treatment of historic burial grounds as well as the investigative processes used for criminal activities and disaster relief.

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Thomas A.J. Crist and Daniel G. Roberts

Engaging the Public Through Mortuary Archeology

Philadelphia's First African Baptist Church Cemeteries

...our particular species is utterly distinctive in this regard, that our very concept of who we are and of our basic worth is inextricably bound up in our abiding impulse to honor and memorialize our dead...the simple act of respect for the dead that is, in its essence, an expression of respect for their lives.

*—Newsweek**

Photos courtesy John Milner Associates, Inc.

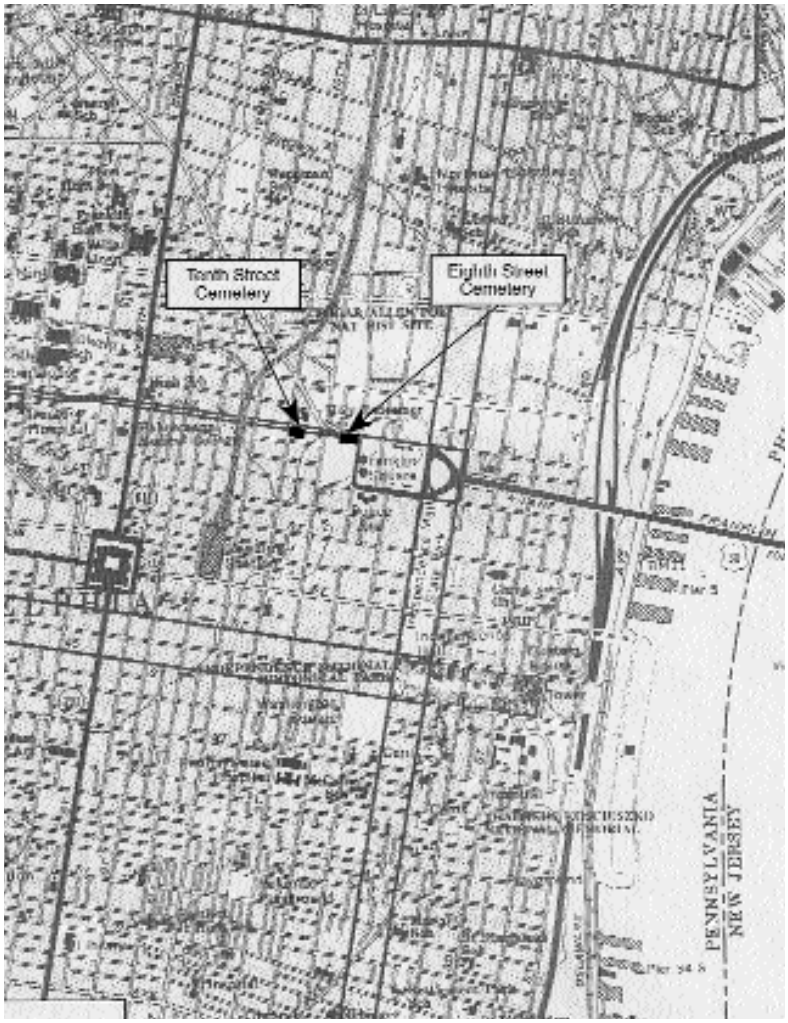
In today's economic and political climate it is fundamentally important for archeologists to promote archeology to the public. This is especially true since public dollars fund the vast majority of archeological research currently conducted in the United States. While many archeological projects are worthy of, and indeed attract, public attention, it is mortuary archeology projects that frequently elicit the most intense public interest and community response. As such, historical cemetery archeology provides a natural educational forum through which archeologists can reach and engage the public.

Over the past two decades, most of the historical cemetery excavations conducted in the United States were undertaken in compliance with federal preservation mandates, especially the National Historic Preservation Act of 1966. These laws and implementing regulations make cultural resource consideration an important aspect of the environmental and land planning processes. Local and state ordinances regarding abandoned or unrecorded cemeteries are also frequently invoked when development threatens a historical burial ground. Along with federal preservation legislation, local and state statutes offer various levels of protection for undocumented cemeteries. While many of these statutes fall short in terms of enforcement, their existence has facilitated either the avoidance or the professional archeological excavation of numerous historical cemeteries.

Members of the First African Baptist Church and the project team prepare for the Tenth Street Cemetery Reburial Ceremony at Eden Cemetery on May 8,1995. The human remains were reinterred in a plot adjacent to those from the Eighth Street cemetery, buried in 1987.

The past two decades have also witnessed a fundamental change in the way archeologists and anthropologists approach their research. Two sociopolitical currents have come together to make anthropologists realize that they no longer have complete domain over the data they can potentially collect. First, various Native American groups have begun to assert their claims to cultural property, whether newly discovered or held by American museums, particularly human remains and grave goods associated with their ancestors. This movement culminated in the Native American Graves Protection and Repatriation Act, enacted by Congress in 1990. This legislation protects Native American human remains and associated cultural items and sets out guidelines for the appropriate treatment of these materials. Second, the public has increasingly demanded an active role in scientific research, especially that which affects interpretations of the past. In the archeological realm these currents have resulted in a new focus on public outreach and the engaged involvement of communities descended from those buried in threatened cemeteries.

The inclusion of cultural, social, political, and spiritual components of historical cemeteries benefits both archeologists and the public at large (Crist, in press). For the archeologist, such inclusion serves to bring into clearer focus the non-scientific values embodied in past human remains. For the public, these projects serve to heighten



Although used by separate congregations, both First African Baptist Church cemeteries were located within two blocks of each other along the northern boundary of 19th-century Philadelphia. Today the Vine Expressway carries thousands of vehicles over the former site of the church's original meeting house. Drawing by Sarah Ruch.

awareness about the scientific value of studying past human remains while also enhancing knowledge about historical American social groups about which only incomplete documentation exists. Further, educational outreach programs that celebrate a past group's heritage frequently foster cultural pride and community involvement. Because people are interested, they often become active in exploring their community's history. Many times this interest extends to the children in the community, a traditional focus for many of the Archaeology Week programs sponsored by State Historic Preservation Offices around the country.

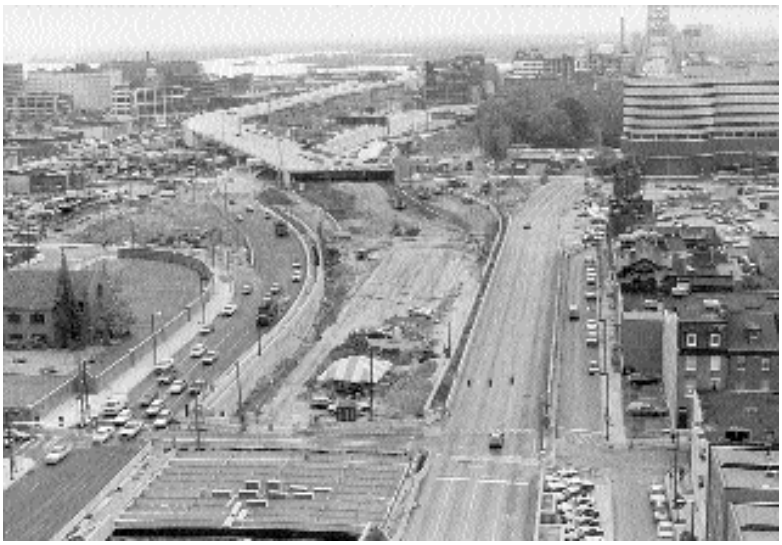
Public interest in African-American archeology has increased in recent years due to the excavation of several historical African-American cemeteries, most notably in Baltimore, Dallas, New York, St. Louis, and Philadelphia. These excavations were all necessitated because construction activities threatened unmarked burial grounds obscured by highways or modern buildings. In Philadelphia, the First African Baptist Church Cemetery Projects brought archeologists and the public together through a series of educational outreach efforts designed to engage the community in the excavation and analysis of remains from two separate cemetery sites (Roberts and McCarthy 1995). The results effectively focused public attention on the urban experience of Philadelphia's free African Americans during the first half of the 19th century. Close cooperation with the leaders and members of the current First African Baptist Church provided them with opportunities to learn more about the church's founding, as well as the growth and development of other African-American Baptist congregations in the region.

Thirteen African Americans founded the First African Baptist Church in 1809. The church subsequently split into two congregations in 1816. The splinter group relocated to property owned by the Reverend Henry Simmons at Eighth and Vine Streets about 1824 and buried their dead there until about 1842. The original congregation worshipped at a meeting house on Tenth Street below Vine, where a burial ground was used between circa 1810 and 1822. The Tenth Street church relocated to a building in south Philadelphia in 1906, where the congregation currently meets.

The Eighth Street cemetery, in use between circa 1823 and 1842, was discovered during archeological monitoring activities associated with the construction of a commuter rail tunnel in 1980. Excavated by archeologists from John Milner Associates, Inc. in 1983 and 1984, the remains of 140 individuals and associated mortuary artifacts were identified and carefully removed from the site.

Recognizing the keen public interest in the excavation of the Eighth Street cemetery, the archeologists erected a wooden platform at the site so that visitors could safely view the excavation in a panorama-like setting. Staff members from the Afro-American Historical and Cultural Museum, located three blocks from the former cemetery, provided organized tours from the platform's vantage point. Advertisements for the tours were placed in all major Philadelphia newspapers, including the African-American Philadelphia Tribune. Almost 3,000 people took advantage of these tours over the two field seasons, including school groups and numerous members of the First African Baptist Church congregation.

A significant area of community engagement centered on the current members of the First African Baptist Church. The archeological team apprised church members of the excavation's research design early on in the project and the latter actively participated in assembling data on the church's founding and early history. The scientific team periodically made presentations to the congregation regarding the excavations and actively solicited church members' input. Most significantly, members of the congregation became

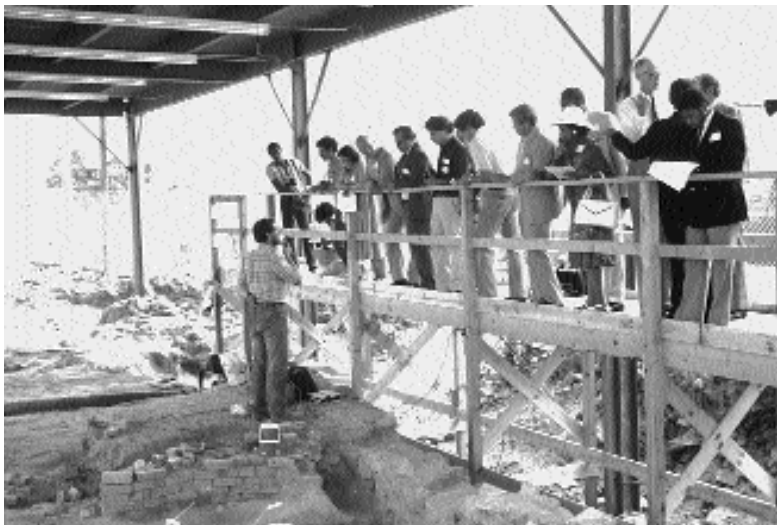


The Tenth Street cemetery site was located just west of the Benjamin Franklin Bridge between the eastbound and westbound lanes of Vine Street.A tent was erected to protect the human remains and associated artifacts during the excavation.

directly involved in planning the reburial of the human remains disinterred from the site. The reburial ceremony took place in July 1987 after three years of study at the Smithsonian Institution. The remains were reinterred at Eden Cemetery in neighboring Delaware County, presently used by the modern First African Baptist Church congregation.

Due in no small part to the active engagement of the African-American community and members of the church, media attention generated by the project was particularly positive. The local newspapers carried numerous articles about the excavation, while radio and television news programs devoted several segments to the project. A local filmmaker also produced a documentary video that chronicled the archeological investigation. Narrated by a prominent Philadelphian, the Reverend Paul Washington, the film *Ground Truth: Archaeology in the City* was released in 1988 and has been shown in classrooms across the nation and around the world.

John Milner Associates, Inc. also excavated the Tenth Street cemetery at the former site of the original church building. The Tenth Street site was identified prior to construction of the Vine Expressway through center-city Philadelphia and was excavated in 1990. This time the location of the site within the lanes of Vine Street precluded public observation of the excavation, although members of the congregation again visited the site on numerous occasions. Here, the archeologists excavated the skeletal remains of 89 individuals and associated funerary artifacts interred between circa 1810 and 1822, including well-preserved coffin hardware and clothing fragments. These remains were analyzed at John Milner Associates' Osteology Laboratory in Philadelphia, located four blocks from the site.



Nearly 3,000 people observed the excavation of the Eighth Street cemetery site in 1983 and 1984.The archeologists fielded questions from the visiting groups and also distributed a short brochure outlining the project and its progress.

Since public involvement during the Tenth Street cemetery excavation was limited, a concerted effort to engage the public in the laboratory analysis of the remains ensued. The firm hosted over 50 school groups and tours in the laboratory during the course of the subsequent several years of study. These groups ranged from first-graders to graduate students, with a particular emphasis on children from the inner-city schools. Groups from the Phil-A-Kids program sponsored by the local Atwater Kent Museum also toured the laboratory each summer during this phase of the project.

The highlight of the laboratory tours was an ancestral homecoming ceremony conducted in June 1993 by the project's cultural anthropologist for members of the First African Baptist Church congregation and other interested members of the community. This ceremony brought together the project's scientific team and the current members of the church to honor the spirits of those interred in the cemetery, discuss the findings of the analysis, and begin preparations for reburial of the human remains. In the months following the ceremony, church leaders actively planned the reinterment of the remains, again at Eden Cemetery, adjacent to the burial plot in which the Eighth Street cemetery remains were reburied in 1987. The Tenth Street cemetery reburial ceremony took place in May 1995 and was attended by over 40 members of the current church and most of the scientific team. At the congregation's request, the mortuary artifacts from the Tenth Street site are permanently curated at the Afro-American Cultural and Historical Museum in Philadelphia, completing the circle of engagement that began with the excavation of the Eighth Street cemetery 12 years earlier.

The two First African Baptist Church Cemetery Projects elicited the involvement of Philadelphia's African-American community in a meaningful exploration of its past. The research findings and public presentations made by the project team effectively focused public attention on

the many ways in which African Americans contributed to Philadelphia's history and society in general. Both projects highlighted the benefits of public outreach in mortuary archeology projects and underscored the potential to effectively engage the community in the various aspects of archeological excavation and analysis. They also emphatically demonstrated that involvement of the public in mortuary archeology projects has significant benefits for all, as long as archeologists are willing to recognize concerns of the interested or affected segments of the community and most importantly, respect those non-scientific values embodied by burial grounds and human remains that the community holds as important.

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* Quoted from an article by Meg Greenfield in *Newsweek*, April 22, 1996, p. 88.

