

Nikki L. Rogers,<sup>1</sup> Ph.D.; Kenneth Field,<sup>2</sup> M.B.A.; Richard C. Froede,<sup>3</sup> M.D.; and Bradford Towne,<sup>1</sup> Ph.D.

## The Belated Autopsy and Identification of an Eighteenth Century Naval Hero—The Saga of John Paul Jones

**ABSTRACT:** John Paul Jones, the “Father of the American Navy,” is known for the battletime assertion that he had “not yet begun to fight.” His central role in a triumph of scientific forensic identification more than a century after his death is less known. John Paul Jones died in 1792 and was buried in Paris, France. The location of his grave was lost over time and a search for his corpse began in 1899. Remains matching his physical characteristics and circumstance of burial were discovered in 1905 and returned to the United States for a hero’s burial. Some questioned the identification at the time and the major source of identifying information (17) has since been shown to contain false information. The published forensic literature fails to address existing critiques of the identification. We provide a substantive analysis and conclude that the available evidence supports the identification of the unknown remains as those of John Paul Jones.

**KEYWORDS:** forensic sciences, John Paul Jones, history of forensic sciences, forensic anthropology, anthropometry, photographic superimposition, autopsy, U.S. Navy

John Paul Jones, the “Father of the American Navy,” is perhaps most famous for declaring that he had “not yet begun to fight” during the Revolutionary War battle in which he captured the British Navy’s most advanced naval warship, H.M.S. *Serapis*. He devised the framework upon which the U.S. Navy was built, and his nautical prowess earned him military honors and the favor of European royalty. His many naval exploits have been told by way of Hollywood and a Pulitzer prize-winning biography (1), and continue to be of interest to biographers and students of history (2). Many may be surprised, however, by his inadvertent supporting role in an early triumph of scientific forensic identification more than a century after his death. This report details the life, death, and postmortem adventures of America’s most legendary naval hero. While other authors have written about Paul Jones’ postmortem identification, most have confined themselves to description (e.g., 3,4), or reprinting large portions of the original reports with little commentary (5). We address critiques of the identification and conclude that the corpse in question is that of the American patriot John Paul Jones.

### The Life of John Paul Jones<sup>4</sup>

Born on July 6, 1747, in Abridgland, Scotland, John Paul began his naval apprenticeship at 12 years of age and earned his own

command by the age of 21 while serving as a merchant sailor in the West Indies. His early career was highlighted by two controversial incidents. In 1770 murder charges were leveled against Paul for the death of Mungo Maxwell. Maxwell was a crewman who Paul ordered punished by flogging and who subsequently died following transfer to another ship. By 1772 Paul obtained records that showed Maxwell suffered no permanent damage from the flogging and had died of an unrelated fever. And, while quelling a mutiny in the fall of 1773, Paul fatally injured a crewman with his sword. Although he cooperated with authorities, the pretrial process was expected to take more than a year. Taking the advice of friends, Paul emigrated to the North American Colonies to await his trial in anonymity. During this time Paul adopted the additional surname *Jones* and retained it for the rest of his life.

A ban on trade between the American Colonies and the West Indies issued in May of 1775 prevented John Paul Jones from returning to Tobago to stand trial (1). The outbreak of hostilities enticed the Scotsman to request a commission in the Continental Navy, the precursor to the U.S. Navy. Paul Jones was among the first naval officers commissioned by the newly independent United States of America, was the first commander to hoist an American flag on a warship (in 1775), and was the first commander to receive a formal naval salute to the Stars and Bars by a foreign power (France, in 1778). During the American Revolution, Paul Jones successfully commandeered British merchant ships through daring attacks and cunning naval strategy. He was called a pirate by the British and a hero by the colonists.