Gregory F. Walwer

Combining Archival and Archeological Research

The Connecticut School for Boys Cemetery

When it was announced that state land which lies adjacent to the State Police Headquarters in Meriden, Connecticut would soon serve as grounds for a multi-million dollar hospital project, considerable public outrage ensued. Concerned citizens indicated that many adolescents were interred on the property when it was occupied by the Connecticut School for Boys, a reformatory and orphanage that operated between 1853 and 1973.

Also known as the Meriden School for Boys and the State Reform School, the facility housed up to several hundred juvenile males at any given time. Historic sources indicate that many of the boys who had died at the school were interred somewhere on the property. While none of the available records suggest which portion of the grounds was used as a cemetery, word of mouth and local newspaper accounts indicated to many that a small hill represented the principal burial grounds at the facility. In 1986, a monument marking the site was installed.

Despite this information, local citizens were convinced that the boys had been buried throughout the 50-acre property. To support this contention, they contrasted the small size of the hill with a list of well over 100 names of boys who they had determined to be buried at the facility. To add confusion to the matter, community members were concerned about several depressions in the earth, which were later found to correspond to areas of previous geological testing. As a result of vague historic information and intense concern expressed by local citizens, the Connecticut

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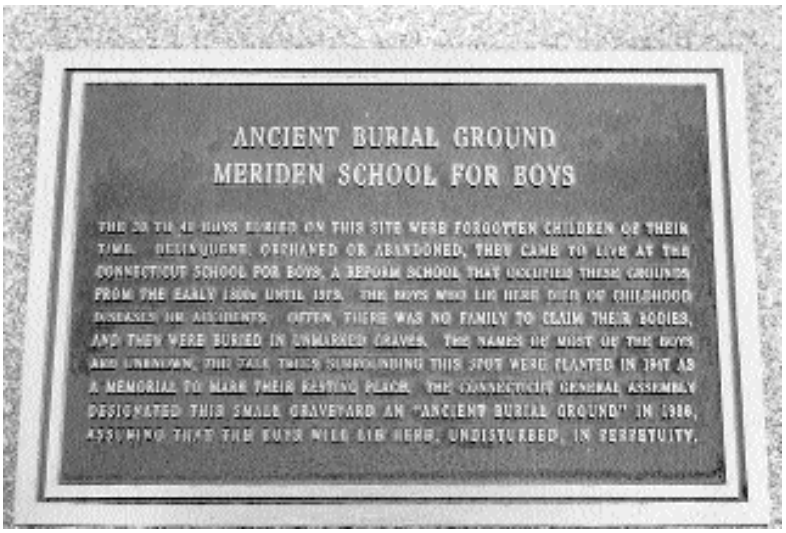


General Assembly enacted Special Act 95-25 which called for the Connecticut Department of Public Works to more thoroughly investigate the possibility for the existence of burials and their location on the property before its final transfer to the hospital development group.

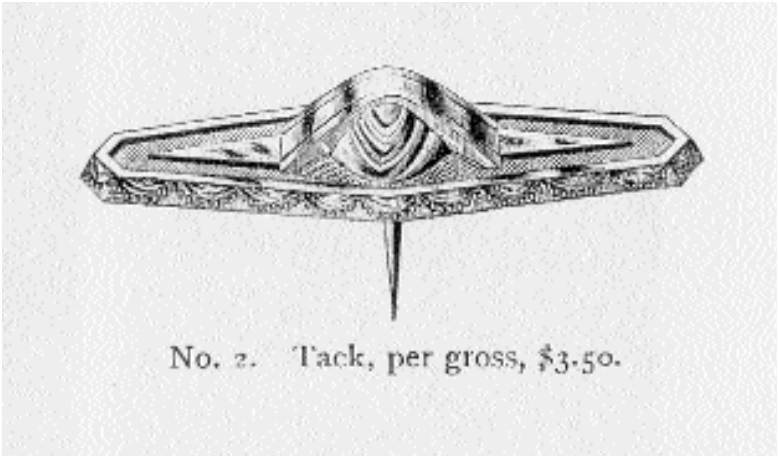
The Public Archaeology Survey Team Inc. conducted a ground penetrating radar study of the small hill which was marked by the monument, as well as a similar hill located within 200 feet of the first. The first hill revealed a high density of both point and multiple anomalies as well as a scatter of shallow metal strikes, while the adjacent hill revealed a rather normal distribution and density of anomalies.

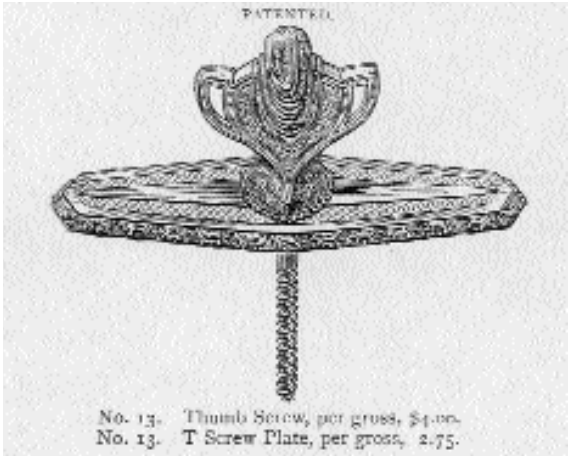
Armed with the citizens' list of names, death certificates for many of the boys who died at the school (provided by the Connecticut Office of State Archaeology), and the results of the remote sensing study, Archaeological Consulting Services conducted research using a combination of archival and archeological methods in order to determine the location of burials on the property, the probable number of interments, as well as any other cultural resources which might be present. Archaeological Consulting Services worked with the Connecticut Department of Public Works, the Office of the State Archaeologist, and the Connecticut Historical Commission (State Historic Preservation Office) in creating an appropriate research design.

Various sources were consulted in an effort to independently document the location of the cemetery, the names of boys who had died at the school, and their final disposition. Local histories and historic maps revealed that the project area was initially open space, and subsequently used as an orchard by the late 18th century. For much of the school's history, the proposed project area, beyond the limits of the "recognized" cemetery area, was used for agriculture that supported the school in its administrative goal of self-subsistence. Toward the middle of the 20th century, ball fields had replaced the agricultural fields. In 1973, the school closed and the project area served as a training ground for the State Police K-9 unit until construction began earlier this year. None of the historic sources yielded a clear indication of the cemetery's location.

The initial list of boys included those which had been found through research of the Town of Meriden's death indices by concerned local citizens. Some names also came from an 1899 ledger of a former school superintendent. Public records kept by the state provided a yearly account of how many had died at the school (121 deaths by 1940), but no specific names or information on burial location. Unfortunately, the state's accounting often conflicts with the yearly count of deaths from town hall records. In order to help resolve this problem, Archaeological Consulting Services independently reviewed all available death indices at the town hall. In many cases, the names provided on initial lists appear in the death indices and other sources with the place of death noted as the school (86 total), but without specific burial location information. In other cases, the entries did not give the school as the place of death and apparently had been included because of youthful age or lack of parents' names in the records (21 total), thus their affiliation with the school remains unsubstantiated.

Available death certificates, death indices from the town hall, and the 1899 ledger confirm that at least 23 boys were buried at the school, which still left a significant discrepancy with respect to the total number of boys known to have died at the school. Archaeological Consulting Services then consulted the Hale Index to headstone inscriptions in Connecticut. This mega-volume reference, a 1934 Works Progress Administration compilation, includes comprehensive indices of alphabetized names appearing on headstones within each town. Between death certificates indicating burial location and a search of the Hale Index corresponding to the known birth location or previous town of residence for each boy, 24 of the originally listed boys were found to be buried off-grounds. Others may have been buried in unmarked graves in their respective home towns; in other locations throughout Connecticut as families relocated; out of state as determined for a few of the boys; or in the several Town of Meriden cemeteries where there are many headstones with either initials or last names that correspond to the names of boys whose burial locations could not be further determined. Therefore, of the 86 boys who were confirmed as





Illustrations, from the Catalogue of Casket Trimmings Manufactured by the Meriden Britannia Company, West Meriden, Connecticut, USA *(1880), of coffin hardware recovered from archeological testing at the Meriden School for Boys site.*

having died at the school, the burial location of 39 remains unknown.

The 1899 ledger, a highly confidential document, indicates that 36 burials took place on the property by the turn of the 20th century. Improved medical techniques and conditions at the school by this time drastically reduced the mortality rate, as indicated by the seven burials and less than two dozen deaths known to have occurred after this time until the school closed. The long list of causes of death listed on the death certificates includes albuminuria, appendicitis, brain congestion, brain dropsy, cerebro-spinal congestion or meningitis, cholera, consumption, convulsions and paralysis, diabetes, diarrhea, drowning, dysentery, endocarditis, epistasis, heart failure, influenza, internal hemorrhage, liver disease, malarial fever, membranous croup, nephritis, otitis media puruleuta, pericarditis, phthisis, pneumonia, reno-cardiovascular disease, rheumatism, scarlet fever, skull fracture, spinal cord apoplexy, suicide, sunstroke, transverse myelitis, tuberculosis, tumor, and typhoid fever, some of which reflect the difficult working conditions and possible physical abuse at the school early in its history. While archival research indicates that as many as 100 boys could have been buried at the school, only 23 individuals could be confirmed as buried at the school, and best estimates indicate about 50 to 60 burials on the property.

Field testing included excavation units on the two hills, a stratified-systematic placement of shovel tests throughout the property, and the systematic placement of mechanically-assisted test trenches. The latter test units covered approximately 10% of the 11.5-acre impact area to the north of the two hills, and were excavated in approximately six-inch intervals in order to expose possible burial features. All test units were excavated to a depth which revealed undisturbed glacial gravel, so as to exhaust all possibilities of revealing interment features and/or their contents.

Two excavation units were placed on the hill marked by the monument, and situated so as to cover the greatest density of anomalies and metal strikes revealed by the remote sensing study. The first unit revealed an intricate network of holes or tunnels created by a burrowing animal, as indicated by a nest, at a depth of three feet, containing pine needles and modern debris. Several casket trimmings found in this test unit represent intrusive material as a result of the animal tunnels.

The second excavation unit revealed a significant feature which was detected at less than six inches below the surface. The feature turned out to represent the edge of two overlapping features which lacked the normal stratigraphy of the surrounding soil matrix. By a depth of approximately four feet, one part of the feature tapered into the side wall of the unit, while the main portion of the feature revealed a soft, brown stain in a corner of the unit. Further excavation in this area revealed the crumbled corner of a casket and a high density of casket trimmings.

Analysis of the features and recovered material produced interesting results. The overlapping of interment features is a good indication for the historic lack of headstones and the school's lack of precise record-keeping regarding prior burials. In addition, the burial orientations do not reflect a traditional facing to the west or nearest road; this situation is not unusual given the nature of this historic institutional setting. The wood species of the casket, however, was revealed to be *Liliodendron tulipifera*, or yellow poplar, which is a good quality soft-hardwood. The exterior of the wood exhibited a fine varnish coating. Most surprising, perhaps, was the inclusion of silver-plated casket trimmings. The ornate, zinc alloy coffin tacks and screws were determined to have originated from the Meriden Britannia Company, a large producer of fine household goods until well into the 20th century. The terminal date for the manufacture of the coffin hardware has not been determined, but they appear in an 1880 catalogue

Community activists protesting the presumed desecration of unmarked burials associated with the former Meriden School for Boys. Photo courtesy Archaeological Research Specialists.

of casket trimmings and do not appear in the 1869 catalogue. The fine crafting and expense devoted to at least two of the caskets is surprising given this institutional setting.

Three partial features were exposed in the 200 square feet of excavation. The demarcated bounds of the "cemetery" that correspond to the raised hill enclose an area that measures approximately 5,000 square feet. This suggests a density which could accommodate up to 75 burial features, taking into account the partial exposures and overlapping features. It was therefore concluded that the cemetery area could very well contain all 50 to 60 suspected burials.

A single excavation unit was placed on the second hill in an area for which the remote sensing study revealed the highest number of point anomalies. Excavation to a depth of less than two feet revealed a glacial gravel substratum as predicted by surficial materials maps. In addition, small boulders were found throughout the unit, thus accounting for the anomalies which in the remote sensing study merely indicate notable changes in density beneath the surface. Several bones were found, but all were identified as belonging to domesticated animals which were known to have been raised at the school.

No other archeologically examined areas revealed any traces of burial features or remains of a funerary nature. Information from shovel tests throughout the project area confirmed the presence of a plow zone that reaffirms the contention that the grounds outside of the cemetery area were used primarily for agriculture. This disturbed stratum contained a scatter of whiteware plates and chamber pot fragments whose density increased towards the school buildings which lie outside the project area.

Archaeological Consulting Services strongly recommended that the cemetery area be avoided and preserved; final design plans for the proposed hospital reserved the cemetery as open space. As a final protective measure, Archaeological Research Specialists monitored construction-related activities in order to ensure *in situ* conservation of the unmarked burials.

The Connecticut School for Boys Cemetery demonstrates the importance of using a combination of archival and archeological research to solve 20th-century problems. More significantly perhaps, research confirmed the cemetery area as the final resting place for those boys who had died at the school without violating the trust that they would remain "undisturbed, in perpetuity." Likewise, archeological research ensured that an important 20th-century development project could proceed.

A highly vociferous handful of local residents, who strongly opposed the proposed hospital project based upon their fears that the new facility would in fact provide fewer medical services than the existing health care system, produced an interesting aside to this project—a different archeological consultant for each phase of the investigation. This group continually refused to accept the archeological results and even cast aspersions regarding the "independence" of the researchers. In contrast, the Office of the State Archaeologist, the Connecticut State Historic Preservation Office, the participating agencies, and the general public realized an unintentional extra benefit from this local controversy—the professionalism and integrity of three Connecticut-based archeological consulting organizations applied to a common purpose: the identification and protection of the school's historic burying ground.

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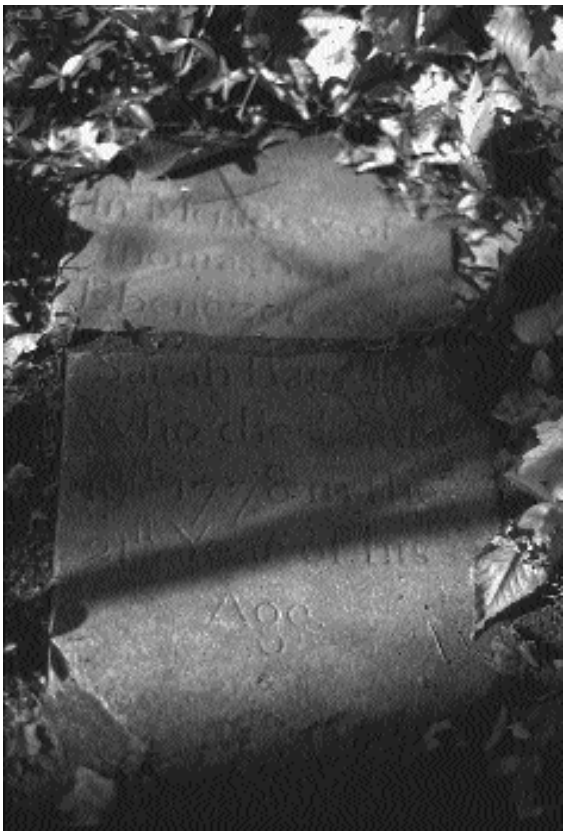
Although 23 burials at the school were confirmed through historic documentation, public records of the State of Connecticut indicate 121 deaths at the school between 1853 and 1940. Only 86 individual deaths at the school were reported in the death indices at the Meriden Town Hall or other sources. At least 24 of these were found to be buried in their home towns or other Meriden cemeteries, thus accounting for 47 of the 86 confirmed deaths. The school cemetery contains an estimated 50 to 60 graves.

David A. Poirier

In Perpetuity

The Northrup Cemetery



Vandalized 18th-century gravestone from the Northrup Cemetery. Photo courtesy Phenix Environmental Inc.

A small hardscrabble parcel, bordered by a seldom used rail line and a lesser traveled town road, the Northrup Cemetery was a forlorn half-acre. Although the oldest burying ground in Brookfield, Connecticut, the Northrup Cemetery was barely recognizable as sacred ground. The few surviving gravestones had been vandalized, knocked over, and were on the verge of being reclaimed by the surrounding soil. Incomplete strands of barbed wire fencing marked the cemetery's border with the railroad tracks; an adjoining, privately-owned sand and gravel operation threatened to undermine one side of the cemetery. This rural, family burial ground was poised to become another forgotten and abandoned historic site.

Despite its near-terminal appearance, the Northrup Cemetery was identified through extensive cultural resource research associated with the proposed construction of a buried natural gas pipeline through areas of New York and western Connecticut. Consultation among the Connecticut State Historic Preservation Office, the Office of the State Archaeologist at the University of Connecticut (Storrs), and the Iroquois Gas Transmission System revealed that alternate route alignments were not feasible. Parallel routing with the extant rail line posed unresolveable safety issues; other route variations would seriously impact sensitive wetlands or the nearby 20th-century United Jewish Cemetery. Iroquois was literally caught between a railroad and a wetland, rather than a "rock and a hard place."

Proposed narrowing of the pipeline construction right-of-way from the standard 75 feet width to 24 feet was examined as a possible solution. However, uncertainty existed as to the possible presence of historically unmarked graves. Previous research in Connecticut has revealed that, among others, infants, paupers, Native Americans, and African Americans were often interred without gravestones. In an attempt to resolve this important concern, Iroquois Gas Transmission System conducted a ground penetrating radar survey throughout the Northrup Cemetery. The GPR study identified several anomalies which appeared to represent potential grave sites along the proposed narrower construction right-of-way. The archeological excavation of the proposed pipeline construction zone, the professional disinterment of any effected grave, and subsequent reburial elsewhere within the cemetery was considered a viable course of action in light of the complexity of the situation.

After considerable analysis of its options, Iroquois decided that disturbance of this historic cemetery was an untenable solution. In that the GPR study indicated that bedrock occurred between 40 and 120 inches across the cemetery site, the surprising preferred option was to bore through the bedrock beneath the cemetery and install the pipeline within a rock tunnel. The corporate consciousness and flexible decision-making of the Iroquois Gas Transmission System ensured the perpetual rest and continued sanctity of this otherwise neglected late-18th-century colonial cemetery in rural Connecticut. Of equal importance, the Northrup Cemetery is a powerful reminder that creative insights deserve full exploration with respect to the sensitive treatment of other threatened burial grounds.

Dr. David A. Poirier is Staff Archeologist and Environmental Review Coordinator for the Connecticut State Historic Preservation Office.

Nicholas F. Bellantoni and David G. Cooke

Criminal Investigations

A Forensic Archeology Case Study from Connecticut

Recent state legislation in Connecticut has provided for professional archeological involvement when unmarked burials are accidentally encountered during construction and other land-altering activities or as a result of cemetery vandalism. As a result, the Office of State Archaeology at the University of Connecticut (Storrs) and the State Historic Preservation Office have provided technical assistance to law enforcement agencies throughout the state. Most notably, criminal trespass at the Chauncey family crypt at the Indian Hill Cemetery in Middletown, Connecticut, evolved into a case study where forensic archeological and anthropological techniques were employed to assist municipal police to understand the nature of the vandalism, to provide information on the sequence of criminal events, to sort skeletal remains disturbed during the vandalism, and to restore the desecrated family crypt as near as possible to its original condition.

In August 1991, the state archeologist was notified that a human skull had been discovered in a wooded area behind a car wash facility in Cromwell, Connecticut. This discovery appeared to be linked to a different on-going investigation that was being conducted by the Middletown Police Department, which requested our technical assistance in identifying this unusual find.

The specimen consisted of a single human cranium (the part of the skull that includes the bone face, upper jaw, and vault areas). No mandible or lower jaw was present. The discovery was considered to be "old bone" by the Office of State Archaeology in that it contained little organic matter and exhibited a breakdown of the cortical/periosteal surface. Although the skull was found lying on the surface of the ground in a wooded area, it showed no signs of weathering, bleaching, rodent gnawing, or other marks indicative of exposure. In addition, the skull gave no evidence of soil adherence or plant root development in any cranial foramena. Thus, it had been neither buried in the ground, nor exposed to the elements for any length of time. Age, sex, and racial estimates strongly suggested an adult, white female, probably 45 to 55 years old. All dentition was lost perimortem. Cause of death or other pathological conditions could not be discerned.

After preliminary analysis by the Office of State Archaeology, the police requested further technical assistance with an on-going investigation of vandalism at a family crypt in a Middletown cemetery. Police investigators had been working the case for a number of months and questioned whether the Cromwell skull could have originated from the Chauncey family crypt at Indian Hill Cemetery. One investigative "lead" involved certain individuals of known satanic cult associations whose motive for the break-in and vandalism would be to obtain a human skull for ritual purposes.

The Chaunceys were a very prominent early New England family, emigrating from England by 1638. The Chanucey lineage includes the second president of Harvard College, the first full-term graduate of Yale College, celebrated ministers, and a co-builder of the Panamian railroad. The family crypt is architecturally impressive with brownstone arched doorways leading to the 130 square foot interior. Three rows of stacked vaults house 17 members of the Chauncey family dating from 1821 to 1979.

The state archeologist and a team of students and avocational archeologists entered the crypt to identify and interpret human remains and material culture disturbed by the vandalism. Four vaults had been clearly violated. The crypt's marble-tiled floor was littered with disarticulated skeletal remains, wooden and cast-iron coffin fragments, burial clothing, casket linen, and hardware

Chauncey Family Crypt,Indian Hill Cemetery, Middletown, Connecticut.Photo by the author.

Vandalized Gravestone for Lucy Alsop Chauncey resting on the Floor of the Interior of Chauncey Family Crypt.Photo by Middletown,CT Police Dept.

from the desecrated burials.

In order to facilitate the recording of the spatial distribution of the human remains and coffin parts scattered within the crypt, a modified archeological grid system was devised. A wooden frame, constructed and elevated by corner posts over the crypt floor, provided pertinent datum points for subsequent field measurements. A gasoline-powered generator and several large flood lights were installed for adequate lighting. Once in place, standard archeological field methods for the recording of human remains and material culture enabled the controlled recording of horizontal and vertical provenience in order to determine the spatial orientation and relationship of the vandalized burials.

Skeletal remains of four individuals ranging in age from 2 to 68 years at death were documented *in situ* on the crypt's floor and subsequently sorted in order to develop a sequence of criminal activity and to restore the remains to their appropriate burial vaults upon completion of our investigation. In this process, it was established that the cranium discovered in Cromwell was that of Lucy Alsop Chauncey, who died in 1855 at 56 years of age.

Based on the horizontal and vertical distribution of osteological remains, coffin parts, and funerary remains on the crypt floor, the Office of State Archaeology was able to reconstruct the probable sequence of events for the criminal activities. Skeletal elements for all of the individuals whose vaults had been violated were accounted for in the crypt with the one exception of Mrs. Chauncey's cranium. The degree of decomposition of her post-cranial remains were consistent with that of the cranium and the mandible fit into the temporal-mandibular fossa. The archeological recovery of jewelry and other objects of monetary value as well as the haphazard manner in which human and coffin remains were scattered throughout the crypt appeared to eliminate burglary as a motive for the vandalism. There was no indication of any systematic search for artifacts which one would expect if the vandals were looking for material to sell or collect. While we cannot positively account for what else may have been removed, we are absolutely confident that the cranium that was recovered by the police was removed from Lucy Chauncey's crypt, supporting the contention that satanic cult activity may have been a possible motive.

With the evidence from the forensic archeology at the Chauncey family crypt, Middletown Police arrested a suspect, of known satanic cult involvement, for the robbery of a gun store. This individual was taken into custody in lieu of $10,000 bond following his arrest and was arraigned on four counts of interfering with a cemetery or grave site, one count each of third-degree burglary, first-degree criminal mischief and sixth-degree larceny.

Federal, state, and local law enforcement agencies are recognizing the importance of establishing an investigative partnership with archeologists and anthropologists in their efforts to collect physical evidence from crime scenes whenever human remains are involved. Archeological field techniques have been designed to maximize the information retrievable from a given site where ostensibly very little cultural material remains exist for analysis. The application of archeological research methodologies to a criminal investigation will result in a greater degree of accuracy in the location of physical evidence and the best assurance for the recovery of materials and remains that may otherwise be lost. Archeologists are seldom familiar with criminal investigation procedures and require the supervision of a professional criminal investigator. Likewise, the criminal investigator may not be aware of the sophisticated techniques and analyses archeologists can provide. Archeologists need to familiarize themselves with state and local legislation regarding forensic applications of their work as well as the appropriate state cultural resource managers with mandates to oversee such investigations. Cooperative partnerships between law enforcement agencies and archeologists and anthropologists, like the successful case of the Chauncey family crypt, will result in the improvement of forensic sciences and hopefully, successful prosecutions at the community and state judicial levels.

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David G. Cooke is an amateur archeologist who resides in Rocky Hill, Connecticut. He frequently provides technical assistance to the Connecticut Office of the State Archaeologist.

John L. Konefes and Michael K. McGee

Old Cemeteries, Arsenic, and Health Safety

Widespread use of arsenic in embalming fluids began during the Civil War period.

Photos by John L. Konefes.

Embalming human remains for burial has taken a long road to its present state as an art that now minimizes health and environmental concerns of burials. Along the way, health and safety were not always considerations. From the Civil War until about 1910, arsenic was the main ingredient in the embalming fluids used widely throughout the country. Although effective, arsenic is toxic and persistent, and elemental arsenic will never degrade into harmless by-products. Progress in embalming practices during the late 1880s has left a legacy that can potentially harm the health of archeologists or cemetery workers, and impact the environment. Awareness of this potential problem is the first step in alleviating any real damage that might occur.

Arsenic embalming began as a sanitary practice and a practical means to preserve the body until burial or for transport. Considering that the alternative was ice, arsenic embalming seemed like a significant improvement. What the embalming practitioners, or undertakers, did not consider were the long-term effects of placing significant amounts of arsenic in concentrated burial areas—cemeteries.

The arsenic that endures today can pose significant danger to forensic archeologists, cemetery workers, or individuals that may be utilizing potentially contaminated groundwater supplies.

In the U.S., the widespread use of arsenic in embalming fluids began in the Civil War period. Dr. Thomas Holmes, the "father of American embalming," was engaged by the medical department of the Union Army to set up battlefield embalming stations to enable the bodies of Union dead to be returned home. Numerous embalmers were trained in these new techniques, which included preparation of embalming fluids.

Although fluid composition was often a trade secret, arsenic was the primary embalming agent because it effectively killed or halted the microorganisms responsible for decomposition. Other embalming compositions were used less frequently and contained similar toxic materials such as mercury or creosote.

At the end of the Civil War, successful embalmers returned to their hometowns and took their craft with them. This expansion of arsenic-based embalming gradually came to encompass all areas of the country.

From 1856 to 1873, six patents were issued for fluids that contained arsenic, from as little as four ounces to as much as 12 pounds of arsenic per body. Individual embalmers could also create their own formulas by going to the local pharmacy to get the necessary quantities of arsenic. The 1878 publication, *The Undertaker's Manual*, contained several embalming fluid formulas, the majority of which were arsenic based. A popular formula of the time contained about four ounces of arsenious acid (an arsenic trioxide) per gallon of water, with two or more gallons of fluid recommended for proper embalming.

Chemical embalming spread most rapidly in the 1880s, when fluids were compounded and sold commercially. Fluid compounders sent salesmen on the road to demonstrate fluid use and broaden their customer base. The salesmen provided at least rudimentary instruction in embalming techniques and helped continue the growth of chemical embalming.

The demand for chemical embalming stimulated the creation of embalming institutes or schools. Some of the earliest were the Rochester (New York) School of Embalming and the Cincinnati School of Embalming. Correspondence courses overcame geographic barriers and embalming practitioners began providing services

in every state. For example, chemical embalming in Iowa began about 1879. An enterprising young undertaker from Iowa City, Dr. William Hohenschuh, took a correspondence course from Dr. Auguste Renouard, founder of the Rochester School of Embalming. Dr. Hohenschuh spread the technique to his fellow undertakers and by 1899 there were at least 240 registered embalmers in Iowa.

Burials in the late 1800s are most likely to have used arsenic embalming practices.

Burial practices during this time period also have a bearing on problems associated with the release of arsenic. Initially, burials were primarily in wood coffins that were placed directly in the ground. Throughout the latter 1880s, use of metal burial containers, such as the Fisk Metallic Burial Case and combination metal and wood caskets, increased. In either case, no burial vaults that enclosed the coffin were used.

Embalming and metal containers added cost to funeral arrangements, and were generally only used by those who could afford them. In many cases, burial of non-embalmed persons in wooden caskets was still the only viable option. Yet embalming became increasingly affordable and popular.

Both wooden and metal caskets will eventually degrade and begin to allow contact of the embalmed remains with the environment. Arsenic, a basic element, will not change or degrade, but must remain with the remains or move into the environment. As the containers corrode, water moving downward through the soils of cemeteries can dissolve arsenic from the burials and move arsenic into the soil or groundwater. This slow spread of arsenic from numerous sources in an old cemetery can lead to serious environmental and health problems.

To understand the potential impact, assume a hypothetical cemetery in a modest sized town. It is reasonable, for the period 1880 to 1910, to assume that 2,000 people died in that time period. If half of those were embalmed with arsenic, using six ounces of fluid per person, the cemetery contains 380 pounds of arsenic. If the embalmers in the area used more arsenic, such as three pounds per person, then the cemetery would contain over one ton of arsenic. In either case, this is a significant amount of a potent, toxic material to find in the ground at one location.