The pinnacle of Paul Jones’ career came in 1779 when his tactical maneuvering of the poorly outfitted frigate *Bonhomme Richard* defeated H.M.S. *Serapis*. Despite heavy British gun fire, failure of a majority of his cannon, friendly fire from his companion ship *Alliance*, and his master-at-arms’s release of all British prisoners during the early stages of the battle, Paul Jones and his crew forced Captain Pearson of the *Serapis* to surrender just before the *Bonhomme Richard* began to sink. During the attack the British commander asked Paul Jones if he was ready

<sup>1</sup> Wright State University School of Medicine, Department of Community Health, Lifespan Health Research Center, 3171 Research Blvd., Kettering, OH 45420-4004.

<sup>2</sup> American Academy of Forensic Sciences, Colorado Springs, CO 80921.

<sup>3</sup> Consultant in Forensic Pathology, Tucson, AZ 85750.

<sup>4</sup> John Paul Jones has been the subject of numerous biographies of varying quality and accuracy. The reader is referred to Morison (1) and DeKoven (9) for two of the most accurate accounts of his naval and personal lives; although Morison claims DeKoven includes some stories that cannot be verified.

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TABLE 1—*Medical history of John Paul Jones summarized from Refs 1, 8, and 9.*

Citation	Year	Description	Possible Illness
St. George, Grenada Voyage from Grenada-London Paris	5 Aug. 1770 24 Sept. 1771 Feb.—Dec. 1779	Severe, cyclical fever Unnamed illness Insomnia, unnamed illness, bedridden	Malaria/other tropical fever  Physical ailments exacerbated by possible depression due to removal from command of <i>Ranger</i>
L'Orient	Feb. 1780	Sore eyes, extreme light sensitivity, near blindness	
Puerto Rico, Pennsylvania	Fall 1782—late Summer 1783	Cyclical fever	Malaria/other tropical fever recurrence
Paris Copenhagen Russia Kherson, Russia Paris	Aug. 1786—Spring 1787 March June, 1788 Nov.—Dec. 1788 Feb. 1790	Unspecified illness delays travels Bedridden, Unspecified illness Unspecified illness aboard ship	Pneumonia Illness (re)triggered by travels throughout Europe on return to France; inactivity
Paris Paris	Dec. 1790 2 Feb. 1791	Unspecified illness References to long period of unspecified illness	Continued inactivity, lack of financial security
Paris Paris	May, June 1792 July 1792	Jaundice, loss of appetite Edema/ascites, lethargy, loss of appetite, death	Tuberculosis Renal failure Congestive heart failure

to surrender, to which he allegedly replied, “I have not yet begun to fight.”<sup>5</sup>

Paul Jones became a popular figure in both American and European society following this victory. Louis XVI of France awarded him an ornate ceremonial sword, the Order of Military Merit and the title of “Chevalier,” which carried the rank of Commodore in the French Navy. The Dutch royal family accepted him in their court. And, famed neoclassical portraitist Jean Antoine Houdon sculpted his portrait bust for his collection of “great men.”

In 1782, Paul Jones sailed with a French fleet to the West Indies where they joined forces with the Spanish in attempts to destroy British forces in the Caribbean. After these missions were halted by the peace treaty with Britain, Paul Jones briefly served as an appointed American official to the Netherlands. An offer to serve in the Russian Navy to fight Empress Catherine II’s war against the Turks lured him back to sea in 1788. Although he did not speak Russian, Paul Jones served alongside commander Prince Grigory Potemkin in the Black Sea and was promoted to Admiral. Despite a number of successful battles, Paul Jones’ nature gained him enemies in Catherine’s court. In 1789, the Admiral was accused of sexually assaulting a 10-year-old girl, for which the Empress relieved him of duty. Despite Paul Jones’ claims of innocence and conspiracy (for which there was some evidence (7)), he never regained the Empress’s favor and retired to France in hopes of finding other opportunities for naval service (1).

John Paul Jones never reclaimed his former popularity. While he still had admirers in Paris, his increasingly poor health forced him to refuse most social invitations. It was during this time that the recurrent maladies plaguing Paul Jones since 1770 (Table 1) became more troublesome, and more serious symptoms developed. His health was in serious decline for at least a year prior to his death.