In the early 1900s, arsenic use was banned from embalming. The driving force for the ban was the concern for health of embalming practitioners, and interference with autopsies after embalming had occurred.

Today, arsenic is prevalent in or near old cemeteries. Some of the most compelling evidence is the recent analysis of the remains of an embalmed Civil War soldier. The tissue sample

revealed that arsenic was present at a concentration of 28,000 parts per million, or 2.8 percent. This is firm documentation that arsenic embalmed remains can carry the arsenic residue for many years.

Evidence of elevated levels in the environment near old cemeteries is only now beginning to emerge. Limited sampling of old hand-pump wells that still exist at many smaller cemeteries has been conducted in Iowa. These wells typically access the shallow groundwater aquifer and if still functional, can provide an initial indication of arsenic presence. One problem with these old wells is that they are often located up gradient or peripheral to the burial area of interest and do not provide the ideal groundwater sample.

Fourteen hand pump wells at a variety of Iowa cemeteries were sampled for arsenic. The U.S. Geological Survey staff in Iowa City did not expect detectable levels of arsenic in shallow groundwater samples. Two of the samples contained arsenic at 30 parts per billion, above the new proposed drinking water standard for arsenic.

Installing groundwater monitoring wells near cemeteries can provide a better indication of the impact of arsenic. In one study at Hamilton College in Clinton, New York, up gradient and down gradient wells were installed outside of the College cemetery. The cemetery contains at least 68 graves from before 1910. Samples from the wells indicate elevated levels of arsenic down gradient from the cemetery. Zinc, copper, and lead also increased down gradient.

Hand pump wells in old cemeteries are a good source of shallow groundwater samples for arsenic and other metals analysis.

What significance does the presence of arsenic have for archeologists, cemetery workers and others that may come into contact with contaminated soil or human remains at old burial sites or cemeteries? Because the main routes of exposure are ingestion, inhalation and skin contact, there can be important health and safety implications for personnel working at sites where arsenic is present in sufficient concentrations.

Acute arsenic poisoning by ingestion can occur as the result of hand contact with dusts or objects containing arsenic compounds, and subsequent hand-to-mouth contact. Another common mechanism includes the dust settling on objects which later have contact with the mouth, including the tops of soda cans, cigarettes in a shirt pocket, or eating utensils. The smallest recorded fatal dose is 130 mg, although recovery has occurred after much larger doses.

Most ingested arsenic is quickly absorbed through the stomach and intestines and enters the blood stream. A common effect of arsenic ingestion is irritation of the digestive tract, leading to pain, nausea, vomiting, and diarrhea. Other effects characteristic of oral exposure include abnormal heart function and impaired nerve function, causing a “pins and needles” sensation in the feet and hands.

The inhalation route of exposure may be operative at dry, dusty sites, or during the handling of objects coated with dust. Inhalation exposure to arsenic can produce the same types of systemic health effects as oral exposure, although symptoms and effects are usually milder. The current Occupational Safety and Health Administration Action Level for arsenic inhalation exposure is 0.005 mg/cubic meter.

Direct dermal contact with arsenic compounds may result in mild to severe irritation of the skin (dermatitis), as well as irritation to the mucous membranes of the eyes, nose, and throat. Dermatitis of the face and eyelids is sometimes accompanied by conjunctivitis, with redness, swelling, and pain.

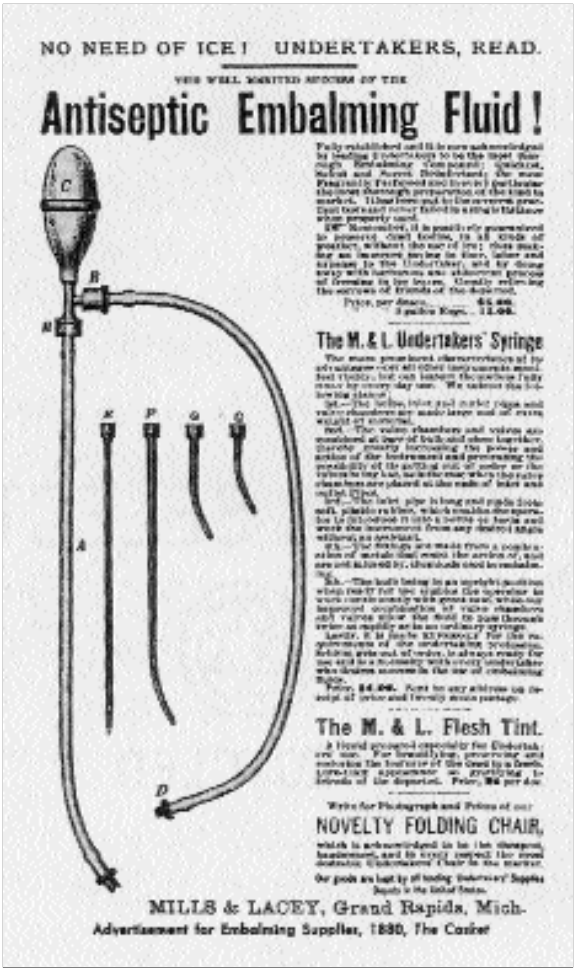
Due to the level of toxicity associated with arsenic, it is important to take precautionary measures when working in and around burial sites that may contain arsenic embalmed remains. Protective measures include using protective work clothing and equipment, housekeeping, and hygiene practices. Individual project requirements may differ; Occupational Safety and Health Administration standards, in particular 29 CFR 1910.1028, can give further guidance on proper procedures.

Protective work clothing would include coveralls or similar full-body work clothing, gloves and shoes or shoe coverlets. Face shields or vented goggles should be worn when necessary to prevent eye irritation. Protective clothing and equipment should be replaced at least weekly, and preferably on a daily basis. Disposable clothing is preferred because laundering clothing and gloves can result in additional exposure problems. Disposal of arsenic contaminated materials must comply with federal, state, and local hazardous waste regulations.

Engineering controls, such as exhaust ventilation, will not be available to control dust exposure in many applications. In that case, respiratory protection should be used to control dust exposures within acceptable limits. The minimum level of respiratory protection would be a half-mask air purifying respirator equipped with high efficiency filters. Efforts must be taken to keep the inside of the respirator free of dust, and filters should be changed frequently, usually at least daily.

Surfaces should be kept as free from dust as practical. Use of compressed air, sweeping or brushing should be avoided, since these methods will increase ambient air dust levels. Vacuuming is an effective method; however, special high efficiency equipment should be used.

Smoking, eating, or drinking should not be allowed in any work areas where arsenic may be present. Hands and face should be washed prior to eating, drinking, or smoking. Protective clothing must be removed and handled carefully to avoid



Advertisement for Embalming Supplies, 1880, The Casket

Chemical embalming fluid suppliers aided the rapid spread of arsenic embalming.

the generation of dust. A separate area for storage of street clothes should be available and a shower should be taken at the end of each work period.

These general guidelines are a starting point for protective measures needed to work at old cemeteries, or with materials from old cemeteries, that may contain arsenic embalmed remains. It is recommended that a certified industrial hygienist be consulted before beginning a project for specific measures.

Without an extensive review of public agency or private funeral establishment records, accurate determinations of the number and location of arsenic-embalmed bodies present in the nation's graveyards is impossible. Even if records were made available, they may not contain sufficient information to verify use of arsenic and the effort to obtain such information would be enormous.

The best opportunities to ascertain the presence and impact of arsenic in old cemeteries can come through cooperative efforts of forensic and other archeology experts with environmental scientists. Opportunities to collect and analyze soil and groundwater samples from excavations should be utilized. Not only will this provide information on the dangers to the environment, it will also provide critical information needed for proper protection of those engaged in archeological endeavors that could expose them to arsenic.

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The authors would like to acknowledge past contributions of Melissa Johnson Williams of Chicago to the historical research on arsenic embalming.

Paul S. Sledzik

Federal Resources in Mass Disaster Response

Americans have endured a torrent of natural and man-made disasters in recent years—floods, hurricanes, bombings, and aircraft accidents. Amid these difficult events, disaster workers respond to return normalcy to the community, to recover and identify the dead, to help obtain and provide information, and to help families grieve.

A disaster becomes a "mass fatality incident" when the local resources of the medical examiner or coroner cannot manage the fatalities. The medical examiner or coroner, who has the legal responsibility to document and identify the dead, can request the assistance of experts in pathology, anthropology, dentistry, mortuary affairs, and search and recovery. Forensic anthropologists have played an increasingly important role in recent American disasters because of their archeological and physical anthropological skills.

Anthropologists are relatively recent additions to disaster response teams. T. Dale Stewart's *Personal Identification in Mass Disasters*, published in 1970, was the first publication combining physical anthropology and mass disaster response. Since then, forensic anthropologists have gained prominence in the medico-legal community not only in mass disaster response, but in other types of investigations.

Two federal organizations recognize the importance of forensic anthropology to disaster response. The Armed Forces Institute of Pathology and the Disaster Mortuary Teams of the Public Health Service provide aid to local communities in mass fatality incidents. Forensic anthropologists are important members of the emergency response teams for these agencies.

The Armed Forces Institute of Pathology, a Department of Defense agency, is known internationally for its expertise in consultative pathology and medical research. Additionally, it has a long history of documenting the remains of soldiers killed in battle. The Institute was founded as the Army Medical Museum in 1862 for advancing the state of medical care for Civil War soldiers. The Armed Forces Institute of Pathology's role in military mass disaster victim identification is largely an outgrowth of military aircraft accident investigations after World War II.

Within the Institute, forensic anthropologists specializing in mass disaster victim identification are employed in the Office of the Armed Forces Medical Examiner and the National Museum of Health and Medicine.

The Office of the Armed Forces Medical Examiner (OAFME) is responsible for investigating all military fatalities as well as civilian deaths under federal jurisdiction. When called for emergency assistance, OAFME sends a team comprised of pathologists, dentists, anthropologists, and forensic scientists. OAFME has a close relationship with the Federal Bureau of Investigation's disaster team, the National Transportation Safety Board, and other federal investigative agencies. Within OAFME, the Armed Forces DNA Identification Laboratory is responsible for the DNA identifications of military fatalities, including those from the Vietnam and Korean Wars. The staff of the Armed Forces DNA Identification Laboratory have also been involved in the identification of victims from several recent mass disasters.

The National Museum of Health and Medicine also has forensic anthropologists on staff to support OAFME needs and to conduct research and teach in the field. The museum's collections of human skeletal specimens and archival materials are similarly available for research in forensic anthropology. In addition, both OAFME and the National Museum of Health and Medicine offer courses in forensic pathology, forensic dentistry,

Anthropological Skills in Mass Disasters

Skill	*Examples*
Devise grid systems for search and recovery	USAir 427 Oklahoma City bombing
Devise search criteria based on size and scope of disaster	Hardin cemetery flood Oklahoma City bombing
Identifying and reassociating fragmentary remains	USAir 427 American Eagle 4184 Valujet 592 TWA 800
Forensic anthropological analyses (age, sex, stature, etc)	All cases
Radiographic comparisons of skeletal structures	Oklahoma City bombing
Positive identification based on biological criteria	All cases
Reconstructing injury and fragmentation patterns	Operation Desert Storm USAir 427 Oklahoma City bombing
Determine reburial criteria based on remains recovered	Hardin Cemetery

DMORT Contact Information

Main Office: 1-800-USA-NDMS, extension 205

Regional Contact Information

Region 1: CT/MA/ME/NH/RI/VT	Dwight Camp	802-457-1222
Region 2: NJ/NY/PR/USVI	John Oldfield	212-362-6160
Region 3: DC/DE/MD/PA/VA/WV/VA	Howard McComas	410-676-4600
Region 4: AL/FL/KY/GA/MS/NC/SC/TN	Fred Berry, Jr.	423-577-6666
Region 5: IL/IN/MI/MN/OH/WI	Gary Strand	414-639-8000
Region 6: AR/LA/NM/OK/TX	Jack King	409-295-6363
Region 7: IA/KS/MO/NE	Dean Snow	816-776-2255
Region 8: CO/MT/ND/SD/UT/WY	Don Heer	970-842-2821
Region 9: AZ/CA/HI/NV	Robert Hennis	602-464-8728
Region 10: AK/ID/OR/WA	Charles Parks	503-397-1154

forensic anthropology, and DNA identification methods.

The Office of the Armed Forces Medical Examiner and the National Museum of Health and Medicine have supported local resources in several recent mass disasters, including USAir 427, American Eagle 4184, the Oklahoma City bombing, and TWA 800. Under a mandate to investigate all federal and military crashes and deaths, OAFME staff have identified remains from the crash of Department of Agriculture Secretary Ron Brown's plane in Bosnia in 1996 and the shootdown of two US Army Blackhawk helicopters over Iraq in 1994. National Museum of Health and Medicine staff also provided technical guidance for cemetery floods in the towns of Hardin, Missouri (1993) and Albany, Georgia (1994).

OAFME and NMHM staff can respond to nonmilitary mass fatality incidents if a request is made through the Director of the Armed Forces Institute of Pathology. For assistance, contact Dr. William Rodriguez, Chief of Special Operations, Office of the Armed Forces Medical Examiner, at 301-319-0000, or Paul Sledzik, Curator, NMHM/AFIP, at 202-782-2204, or <sledzik@email.afip.osd.mil>.

Within the U.S. government's *Federal Response Plan,* Emergency Support Function No. 8 tasks the Public Health Service to staff an Office of Emergency Preparedness. This office provides the federal government with coordinated assistance to supplement state and local resources in response to mass disasters. Implementation of Emergency Support Function No. 8 provides medical assistance (patient evacuation, health surveillance, personnel, supplies, and equipment) and victim identification and mortuary services.

The Office of Emergency Preparedness established the National Disaster Medical System to further the ESF No. 8 function. A critical component of the National Disaster Medical System is the **Disaster Mortuary Teams,** or DMORTS. Each team consists of forensic scientists (anthropologists, dentists, and pathologists), funeral directors, embalmers, medical records technicians, and specialists in mass fatality incident management. When activated for a mass fatality incident, the National Disaster Medical System pays all associated expenses for DMORT team members. DMORT teams can only be activated for a presidentially-declared disaster. Qualified specialists who are interested in professional participation with a team should contact the appropriate team leader in their region.

DMORT teams have been activated three times since formed in 1992. In July 1993, nearly 700 graves from the town cemetery in Hardin, Missouri, were eroded by flood waters. The DMORT team worked to locate, recover, and identify the remains, which dated from the US Civil War to the time of flood. In 1994, flood waters inundated two cemeteries in Albany, Georgia, forcing over 400 caskets into the central part of the city. Using their experience from the Hardin flood, DMORT teams worked with the Georgia Bureau of Investigation to recover and identify the remains. Following the Oklahoma City bombing in 1995, DMORT personnel provided anthropologists, funeral directors, and medicolegal investigators to support the Office of the Medical Examiner.

The National Foundation for Mortuary Care was founded in 1991 as a nonprofit organization with several objectives: to assist civil authorities with incident command and mortuary services during a mass fatality incident; to recruit and train DMORT team members; to coordinate disaster training and educational programs; to publish *Disaster Management News;* and to provide $1,000,000 in liability insurance protection for DMORT staff active during a mass fatality incident.

The National Foundation for Mortuary Care also operates a mobile morgue containing equipment and supplies used in identification and morgue operations. The morgue supported activities at the crashes of USAir 427 and American Eagle 4184. For more information, contact National Foundation for Mortuary Care, 1900 Whittles Wood Road, Williamsburg, VA 23185-7697 (phone/fax: 804-258-4504).

Paul Sledzik is Curator of the Anatomical and Pathological Collections at the National Museum of Health and Medicine in Washington, DC. His specialties include the application of forensic anthropology to mass fatality incidents, paleopathology, and historic period skeletal biology.

Douglas W. Owsley

Forensic Anthropology and Bioarcheology at the Smithsonian Institution

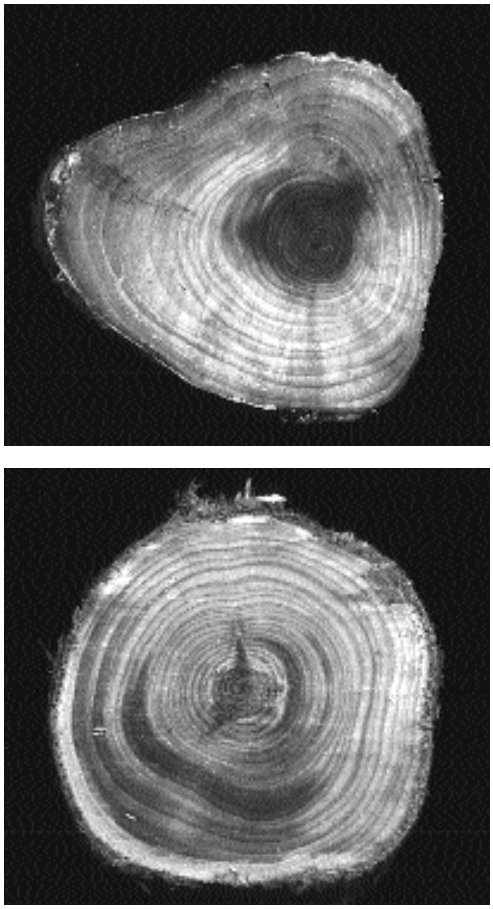
The Smithsonian's Division of Physical Anthropology has a long history of providing assistance to law enforcement agencies by completing examinations of human remains and providing expert witness testimony. Additional contributions include professional advice and training regarding technical procedures involved in the discovery, recovery, and analysis of human skeletons; Smithsonian staff also conduct forensic-related research.

Smithsonian forensic cases generally involve skeletonized or poorly preserved bodies that need identification and examination for trauma or other pathology that might explain the death of the individual. This work involves not only laboratory evaluation of the remains, but also frequently includes field research and excavation assistance. This expertise is currently provided by two forensic anthropologists, Douglas Ubelaker and Douglas Owsley, who are employed as research scientists and curators of the human skeletal collections at the National Museum of Natural History. In this capacity, their research deals with bioarcheology, particularly as it relates to prehistoric and early historic populations; topics dealing with demography, pathology, morphometric variation, and adaptation; as well as involvement with legal investigations as forensic scientists.

Affiliation with the Smithsonian and its extensive collections often proves to be of assistance in the resolution of specific human identification cases. The museum's anatomical collections are frequently consulted for comparative reference when specific questions arise during examinations of individual cases. Reference collections are essential for understanding individual and population variation in skeletal and dental morphology. The importance of this resource is often realized when attempting to establish personal identification of remains through comparison of antemortem and postmortem radiographs. The significance of an unusual feature for establishing an identification can be gauged by systematically surveying appropriate reference collections to determine its occurrence by age, sex, and population.

Identification of the cremated remains of two American journalists who disappeared in Guatemala in 1985 depended on this type of comparative information (Owsley 1993). A field search recovered the incomplete and fragmented remains from the location where they had been burned and then scattered. Three small, completely calcined, fragments of the frontal bone of one person could be pieced together, which collectively represented a portion of the forehead the size of a quarter. This segment contained a well-defined sulcus in the frontal crest that overlapped a centrally placed lobe of the right frontal sinus, a structural feature that was also visible in an antemortem radiograph taken four years before the disappearance when one of the journalists was involved in an automobile accident. To rule out the possibility of a coincidental match, 350 crania of African and European American males and females and a large series of radiographs were examined to determine patterns of variability with respect to internal frontal crest and sinus morphology. The comparative research demonstrated the uniqueness of the radiographic pattern observed in this small piece of frontal bone. Even in instances of extreme fragmentation and burning of bone, positive identification can be achieved, which in this instance was validated by comparative collections that provided population data (as well as a better understanding of cranial anatomy).

In another case, Ubelaker (1990) was asked to examine the skeleton of a homicide victim found in a shallow grave on the Pine Ridge Indian Reservation in South Dakota. His evaluation identified the male as Native American, and the osteological profile and the estimated time since death matched a missing member of the Sioux tribe. As dental records were not available, confirmation depended on thoracic radiographs obtained from the local Public Health Service hospital. These antemortem films revealed an unusual notch in the axillary border of the right scapula, a trait that was also evident in the skeleton. To determine the uniqueness of this feature as a basis for establishing personal identification required checking scapulae in the Smithsonian's collections including



Abnormal growth rings (top photo) in an eastern red cedar indicating that the tree was pushed over when a body was buried against the trunk. Smithsonian Institution photos, 1995.

Native Americans from the Northern Plains. No other examples were found during this survey, which reinforced the uniqueness of this anomaly as basis for identification. With the return of Native American human remains to appropriate tribal governments as a result of the Native American Graves Protection and Repatriation Act (NAGPRA), future identifications based on comparative evidence will prove more difficult to the disadvantage of law enforcement agencies and the families of missing persons.

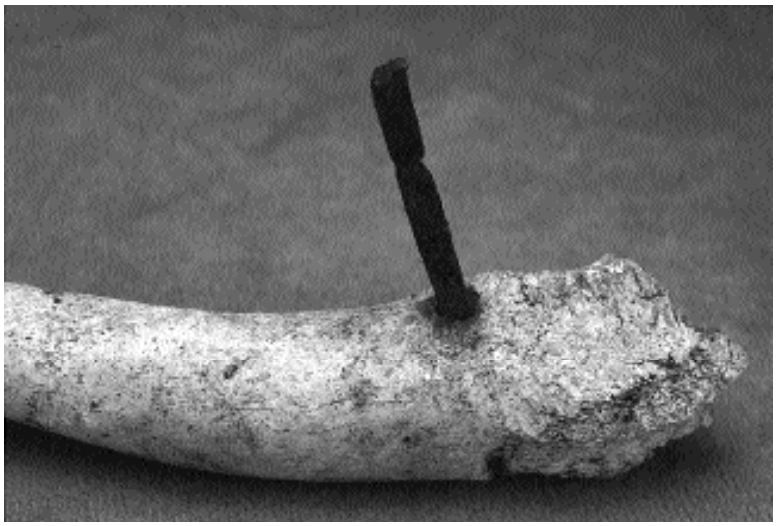
The collections of the Department of Vertebrate Zoology have also proven invaluable to forensic investigations. Each year, incomplete or fragmentary bones that have been burned, sawed, or scavenged by animals are submitted for identification as potentially human. Two calvaria (i.e., the superior portions of the cranial vault) with human proportions but atypical morphology were identified as hydrocephalic calves through comparison with documented museum specimens (Ubelaker, Berryman, Sutton, and Ray 1991).

Besides immediate access to collections, forensic anthropologists at the Smithsonian have the benefit of ready consultation with other museum specialists. Scientists representing a variety of specialties including botany, entomology, zooarcheology, and geology have advised on specific cases. Determining time since death, for instance, has been aided by evaluations of insects found with the remains, as well as by the size and complexity of plant roots growing in and around the bones. When a partially buried skeleton of a stabbing victim was found against the trunk of a small cedar, the tree's growth rings were analyzed to see if there was a noticeable "fertilization effect" due to the availability of nutrients from the decaying body. Recovery of skeletal remains and clothing indicated that the body had been placed there several years ago. Cross-sections of two trees of the same species, but from a short distance away, were used as controls. Analysis did not demonstrate an obvious nutritional effect; however, the vertical orientation of the tree trunk was apparently altered at the time of burial. Unlike the circular growth rings of the control trees, the cross-section of the test tree showed eccentric rings and the formation of compression wood. This atypical feature was used to estimate the number of years since death for the murder victim, because it clearly indicated a growth-related response to a disturbance of the tree's normal developmental pattern.

Zooarcheologists have helped with many cases requiring the identification of nonhuman bones. For instance, the search of Jeffrey Dahmer's boyhood home in Bath Township, Ohio, recovered the fragmentary skeleton of his first victim along with the bones of several animals (Owsley, *et al.*, 1993). The identifiable nonhuman bones and bone fragments found at this semirural site represented a variety of species: cow, sheep, pig, dog, cat, rabbit, woodchuck, opossum, and other animals and birds. Although many of the bone fragments represented typical cuts of meat found at a market, the skeletons of at least three dogs were represented. The most unusual piece was the femur of a large dog with a metal spike driven into the shaft. There was no evidence of healing, indicating that the modification was made at about the time of the dog's death or soon thereafter.

In 1996, a case required help from the Division of Sedimentology to resolve questions about provenance. Specifically, the investigating agency requested assistance in determining the original location from which the human remains actually came. Soil from the suspected burial site was compared to soil extracted from the medullary cavity of one of the bones to determine whether the bones came from the location where they were reported to have been found.

Multiple analytical procedures were used, including visual examination for color and classification using Munsell soil color charts, texture analysis using a laser particle size analyzer, and X-ray diffraction to determine the mineral composition of the two samples. The samples matched in color and had identical mineralogical diffraction patterns indicating that the same minerals were present in the same relative proportions. The distributions of particle size diameters also agreed, the only difference being the inclusion of larger sized particles in the soil sample. Infill material removed from the medullary cavity consisted of a finer filtrate that had migrated into the bone, a sorting process that had selectively limited particle size. Without question, the samples originated from the same soil series as the location where they were said to have been discovered.



Dog femur with an embedded metal spike recovered from forensic investigations at Jeffrey Dahmer's boyhood home in Bath Township, Ohio.Photo by Robert Mann.

Ties to Bioarcheology

Frequently, remains from archeological contexts become the subject of legal investigations. Several cases each year prove to be historic burials that are exposed by construction activities, vandalism, or land subsidence and erosion. Identification of these remains depends on an evaluation of historical records, associated materials and provenance, and osteological analysis. Cases that involve accidental disturbance or exposure by natural processes generally require no further police investigation, although efforts to establish personal identification can assist legal processes necessary for determining the final disposition of the remains. Intentionally disturbed remains require further investigative action by law enforcement agencies, as unauthorized disturbances or disinterments are violations of sepulcher. In some cases, we have conducted field investigations of broached graves to obtain evidence and ascertain whether human remains were removed. Experience in bioarcheology is invaluable in being able to recognize and evaluate these situations. Bioarcheology and forensic anthropology are closely linked disciplines with shared techniques, methodology, and occasionally similar objectives. Most forensic anthropologists have educational backgrounds that include archeological field experience; indeed, expertise with archeological survey methods, field mapping, and the documentation of ancient burials develops one's technical capabilities and an appreciation for the importance of context, provenance, and proper recordation. These basics directly apply to medicolegal investigations. In the laboratory, the analysis of archeological samples provides greater understanding of intra- and inter-group variability and an appreciation of taphonomic variables that can effect the preservation of skeletal remains. The ability to accurately distinguish postmortem fractures that occurred long after death from those incurred at the time of death can be gained only through working with samples that show changes or damage as a result of burial or recovery processes.

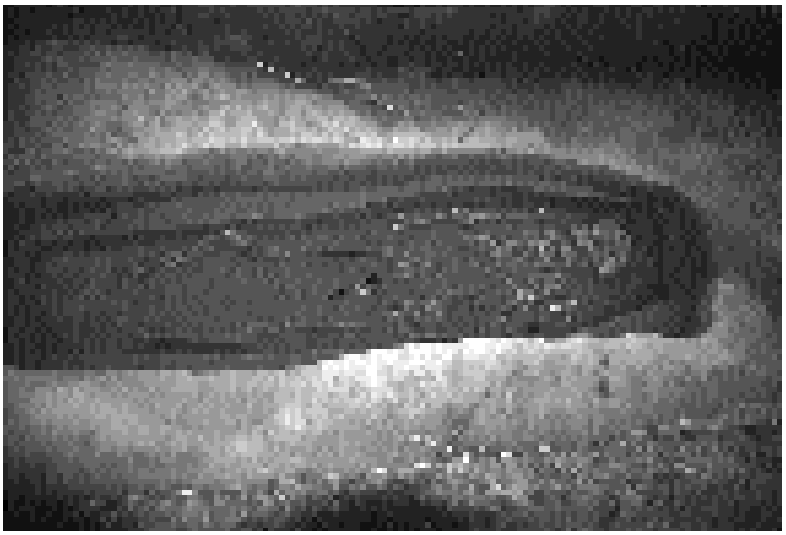
Smithsonian's Bioarcheological Database

Bioarcheology at the Smithsonian is directed toward the analysis of human skeletons using a comprehensive osteological database approach. The application of modern biological and anthropological techniques to samples from archeological contexts provides data effective for studying biocultural adaptations, trends in demography, trends in health and the history of disease, and cultural and historical relationships. Information about archeological provenance and dating, bone inventories for each skeleton, demographics (including determinations of age, sex, and race), skeletal and dental pathology, nutrition, cranial and postcranial measurements, dental and skeletal growth and development, and taphonomic observations are incorporated into the Smithsonian's computerized databases as a basis for comparative research using a temporal and geographical framework.

Historic populations are an important focus of this research. Smithsonian researchers are currently involved in the analysis of archeologically-recovered remains from important colonial sites such as Jamestown, Virginia and St. Mary's City, the first colonial settlement in Maryland. Additional research is focused on 18th- and 19th-century groups, including more than 300 skeletons of inmates of the former Richmond (Virginia) Penitentiary. A rather unusual sample consists of a large series of commingled bones that were found in a 19th-century well on the grounds of the Medical College of Virginia. The skeletal remains appear to represent bodies that were disinterred soon after death for use in medical school instruction at a time when it was illegal to use human remains to teach anatomy. The well simply provided a convenient and secure place of disposal after dissection and student practice with surgical procedures such as amputation.