<sup>5</sup> The wording of this famous statement comes from a description of the battle by Paul Jones’ second-in-command, Richard Dale, for J. H. Sherburne’s 1825 biography of Paul Jones (8). Paul Jones’ description of the battle is far less quotable, “The English Commodore asked me if I demanded quarters [surrendered], and I having answered him in the most determined negative, they renewed the battle with Double fury. . .” Letter to Benjamin Franklin, 3 Oct. 1779 reproduced in Stewart (14, p. 146). Capitalization follows the manuscript.

In the two months preceding his death he suffered jaundice, loss of appetite, and complained of severe edema and shortness of breath. In the days immediately preceding his death, Paul Jones suffered from excessive swelling in his legs and lower abdomen, and an “exhausting” productive cough (6). Marie Antoinette’s physician, neuroanatomist Felix Vicq d’Azyr, came to attend Paul Jones in his apartment on the evening of July 18, 1792, but found that he had died, alone (6). His death was officially attributed to “dropsy of the chest.”

Gouverneur Morris, American Minister to France and witness to the Commodore’s will, ordered that the Admiral be buried privately and inexpensively. Morris attributed his decision to Paul Jones’ relative penury and a belief that he had no right to spend the sailor’s money without his heirs’ permission (6,8). The king’s commissary was traditionally responsible for providing government funds for the burial of foreigners. Commissary Pierre-Francois Simmoneau insisted on personally paying for the funerary services. Expecting that the United States would wish to return their hero to American soil once the turmoil of the French Revolution was over, Simmoneau paid more than five times the minimum cost of burial to prepare the body for journey by sea (1). Following a private ceremony attended by French officials, Paul Jones’ fellow Masons, and the witnesses to his will, Admiral Paul Jones was buried in the St. Louis Cemetery for Protestants of foreign birth. No marker was erected on the grave, and records concerning the burial were scattered and/or destroyed during the ongoing French Revolution (1789–1792) and in the years following. The St. Louis Cemetery was officially closed to further burial six months after the internment of Paul Jones, and only occasional burials were made over the following 11 years (6). There are no records indicating that the United States and France agreed to transfer Paul Jones’ body to U.S. soil. The St. Louis property was sold, the cemetery was covered by landfill, and the burial ground passed into obscurity for more than a century.

### The Search for Paul Jones’ Grave

For unknown reasons, the U.S. Government did not request the return of the Admiral’s remains after the French Revolution. The first attempt to repatriate John Paul Jones to the United States was

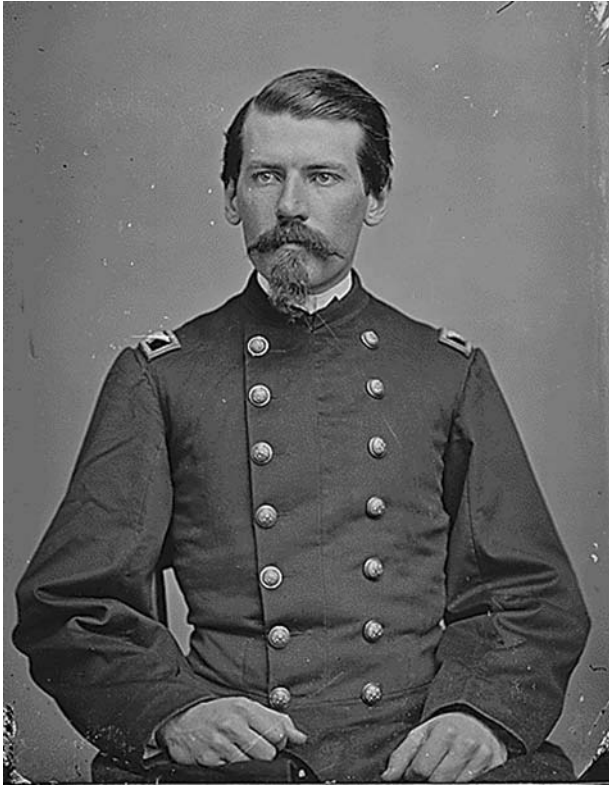


FIG. 1—General Horace Porter (1837–1921). Porter was a graduate of West Point and was awarded the Congressional Medal of Honor in 1902 for bravery in the 1863 Civil War battle of Chickamauga. He was U.S. Ambassador to France at the time of his search for Paul Jones and personally financed the search. Photo 08-0620a by Mathew Brady Studio for the U.S. Army War Department, Office of the Chief Signal Office, courtesy of the United States National Archives and Records Administration.