Smithsonian investigations have also involved remains recovered from battlefields and military cemeteries. Osteological analysis can help to establish the identities of individual soldiers as well as obtain information about overall health and nutritional status and causes of death. Such analysis can also yield information about the medical treatment, primarily surgical intervention, provided to soldiers that subsequently died. Military

burials recovered from several Civil War battlefields including Antietam, Gettysburg, the siege of Port Hudson, Brandy Station, and Glorieta Pass have been examined. A skeletal series from a battlefield, which is somewhat rare in bioarcheological research, presents an opportunity to study the effects of field conditions and physical stress in a special subset of the general population in which physical characteristics are relatively consistent and controlled as a result of military induction criteria. The objectives of these investigations are to record data on age, sex, race, and other physical characteristics; antemortem bone and dental pathology; and perimortem trauma and possible cause of death. Through comparison of such data with military records and descriptive information from diaries and other archival sources, it is sometimes possible to identify specific individuals. Of 31 Confederate soldiers found in a mass grave and one adjacent burial site on the 1862 Battlefield of Glorieta Pass, some 20 miles east of Sante Fe, three positive identifications were achieved and seven more were probable (Owsley 1994).



Archeological investigation (work-in-progress) of Jamestown's first colonists at St. James Fort,Virginia. Photo by Parvene Hamzavi.

Further, where there are disputes about land and its possible development, bioarcheological research can help establish the historical significance of the property, as was demonstrated at Brandy Station, Virginia (Owsley, *et al.*, 1992). This area of Culpeper County was the site of two military engagements: the artillery duel of the Battle of the Rappahannock on August 23, 1862, and the cavalry battle of June 9, 1863. During the earlier battle, the Washington Artillery, a crack Confederate unit, was positioned on the Culpeper side of the Rappahannock River and in a crossfire lost eight soldiers. Reports following the incident stated that the dead were buried at nearby St. James Church. A real estate developer had purchased the land that surrounds the ruins of St. James Church. Civic and church groups, aware that the land had been the scene of Civil War battles and that the locale probably contained military interments, requested that a survey be conducted of the approximately two acres still owned by the descendent congregation of St. James Church. Physical evidence supporting the historic accounts was viewed as essential data for nominating the battlefield site to the National Register of Historic Places. It was at this point that bioarcheologists from the Smithsonian Institution were asked to contribute to the history and archeology of Brandy Station.

After surveying the environs of St. James Church, subsurface probing identified nearly 50 unmarked burials of which six were selected for further examination. The coffins were described and measured, and in order to hopefully identify these individuals, were opened to expose the skeletal remains and associated artifacts. The burial artifacts were described and inventoried and the skeletal remains were examined osteologically. Of the six burials, five were civilian and one was military. The five civilians were buried at a standard depth in wood coffins with identifiable hardware. In contrast, Burial Number 21 was laid to rest in a shallow grave surrounded by a frame made of reused yellow pine planks. This improvised coffin lacked both a top and bottom, as well as side handles. The skeletal remains were those of an adult white male judged to be about 30-35 years. Coat fragments and buttons, a kaolin pipe, and remnants of his boots were analyzed. The burial context closely matched the mournful scene described by William Miller Owen (1885:106), historian of the Washington Battalion, when he observed that "At night a burial detail performed the sad rites to bury our dead comrades by the flickering light of a blazing fire of logs and rails, having made rude coffins of the pews of St. James Church which, meaning no sacrilege, were appropriated for that purpose."

Comparison of the osteological data from Burial Number 21 with Confederate Army records provided statistics that helped narrow the identity of the soldier to two possible candidates of similar age. Both were Irish born with former occupations as laborers before the war. One of the major accomplishments of this investigation was to demonstrate that, both archeologically and historically, the site of St. James Church meets the criteria for listing on the National Register of Historic

Places. Excavation of the Brandy Station graves also yielded data on late 19th-century burial practices that, with the results of other bioarcheological studies, can enhance understanding of American social history of the past century.

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Douglas H. Ubelaker

Forensic Anthropology and the FBI

Cadaver dog trained to detect decomposing human remains. Photo by the author.

The inclusion of forensic anthropology in criminal investigations involving the Federal Bureau of Investigation can be traced back to the early development of American physical anthropology. Czech-born Aleš Hrdlička (1869-1943) is widely recognized as the founder of American physical anthropology. Hrdlička spent most of his career at the Smithsonian Institution, located near the FBI headquarters in Washington, DC. Although Hrdlička is not known for his work on the forensic applications of physical anthropology, he gradually assembled the comparative collections and established the methodology that made this endeavor possible (Stewart 1982). Smithsonian records show that Hrdlička had some contact with FBI officials, advising them on cases within his expertise.

In 1939, the *FBI Law Enforcement Bulletin* published Wilton Krogman's article on human identification, a publication that raised awareness in the law enforcement community of the potential contribution of forensic anthropology to medico-legal investigation.

The relationship between the FBI and the Smithsonian Institution with regard to forensic anthropology solidified when Hrdlička's student, and his Smithsonian replacement, T.D. Stewart, began consulting for the FBI in 1942. Stewart not only analyzed skeletons for the FBI and others for the next 20 years, but added to the national collections and, even more importantly, published regularly on forensic anthropology topics (Stewart 1979). During this period, the involvement of physical anthropologists in forensic science grew steadily.

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In 1962, J. Lawrence Angel (1915–1986) joined the Smithsonian staff and assumed responsibility for consultation with the FBI (Ubelaker 1990). Angel continued assisting the FBI until 1977 when he decided to take a sabbatical and I took over the work. During this period, he reported on approximately 368 forensic cases, many for the FBI. The latter half of Angel's 15 years of FBI service also witnessed important organizational advancements in the field of forensic anthropology. Key developments include the formation of the Physical Anthropology section of the American Academy of Forensic Sciences in 1972 and the certification program of the American Board of Forensic Anthropology in 1978. Angel also initiated a training program in forensic anthropology at the Smithsonian that provided educational exposure for forensic pathologists and others with regard to his analytical methodologies.

From 1977 until the present, I have continued the Smithsonian tradition of assisting the FBI with those cases relating to forensic anthropology. I have reported on approximately 595 cases, most of them submitted through the FBI laboratory. Together with Smithsonian colleague Douglas Owsley, we provide anthropological input into medico-legal problems relating to our expertise. Smithsonian training is available through individual internships, lecture programs, and an annual course that, in recent years, we alternate hosting at the Smithsonian and in Europe. Additional lectures on forensic anthropology are sometimes available at the FBI's training center in Quantico, Virginia.

When FBI agents or other law enforcement officials bring their boxes of osteological remains to us at the Smithsonian, they recognize that we have the expertise and the necessary comparative collections to help resolve identification problems. The Smithsonian's process begins with documentation of the chain of evidence and then may proceed to determining if the remains are human, age at death, sex, living stature, time since death, what happened to the remains after death but before discovery (taphonomic change), any observations that might contribute to identification and finally, an assessment of evidence for foul play. At times, the Smithsonian's forensic anthropologists also utilize their archeological skills to assist law enforcement in the on-site recovery of evidence.

To best illustrate how forensic anthropology can contribute to the investigative process, the following fictitious forensic case is presented. In a state prison, an inmate tells another inmate that 10 years earlier, he had left a bar with a young woman. During an ensuing argument, the woman pulled a knife on him. The inmate reported that, in defense, he pulled his own knife. When the woman lunged at him, he stabbed her once in the chest and she died. Suspecting that no one would believe that his act had been in self-defense because of his previous record of assault, he took the body to an abandoned farmyard and hid the remains in some brush. According to his story, two days later he returned and buried the remains in a shallow grave that he dug with a shovel that he found there.

His casual confession made its way to the prison warden who notified the police. The inmate was able to take the police to the general area where the burial had supposedly taken place, but he could not remember the exact site. The police notified the local medical examiner and together they decided to ask the FBI and the Smithsonian Institution for assistance. Topographic analysis revealed four locations of possible burial within the general area: two slight depressions in the ground surface, an area of unusual plant growth, and a slight mound of earth. The FBI conducted a detailed analysis of the area using a combination of metal detectors, ground penetrating radar, and proton magnetometers. The remote sensing determined that the two slight depressions appeared to represent old collapsed drainfields. The slight mound of earth showed evidence of subsurface disturbance, as did the area of unusual plant growth.

A team of cadaver dogs, specifically trained to smell human remains, were brought on site. The dogs delivered no strong signals, but their handler thought they gave some weak signs of interest near the mound and the area of plant growth.

A decision was made to archeologically test the two areas of greatest interest, the mound of earth and the area of plant growth. The area was mapped and a standard grid was laid out over the area of plant growth. The excavation team carefully removed the soil with trowels and brushes, a layer at a time. Eventually they discovered that the shape of the original pit and its contents did not represent a burial, but rather the remnants of a former outhouse.

The excavation process was repeated in the area of the earthen mound. Excavation revealed soil patterns suggesting an oval-shaped pit had been dug measuring about six feet in length. In the bottom of the pit, the archeologists found an articulated skeleton.

After thorough documentation of the pit and its contents, the evidence was removed and processed. Small remnants of clothing were recognized and studied by the appropriate specialist. The remains themselves were sent to FBI headquarters in Washington, DC. where personnel in the Hairs and Fibers Unit carefully screened them for trace evidence. Finally, the osteological

remains were boxed up and a FBI agent carried them across Pennsylvania and Constitution Avenues to the Smithsonian's National Museum of Natural History. In the Anthropology Department, they were logged in. Analysis began with a careful inventory. A nearly complete human skeleton was present along with several animal bones. The bones were well-preserved, although some showed evidence of carnivore chewing. Apparently, dogs had discovered the body during the two days between death and burial.

The size of the bones and the state of dental formation and eruption indicated that the person represented was not a juvenile. Observable epiphyses on the long bones were united, but the epiphysis on the iliac crest of the pelvis showed evidence of recent union. This and other indicators suggested the individual was likely between 20 and 25 years old at the time of death (Ubelaker 1989). Female sex was suggested by the appearance of the pelvis, skull, and other bones.

Various features of the face indicated a likely European ancestry (socially classified as "White"). Such ancestry was also indicated by a mathematical computation utilizing measurements of the skull. The procedures for this calculation had been developed through an analysis of measurements recorded from identified forensic cases, which are stored in a computerized databank (Jantz and Moore Jansen 1988).

Measurements of the recovered long bones suggested a living stature of about 5'-6", using formulae developed for White females.

The remains were completely skeletonized although well-preserved and were otherwise consistent with a time since death of about 10 years.

The teeth displayed numerous fillings. In addition, there was evidence of antemortem bone fractures in several ribs and the bones of the face. These fractures were completely healed and showed evidence of advanced bone response, suggesting they had occurred at least two years before death.

Evidence for perimortem (at or about the time of death) trauma consisted of incisions in four of the upper ribs on the anterior right side. The alterations clearly represented sharp force trauma and placement of the ribs in anatomical order indicated that at least four separate insertions of a knife or knife-like instrument had taken place.

The police strongly suspected that the remains were those of a girl who had been missing from the area for about 10 years. She was about 5'-6" tall and of European ancestry. However, her age was known to be 12 years and she had no medical history of broken bones. The Smithsonian's analysis suggested that the missing person was not represented by the recovered remains.

To assist the investigation, Smithsonian anthropologists collaborated with FBI artists to produce a facial reproduction (Ubelaker and O'Donnell 1992). Eraser-type markers were placed on the skull to indicate the depth of the soft tissue. Using a special computer at the FBI, the skull image was digitized and gradually the soft parts were recreated until the anthropologists and artists agreed that a reasonable likeness had been achieved. The facial image was printed out and sent to media in the area. Two days later, a woman called police indicating that she had seen the image on television and it looked a lot like her cousin whom she had not seen in 10 years. The woman would have been 23 years old, about five feet six inches tall, and of European ancestry. The woman added that her cousin had been in a terrible car accident about 13 years ago and had broken bones in her face and chest.

Unfortunately, police were unable to locate the woman's medical or dental records but they did find several photographs taken of her shortly before she disappeared. Using much of the same FBI equipment utilized in the facial reproduction procedure, Smithsonian anthropologists and FBI artists compared the image of the recovered skull with the photographic evidence (Ubelaker, *et al.*, 1992). Both images were properly sized and oriented and then digitized. When the two superimposed images appeared simultaneously on the computer monitor, each anatomical detail on the photograph aligned and matched the corresponding landmark on the skull. The match was impressive. The Smithsonian's anthropologist concluded that it was highly probable that the photograph and the skull originated from the same individual, although the computerized comparison did not allow a positive identification to be made.

Medical and dental records of the missing woman could not be found. However, the family remembered that she had kept her baby teeth when they had fallen out. DNA comparative analysis of those baby teeth and the bone samples confirmed that the recovered remains were those of the missing person.

Eventually, the case went to trial. Testimony was needed from the Smithsonian anthropologist not only to report on the recovery, analysis, and identification of the remains, but also on the evidence for trauma. The finding of evidence for multiple sharp force trauma contradicted the confession that a single knife wound had been inflicted. Rigorous cross-examination by the defense attorney attempted to suggest that the anthropologist had confused evidence of carnivore chewing with that of sharp force trauma. The jury

believed the anthropologist because of his extensive research experience and knowledge of such alterations on the human skeleton and because of the clarity of his testimony.

The above theoretical case illustrates the complexity of forensic anthropology involvement in the investigative process. Forensic anthropologists contribute not only to the recovery and analysis of relatively complete skeletons, but also to that of small fragments and multiple individuals resulting from mass disasters. In 1996, there were about 46 board-certified forensic anthropologists in the United States and Canada. Since this expertise is available to police departments throughout North America, increasingly cases sent to the FBI-Smithsonian investigative team are the most difficult, involving fragmentation, extensive trauma, or those requiring specialized analysis such as the facial reproduction or photographic superimposition techniques discussed in the example above.

Forensic anthropology has become a recognized, regular contributor to the medical-legal investigation of death. The tradition of collaboration between the FBI and the Smithsonian that began over a half-century ago continues productively today.

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Douglas H. Ubelaker, Diplomate, American Board of Forensic Anthropology, received his Ph.D. in physical anthropology from the University of Kansas. Since 1971, he has been employed at the Smithsonian Institution's National Museum of Natural History in Washington, DC. Since 1977, he has served as the primary consultant in forensic anthropology for the FBI and has reported on about 600 forensic cases.

New Publication

In Remembrance: Archaeology and Death.

David A. Poirier and Nicholas F. Bellantoni, editors. Greenwood Publishing Group, Inc., 88 Post Road West, Westport, CT 06881; Price: $59.95; cloth; 264 pp; ISBN: 0-89789-419-7; Order Code: H419; Publication Date: 01/30/97.

In recent years, federal and state governments have recognized their responsibility for the protection of unmarked ancient burial grounds that may be threatened by modern land-use activities and natural disasters. The editors of this new book have compiled case studies that reflect effective answers to removal, analysis, and reburial of human remains by archeologists. Each study provides fascinating research from the excavation of historic cemeteries, which has added considerable knowledge to our understanding of factors relating to health, disease, and trauma, and the social histories of the diverse human communities occupying North America during the last three centuries.

The Introduction highlights recent examples of the way osteological analysis of burials contributes to our knowledge of past histories. Part I examines several socially-disenfranchised groups that are underrepresented in historic records. These analyses demonstrate how archeological and anthropological research can contribute to a better understanding of cultural conditions and life ways of important social groups. Part II consists of articles that illustrate where past and recent traumas and desecration have affected human burials. Part III represents the only technical section, providing a resource guide on professional standards in conducting documentary research as well as field work in the location and excavation of historic burials.

Thomas D. Holland and Robert W. Mann

Forensic Aviation Archeology

Finding and Recovering American MIA Remains

Forensic anthropologists lend their skills to identifying homicide victims for the Federal Bureau of Investigation, excavating Civil War burials for the National Park Service, and recovering American war casualties for the Department of the Army. Each of these endeavors requires the implementation of scientific principles, including crime-scene investigation, forensic anthropology, aviation archeology, botany, photography, medicine, ballistics, medicine, and law. By combining an ever-evolving multidisciplinary approach, forensic anthropologists at the U.S. Army Central Identification Laboratory, Hawai`i (CILHI), are able to resolve the fate of American MIAs.

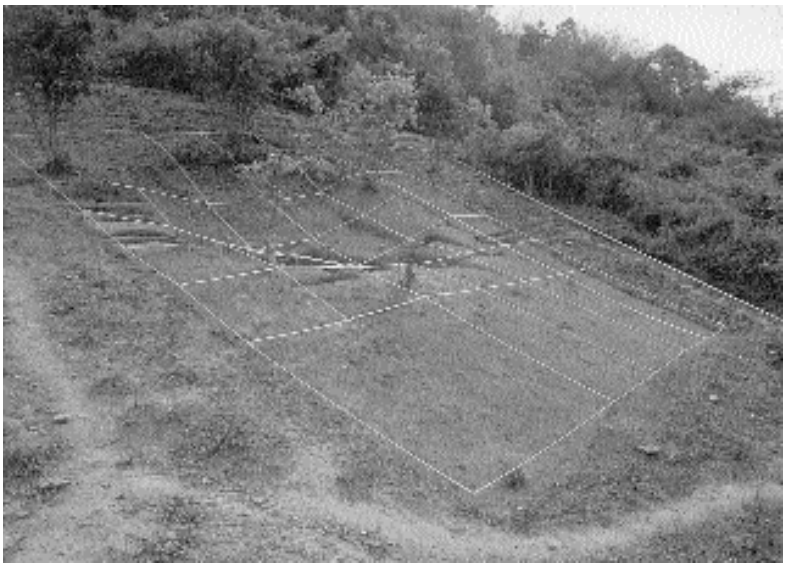
The relationship between anthropologists and the armed services has been long and productive. In particular, forensic anthropology has profited from methods and techniques developed by the Army Central Identification Laboratories for the identification of U.S. war casualties. Historically, the Central Identification Laboratories, under the direction of such notable figures as Charles Snow, Mildred Trotter, T. Dale Stewart, Thomas McKern, and Ellis Kerley, were temporary, mission-specific organizations formed after World War II, the Korean War, and the Vietnam War. Combined, these labs accounted for the identification of thousands of military and civilian personnel, including more than 430 Americans from the Vietnam War. Many of the forensic techniques pioneered in these laboratories continue to be the mainstay of forensic anthropology.

The ejection seat site (clearing) upon completion of excavation.(Note the 65º slope).

In its present—and now permanent—incarnation, the CILHI is the largest skeletal identification laboratory in the world and is recognized as an internationally-respected leader in human identification techniques and forensic aviation archeology. Formally established in 1976, the laboratory's expanded charter includes both the recovery and identification of U.S. war dead from all past military conflicts. These identifications are achieved by traditional methods and techniques, as well as more novel approaches including isotopic analysis, scanning electron microscopy, video superimposition, and most recently, mitochondrial DNA (mtDNA) analysis.

A typical CILHI recovery effort consists of locating and excavating an aircraft crash site or less frequently, an isolated burial. The mission begins when a recovery team departs for the host country. With some variation depending on the mission circumstances, a team consists of an anthropologist, who functions as the recovery leader; an Army officer and a senior non-commissioned officer, who oversee the team's logistical needs; a medic; a photographer; a linguist; an explosive-ordnance technician, to handle the ubiquitous unexploded bombs found on old battlefields; and one to six Army graves registration specialists who provide the bulk of the sweat and muscle. If the mission is to recover a crashed aircraft, a team includes an aircraft-wreckage analyst to identify key aircraft components and aircrew-related artifacts such as flight-suit material.

Sites are excavated using standard archeological procedures and are similar in many respects to any CRM-governed site, with two exceptions. First, the CILHI teams work in some of the most remote and dangerous locales in the world, from the jungles of Southeast Asia to the mountains of the Himalayan Chain to the ocean waters of the Pacific Islands. In addition, team members function in an official capacity as quasi-diplomatic agents of the United States. The site is



The completed 12x16 meter investigation area (grave) in an old bomb crater. The pin-flags mark the locations where the recovery team found human remains and pilot-related equipment.

governed by a foreign country (often a country, such as North Korea, that is on relatively poor terms with the United States government) as are the U.S. team members. A recent recovery in western Iraq, for example, was conducted under the watchful eyes (and at times guns) of the Iraqi Republican Guard. Second, since the identification of human remains is a forensic issue, the recovery site must be treated similar to a crime scene; that is, there must be a proper chain-of-custody for any recovered remains and artifacts from the time they leave the ground to their receipt at the CILHI.

The following example highlights how standard archeological procedures, combined with experience and common sense, have led to the recovery and identification of American MIA remains.

Excavation of Site in Vietnam

One of the CILHI's more complex cases involved the 1972 loss of a U.S. A-7D Corsair aircraft shot down in a remote area of North Vietnam. As there were no American eyewitnesses to the incident, no one could "prove" whether the pilot had ejected from the aircraft or remained in it when it crashed.

In 1994, a preliminary survey team composed of U.S. personnel under the direction of the Joint Task Force-Full Accounting (an umbrella organization charged with accounting for all U.S. war casualties from the Vietnam War) and their Vietnamese counterparts interviewed several Vietnamese informants who claimed that they had found and buried the body of a U.S. pilot in 1972. The survey team located the purported grave of the pilot in an old bomb crater and excavated a 1x2 meter test pit that yielded pieces of flight suit, life support equipment (e.g. oxygen hose), and a few human bone fragments. The team, lacking an anthropologist, closed the site. The human remains were sent to the CILHI, and everything else was forwarded for analysis at the Life Sciences Equipment Laboratory, its adjunct Life Sciences Artifact Section, and additional support laboratories at the San Antonio Air Logistics Center, Kelly Air Force Base, Texas, for detailed analysis.

In an unusual twist, one of the pilot's children paid her own way to Vietnam and visited the crash site. She interviewed a villager who allegedly found the pilot's helmet, and with a little persuasion, she obtained the helmet. She knew it was her father's helmet because she found his name written inside it (the FBI later authenticated that the name had not recently been written). Although no sophisticated equipment was needed to see the name, the survey team had overlooked this piece of evidence. That the survey team had missed such compelling evidence prompted further action by the Joint Task Force and the CILHI, and as a result, the CILHI was directed to deploy a full search and recovery team with more specialists, including an anthropologist, to the site.

In the meantime, the laboratories at Kelly Air Force Base had completed their extensive analysis of the pilot's equipment and aircraft wreckage and formulated an opinion based on reproducible evidence. According to the laboratories, the life-support equipment was torn, stretched, and burned in a manner consistent with being in an aircrash. Their preliminary report stated that the pilot was in the airplane when it crashed.

In April and May 1995, a 12-man CILHI recovery team arrived at the crash site to complete what the earlier survey team had begun. Its objectives were threefold: identify the airplane; recover any associated human remains; and recover evidence to confirm or refute the Life Sciences Equipment Laboratory's preliminary determination that the pilot was in the airplane when it crashed.

The first order of business was to re-interview the witnesses. The pilot, according to the man who had found the helmet, had ejected from the airplane before it crashed. The Vietnamese later found the dead pilot, seated in his ejection seat, hanging in a tree a few hundred meters from the crash site. They removed his body, disposed of the ejection seat, and buried his remains in an old bomb crater down the mountain side.

Based on this information, the recovery team excavated the grave in the bomb crater, enlarging the project area to 12x16 meters to account for any disturbance or scattering of remains through cultivation. The team also excavated the area where villagers claimed to have found the ejection seat and lastly, the crash site itself. All three areas were dug to culturally sterile soil. Fortunately for the pilot's family, the team found more human

bone fragments (within inches of where the survey team had excavated), the pilot's dog tag, pieces of his flight suit, and life-support equipment from the bomb crater. Although the ejection seat site yielded no material evidence, the recovery team found a piece of the aircraft fuselage near the crash site stenciled with A7D 223, indicating the aircraft type and serial number. By the time the team closed its field investigations, there was nothing else to be found. All cultural material—evidence, in legal terms—had been recovered. The evidence was then used to reconstruct the circumstances of the shootdown.

Preliminary field analysis of the material evidence from the burial suggested that the pilot had actually ejected before the plane crashed. The Life Sciences Equipment Laboratory's "evidence" of tearing, burning, and stretching could be explained in another way. Specifically, witnesses told the recovery team that the bomb crater had been cleared, burned, and cultivated for many years. Thus, the interpretation offered by the Life Sciences Equipment Laboratory might be incorrect. The tearing and burning could easily have resulted from activities related to cultivation. The initial survey team didn't have this information, and the Life Sciences Equipment Laboratory's scientists' train of thought didn't entertain such cultural activities as slash-and-burn cultivation.

Anticipating the possibility that the findings of the Life Sciences Equipment Laboratory might be incorrect, the recovery team's anthropologist was careful to document everything found at the grave site. Specifically, he instructed team members to notify him the moment they found bones, teeth, flight-suit material, or a dog tag. Each of these items was photographed exactly as it was found and the anthropologist personally removed them from the ground. The dirt from the dog tag and the piece of serialized fuselage were removed and placed in separate Ziploc bags for further analysis, if so desired. Although the anthropologist didn't know exactly what tests the soil might be subjected to, he was careful to preserve each piece of evidence.

As the case evolved, one piece of evidence that proved critical was the photodocumentation of live, unbroken rootlets growing into the pilot's bones. This evidence served as legal proof that the Vietnamese had not recently "salted" remains in the bomb crater. As a matter of fact, before the excavation was completed, the team anthropologist was asked (by field radio through the U.S. Joint Task Force-Full Accounting office in Hanoi) how he knew the remains had not been recently planted at the site. The "proof," he told them, was the fact that the remains had rootlets growing through them, and along the back of the dog tag. These items had laid in the ground for many months, not weeks. In fact, a more precise age for the rootlets (i.e., the time it took the rootlets to grow to their present lengths based on their species) could later be determined by a botanist. Similarly, a few months later the Life Sciences Equipment Laboratory analyzed the soil adhering to the dog tag and the back of the serialized aluminum fuselage to determine whether these items had originated from the same site. The possibility existed that the Vietnamese had retained these items in some warehouse and salted the site before the recovery team arrived. Soil analysis using EDX (Energy Dispersive X-ray) proved that the items originated from the same area on the mountain.

When it was all said and done, the recovery team had gathered significant evidence supporting the Vietnamese witness' statement that the pilot ejected from the airplane before it crashed. Further, a little cultural curiosity on the part of the anthropologist yielded information overlooked by the initial survey team—namely, that the bomb crater had been cleared, burned, and cultivated. With this information, the Life Sciences Equipment Laboratory reversed their preliminary hypothesis that the pilot was in the airplane when it crashed. The final report reflected this opinion. CILHI had resolved the contradictory questions by conducting a thorough "crime scene" investigation, and excavation of the grave, ejection seat, and crash sites.

The pilot's remains were later identified using traditional anthropological techniques and mtDNA analysis. Aviation archeology, combined with forensic anthropology, botany, chemistry, and photography, had been used to solve the mystery of a 23-year-old MIA death.

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Melissa Connor
and Douglas Scott

Archeologists and the United Nations Tribunals

Not only are archeologists assisting the Croatian government in locating missing people (see Owsley, *et al.*, page 33), but archeologists are also assisting with medico-legal investigations of the United Nations International Criminal Tribunal for the former Yugoslavia (ICTY). Because these excavations are on-going homicide investigations, they cannot be described in the detail presented in the Owsley, *et al.*, article. The work we have done for the ICTY and the International Tribunal for Rwanda (ITR) is in support of criminal investigations relating to extra-judicial executions that have occurred in these countries during civil unrest. The ICTY and ITR are internationally sanctioned judicial bodies investigating alleged genocide and war crimes in former Yugoslavia and Rwanda. The Tribunals are gathering evidence to indict and prosecute alleged perpetrators. Archeologists and archeological site documentation techniques are a significant part of these international criminal investigations.

Through the Physicians for Human Rights (PHR), an organization that completes forensic investigations for the UN, the archeologists work with other PHR scientists and the UN forensic specialists, as well as lawyers and investigators from the Hague. During 1996, archeologists assisted in site documentation and grave exhumations throughout the Srebrenica area of Bosnia and in the Croatian/Serb transition zone near Vukovar, as well as in the African country of Rwanda. This year, over 1,300 bodies were exhumed for the UN investigations. Archeologists from the United States involved in this effort include Rebecca Saunders, Louisiana State University, and Patrick Meyers, as well as three archeologists from the National Park Service's Midwest Archeological Center—Douglas Scott, Melissa Connor, and Ralph Hartley. The NPS archeologists were requested to assist in the investigations in Rwanda and in Croatia because of their skills in computerized site documentation and mapping as well as photographic documentation.

Archeologists assist in locating clandestine grave sites, direct the excavation of the sites, and are responsible for site and evidence documentation, and mapping. The excavation team usually includes at least one archeologist, several forensic anthropologists, and a backhoe and operator. Many of the forensic anthropologists also have an archeological background. The general location of the graves had been previously determined by UN investigators and the sites verified by UN Senior Forensic Anthropologist William Haglund.

The general methodology starts with the archeologists assisting the team in locating ground features consistent with a mass grave. Next, test trenches are excavated with a combination of the backhoe and hand tools until human remains are located. When remains are located, the grave is treated as a feature. The edges of the grave are determined, usually using the backhoe to trench around the edge of the bodies. The top of the mass of bodies is uncovered, to the point possible without allowing the fleshed remains to dry out. This overall view is then photographed and mapped and body removal begins. One person works as photographer and documenter, photographing each body and filling out a form recording basic data. The body, or at least the crania, are mapped, with the method varying as to the site, although the preferred method is using a total station transit and electronic mapping (we use the Sokkia total station, Sokkia Map, and AutoDesk AutoCad programs). When documentation is complete, the body is placed into a body bag and removed from the grave into a refrigerated storage unit. These units are later transported to the morgues for a formal medico-legal autopsy.