initiated by Colonel John H. Sherburne, a former soldier employed as Register of the U.S. Navy. Sherburne was an acquaintance of Paul Jones and author of an 1825 biography of John Paul Jones (8). In 1847, he began working out a plan with U.S. officials to return John Paul's remains should he locate the corpse (9). Missing and incomplete records complicated his search for the location of the gravesite, however, and at least one source (10) claims that Paul Jones' family delayed his search by protesting his actions. Based upon available information, Sherburne erroneously concluded that the St. Louis Cemetery was the same as the pauper's cemetery located behind the Hotel Dieu Hospital in central Paris. His sources further indicated that all remains from this cemetery had been removed to the Parisian catacombs (9,11). He abandoned his quest and died in 1852 (12).

Nearly half a century later, in 1899, General Horace Porter (Fig. 1) was appointed U.S. Ambassador to France. While in Paris, Porter began his attempts to return Paul Jones to America because he felt:

a deep sense of humiliation as an American citizen in realizing that our first and most fascinating naval hero had been lying for more than a century in an unknown and forgotten grave . . .”  
—Porter (6, p. 49)

His six-year search identified the long-abandoned St. Louis Cemetery in northeast Paris. The process of securing the permissions to excavate the property was extended by two years because ambitious parties purchased the excavation rights with the intention of reselling them to Porter at a great profit (11). After waiting out these

TABLE 2—Chronological list of events.

Date (all 1905)	Event
February 3	Excavation of St. Louis Cemetery began
February 22	Coffin 1: ME Anglois
March 31	Lead coffin 3 discovered (John Paul Jones)
March 23	Coffin 2: Richard Hay
April 7	Coffin 3: opened on site, resealed with plaster, transferred to Ecole de Medecine overnight
April 8	Coffin re-opened at the Ecole de Medecine and autopsy performed
April 11	Monpillard photographs corpse from coffin 3
April 13	Coffin 4: Cygit Georges Maidison
April 13	Doctors Capitan and Papillault conduct autopsy
April 14	Scientific examination closed
April 18	Coffin 5: unknown male, > 6 ft tall

parties and obtaining permissions, Porter enlisted the aid of French engineers to oversee the work and excavations began on February 3, 1905 (Table 2).

Weiss (13) states that the St. Louis Cemetery for Foreign Protestants was clearly marked on Verniquet's Paris map of 1791. It was located at the intersection of two streets, running 130 ft (39.6 m) parallel to Rues de Ecluses Saint Martin and roughly 120 ft (36.6 m) along Rue Grange-aux-Belles (6). A rectangular courtyard with small peripheral buildings lined the property on the St. Martin side, with the cemetery located behind it, roughly 3–4 m lower in elevation. In 1805, the land was sold and the cemetery area was filled to make it level with the courtyard area. A laundry house, a stable, a barn, and other utility buildings were built on the site in the intervening years. Although these structures covered the original courtyard and cemetery areas, the dividing wall between the two remained visible in 1905 (13).

Because the landowners wished to maintain the integrity of the existing structures, excavations were conducted below ground level using shafts and galleys from which sounding bars were probed into surrounding soil. In his August 8, 1792 letter to Paul Jones' sister following the Admiral's death, Colonel Samuel Blackden stated that the Commodore's body was interred in a lead coffin. This was a rare treatment reserved for the wealthy, especially during the French Revolution. The search for the body was therefore restricted to a search for lead coffins in the St. Louis Cemetery.