The skills archeologists bring to a medico-legal investigation are critical in documenting how a clandestine grave was dug, the method of body disposal carried out, and in documenting physical evidence associated with the event, such as the locations of expended cartridge cases and bullets. The evidence collected and documented by the archeologists, along with the testimony of forensic anthropologists and forensic pathologists, will be used by the courts in the prosecutions of those accused of genocide and war crimes. Applied archeology/anthropology, in the form of archeological documentation methods, is becoming integral to forensic investigations on this international stage.

Melissa Connor and Douglas Scott are archeologists with the Midwest Archeological Center, National Park Service, Lincoln, NE.

Douglas W. Owsley, Davor Strinović, Mario Šlaus,
Dana D. Kollmann and Malcolm L. Richardson

Recovery and Identification of Civilian Victims of War In Croatia

The aftermath of war; destroyed homes in the town of Glina.

Photos by Dana D. Kollman.

Residents set fire to their agricultural fields in order to detonate land mines.

An hour after leaving Zagreb and traveling south toward the current border between Croatia and Bosnia, we were overwhelmed by the devastation caused by the conflict that began in August 1991. The Croatian military had regained this territory from Serbian forces in August 1995. Small villages consist almost entirely of ruins of former homes; partially destroyed walls of concrete and terra cotta blocks are the remnants of sturdy houses that are generations old. Roofless and without doors or windows, the houses bear the scars of war created by rockets and artillery. Also visible are the pockmarks from grenade fragments and automatic weapons.

Fires consumed all the combustible parts of the homes, including the furniture and other comforts and keepsakes. In the early spring of 1996, the fields of these farming communities remain untilled because they are still seeded with land mines. Although a few residents are beginning to return and rebuild, most are still absent, having fled to places of safety. Other villagers are absent because they lost their lives during acts of brutality when they would not desert their homes.

These were our first impressions as part of a joint Croatian-United States forensic investigation team during its initial visit to the area around the small town of Glina to search for burials, systematically recover the remains, determine the cause of death, and identify the victims. The three-person team representing the Smithsonian Institution was headed by a forensic anthropologist (Dr. Douglas Owsley), accompanied by an archeologist and a criminalist on loan from the Baltimore County Police Department's Crime Laboratory. The Croatian contingent was led by forensic pathologist Dr. Davor Strinović, Department of Forensic Medicine and Criminology at the University of Zagreb, and physical anthropologist Mario Šlaus of the Zavod du Arheologiju at Zagreb. The recovery effort was sponsored by the Croatian-American Joint Science Board.

The goal is to aid the development of forensic anthropology in Croatia by demonstrating techniques and instrumentation employed in the discovery, excavation, and examination of human remains. Depending on the preservation and completeness of the remains, forensic anthropologists can supply information on age at death, sex, race, stature, time elapsed since death, dental and osteological pathology, perimortem trauma (injuries occurring at the time of death), and cause of death. In some instances, skeletal attributes also provide clues to lifestyle, occupation, habitual patterns of activity, and other sociobehavioral characteristics.

The primary objective in Croatia was to establish the identification of the deceased and to determine the cause of death. The forensic team also recorded cranial and postcranial skeletal measurements for an osteometric data bank being developed for this region, which will aid future personal identifications by providing important comparative data. This initiative is patterned after the forensic anthropological data bank that has been developed for North America by the Department of Anthropology of the University of Tennessee, Knoxville.

Prior to assembling the joint team, Croatian government investigators interviewed friends, relatives, and neighbors of persons that are missing. Files have been created on those reported killed or missing, including detailed physical descriptions, photographs, and data about the time and circumstances of their death or disappearance. The investigators were thorough in collecting evidence and when the government teams visited areas of reported atrocities, they successfully located the aftermath of many multiple or mass burials.

The roads leading from the village of Glina to these scenes of tragedy were single-lane dirt tracks that were deeply rutted and eroded. They are rarely used, as the former inhabitants are gone and the roads have received no maintenance. In most areas, formerly cultivated fields on both sides of these roads were delineated with plastic tape warning of the danger of mines. Many of these fields were on fire; their owners hoping that the heat would explode mines and release or expose tripwired booby-traps. Several abandoned bunkers and rifle pits held commanding positions along the rude roads. The bunkers were constructed of sand-filled

Probing a suspected burial site to determine the location and outline of the grave. The decomposed bodies of four males, who were shot in the adjacent house, were recovered.

ammunition boxes with roofs of logs or planks covered with sod.

During the fieldwork, the many liaison matters were expertly dealt with by a military commander and a high-level civilian government official; both, along with their personnel, were dedicated to the task of investigating all such burials in Croatia. The crews were escorted to and protected at every location by Croatian police. Military personnel successfully led the vehicle convoy over unmined roads and paths past areas cordoned with razor wire. Upon arrival at a reported burial site, a military explosive ordnance disposal team first cleared the work area for mines. While the forensic team was occupied with their tasks, these specialists continually broadened their search area and, in addition to finding and collecting mines, also gathered live but unexploded grenades, rockets, and mortar and artillery shells. Loud explosions attested to their success in locating and disposing of these remnants of war that are retarding the return of former inhabitants to the area and their pursuit of a peaceful livelihood.

The first clues to soil disturbances were visual surface anomalies such as depressions, unusual soil concentrations, changes in vegetation, or the presence of sub-surface soils. There are a variety of remote-sensing techniques that can be used for validating surface features or for detection of soil disturbances when such clues are not present. These tools range from the simple to the complex and include probes, resistivity meters, magnetometers, and sophisticated ground-penetrating radar devices. Considering that our areas of investigation were remote, and often in rugged terrain accessible only by foot and with no available electrical power, the highly portable and effective stainless steel probe was the obvious choice for our field studies. The investigator determines the amount of resistance to the probe in undisturbed soil. When inserted in the less compacted soils resulting from previous excavations, the ease of entry is apparent. Disturbed soil stratigraphy was verified by examining a soil coring sample.

Once a burial was delineated, the upper soils were removed by supervised military personnel with shovels. The pyrotechnic specialists regularly checked for booby-traps. After exposure, the remains were photographed and detailed notes taken and drawings made of the positions of the bodies and their coverings and clothing. A precise method of control was employed that included the assignment of identifying numbers and provenances to the remains of these victims. The bodies were carefully removed from their temporary graves for transport to Zagreb. The soil around and beneath the individuals was thoroughly checked for additional evidence.

Our first investigation was of a burial reported to contain five victims. The pit was deep, having been dug through several stratigraphic layers of heavy clay soils. It appeared to have been excavated mechanically, probably with a backhoe. The grave contained the bodies of four men in various positions and the skeleton of a dog. Several possessed identifying cards and papers, and one man's trouser pocket contained a large sum of money. One individual had the end of a length of chain attached to his ankles, possibly used to drag the body to the burial place. All had been shot. Near the burials was a one-man bunker protected with banked earth and a look-out or sniper's perch in a tree. The men reportedly had been killed in the adjacent house, and an examination of a ground-floor room disclosed the pockmarks left by weapons fire on the concrete walls. On the floor were numerous 7.62 mm shell casings that can be fired from an SKS or AK-47 automatic weapon.

While the first multiple grave was being excavated, a second crew was dispatched to the reported site of another burial about a half mile away. This second site was accessible only by foot over a cleared path through the mined fields. Located at the base of a gentle slope along the edge of a swampy field, the grave was evident by a boot that protruded up through the soil and by a cloth-covered object that later proved to be the knee of another victim. The grave was a shallow burial sparsely covered by soil. Three individuals were found covered by a plastic sheet. Two were reported to be brothers and the third a cousin. They had been shot and some body parts were missing. Local people reported that the men had decided not to abandon their farm and home by fleeing and shortly thereafter were gunned down in a field and left there. Unfortunately, feral pigs attacked the bodies before villagers could safely return and attend to their dead relatives and neighbors. Approximately a week later, the decomposing and partly scavenged bodies were transported into the woods and quickly buried.

A third site was investigated and contained the remains of a woman. Her death was caused by gunshot wounds and had resulted from her refusal to leave her home. She was buried in front of her house which had been vandalized with graffiti that served to identify the perpetrators. Having died during December, this woman and all of the men in

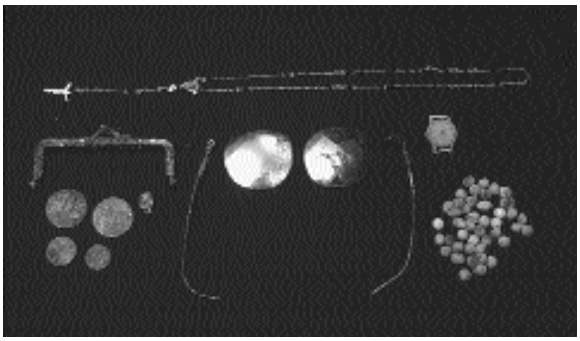
the other burials wore multiple layers of heavy winter clothing, i.e., long underwear, several pairs of long pants, skirts, an apron, shirts, vests, sweaters, a scarf or shawl, and heavy coats.

The first day of fieldwork culminated with the investigation of a purported slaying and burial of a woman on her farm. She was said to have been buried in front of a brick and tile milk house. Probing identified a potential burial shaft and diligent digging in the early evening began to expose a rectangular pit. It was extraordinarily deep, but the bottom was eventually reached. To our surprise and emotional relief, we did not find the remains of the missing woman but instead the complete skeleton of a cow.

Subsequent plans called for exploring a deep well reported to contain the remains of a large family and for also investigating the burned remnants of the nearby house. Croatian government officials excavated the well prior to the arrival of the full forensic team. Excavation of the well required heavy equipment before the bottom was reached. The information obtained from local residents was inaccurate; the well contained no bodies.

Unlike most houses that are made of concrete and terra cotta block in this part of Croatia, this house had been a small, wooden structure with a clay tile roof and packed clay floors, except for a concrete floor in the kitchen. The house was burned in late 1991 and remained untouched since that time. The larger, charred pieces of the burned structure and the non-combustible furnishings, appliances, and equipment were carefully removed to expose the underlying debris. The floor of the entire structure was then closely inspected for human remains. Small, calcined fragments of human bone were found among the ashes in the kitchen. Two clusters of small animal bones were located in other rooms of the house. These bones were identified as belonging to an immature pig; a neighbor reported that the family had been butchering a pig on the day of the attack. The kitchen was isolated for special treatment. The remaining rooms were carefully cleaned with flat-blade shovels; no other osteological evidence was found.

The kitchen was then sectioned into quadrants for purposes of control and the exact positioning of pertinent artifacts. Excavation of the quadrants was accomplished in two levels. The upper level contained large charred fragments of the building, segments of the clay-tiled roof, and curved pieces of whitewash that at first glance resembled burned bone fragments. The lower level consisted of fine ash particles among which were scattered kitchen implements and a large concentration of small human bone fragments that had been calcined from extreme heat. The commingled bone fragments were from two adult females, one significantly older than the other. Among the bone fragments were several metal dental crowns, one of gold, and personal articles including metal eyeglass frames, a chain that once held wooden rosary beads and the metal fasteners of a coin purse.



The metal hinge of a purse, coins, eyeglasses, and a rosary chain and beads found in association with calcined bone fragments.

The neighbors believed that the family had been killed by knives or axes, as no gun shots were heard. However, expended shell casings and spent bullets from a 7.62 mm assault weapon and two different caliber pistols, a 9 mm and a 32 automatic, were recovered.

While excavation of the kitchen ashes was underway, Croat team members investigated a rumor which circulated among the neighbors. It was said that the matron of the house had buried a chest containing family heirlooms and keepsakes under the floor. Using probes, two buried objects were found; a wooden chest and a glazed steel box containing national costumes, laces, shawls, pictures and family papers and documents that were considerably damaged by moisture. Examinations were conducted in the morgue and laboratory facilities in the Anatomy Department of the Medical School of the University of Zagreb. Various states of deterioration among the remains reflected differences with respect to the acidity of the soil, burial depth, and length of time since interment. Many consisted of bones having small segments of soft and connective tissue still covered by clothing. Adipocere was present in some remains; and in several cases, the tissues had almost totally saponified on the skeleton and as such, they resembled figures constructed of plaster of paris.

The autopsies and forensic examinations were conducted jointly by the pathologist and forensic anthropologist who continuously dictated notes to a nearby member of the team equipped with a notebook computer. A vast amount of information about each individual was recorded relating to clothing, age, sex, stature, antemortem injuries and diseases, perimortem trauma, and postmortem damage when present. Important observations were recorded by the ever-present camera of a full-time photographer. Portable photographic studio equipment had been brought from the Smithsonian Institution in order to photograph all bones that showed trauma and other burial artifacts. Also photographed were bones that revealed diseases, mended bones, surgically implanted devices, and those showing past health problems.

The remains of each individual were carefully examined by plotting the position of bullet entrance and exit holes in their clothing or damage to the bones. Each of the multiple garments was described and cataloged as it was removed and the contents of garment pockets were inventoried. As outer layers were removed, the continuity of bullet holes was verified in lower garments and finally matched with entrance and exit wounds in the body or with projectile-fractured bones.

Time-consuming attention was given to the analysis of the bone fragments of the women burned in the house, as they were the most difficult from which to extract data for identification. The two sets of fragmented remains could be effectively sorted on the basis of bone size and robusticity, osteoporotic changes in the older woman, and perceptible differences in the color of the calcined pieces of bone of each woman. The rewards were significant: by determining their ages, health conditions, past diseases, dental work (the gold crown), and the metal framed eyeglasses, the identities of the two women could be established.

The identities of others were ascertained by matching forensic data with information collected by officials during earlier interviews. In North America, personal identification is often confirmed by the comparing and matching of detailed bone and dental features seen in antemortem radiographs with those present in the skeleton or dentition being examined. In Croatia and Bosnia, however, even when such records originally existed, medical facilities were often targeted and destroyed. As a consequence, identification criteria depend heavily on descriptive information provided by friends and relatives. As a supplement to the information contained in the antemortem database, when probable identifications were indicated, family members were brought to Zagreb to discuss the findings of each investigation with the forensic team. Friends and relatives attending these conferences were shown photographs of clothing and personal items and relatives often recognized apparel belonging to a missing individual based on the garment's color, style, or pattern.

Through this collaborative effort, a tremendous amount of work in the field and laboratory was accomplished. Croatians and Americans worked side-by-side, sharing their expertise and knowledge to complete these unpleasant but necessary tasks. All were rewarded by knowing that the results of their work provided the relatives of the missing villagers with important facts concerning the fate of their loved ones as well as providing data to the Croatian government concerning the circumstances surrounding the deaths of some of its citizens.

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