The entire St. Louis Cemetery was probed, and five lead coffins were discovered. Four coffins were not subjected to further study because they had legible nameplates identifying them as someone other than Paul Jones (coffins 1, 2, and 4), or contained the body of a male more than six feet in stature (coffin 5). All contemporary descriptions of Paul Jones describe him as being of short stature. The third coffin, unearthed on March 31, 1905, had no nameplate and was examined at the excavation site. It contained the body of a male under six feet tall who had been subject to elaborate funerary treatment, including immersion in alcohol. There was evidence that the lead coffin had been encased in wood that had been destroyed by weathering and/or the later interment of another body atop it (6).<sup>6</sup>

Coffin 3 was opened at the excavation site on April 7, 1905, in the presence of excavation officials and workmen who were surprised by the corpse's excellent state of preservation. The stature was approximated onsite and fell within a range of that reported for Paul

<sup>6</sup> After the identification was concluded, loss of the wooden outer casing or the unavailability of engraving services amidst of the French Revolution were cited as possible reasons for the lack of a nameplate on the coffin (15).



FIG. 2—*Louis Capitan* (circled), an anthropologist incorrectly listed in all reports as *J. Capitan*, performed the autopsy. This photo shows him at a burial site unrelated to Paul Jones. Photo courtesy and © the Field Museum, negative #CSA58841.

Jones. Officials at the site had a copy of Paul Jones' Congressional Medal and compared it to the corpse.

Upon placing a medal near the face, comparing the other features and recognizing the peculiar characteristics—the broad forehead, contour of brow, appearance of the hair, high cheek bones, prominently arched eye orbits, and other points of resemblance—we instinctively exclaimed 'Paul Jones!'  
—Porter (6, p. 62)

After the remains were identified as belonging to John Paul Jones (see below), Charles W. Stewart, Superintendent of the Library and Naval War Records, compiled all reports regarding the search for Paul Jones' grave and identification into a book entitled *John Paul Jones: Commemoration at Annapolis, April 24, 1906* (14). Most of the published literature necessarily relies heavily on this work, but in the years since its publication there have been critiques and criticisms of the identification of John Paul Jones that have not been addressed in the literature. We take this opportunity to now address these issues and assemble a case of circumstantial evidence that supports the identification of the corpse in coffin 3 as the remains of John Paul Jones.

### Autopsy and Confirmation of Presumptive Identification

Coffin 3 was opened on site and resealed April 7, 1905, and was then taken to the Paris School of Medicine for further examination. Professors Louis Capitan<sup>7</sup> (Fig. 2), Georges Papillault, and Georges Hervé of the French School of Anthropology examined the body. Professor Victor Cornil of the Paris School of Medicine examined pathology specimens, and Fernand Monpillard, a member of the Societe Francaise de Photographie, took the only existing photographs of the body and the pathology slides used in the analysis.

The strong odor of an alcohol-like substance was noted when the coffin was opened, suggesting intentional preservation. Straw was packed around the corpse so tightly that the coffin had to be cut along the midline to remove the body. The corpse was wrapped in

a linen sheet and wore a white linen shirt with a ruffled neck. The hands and feet were wrapped in a type of foil, perhaps to protect them during transport. Stewart suggests that the foil may have been associated with the Scottish Mason rite of Kadosh (11), supported by the fact that Paul Jones' funeral was "conducted by M. Marron, who was head of the Scottish [sic] Rite Masons in Paris." The presence of foil is not noted as an unexpected nor unusual practice, and Capitan states (15, p. 82) "... It is, besides, a process still in use at the present day." He does not suggest that the foil is associated with a Masonic ritual, nor clarify the funerary role that foil played in contemporary practice. If the investigators thought the foil was associated with a Masonic rite, we submit that its presence would have been listed as evidence establishing the corpse as Paul Jones.

The exhumed corpse (Fig. 3) was interred in a supine position with its arms crossed over the abdomen. No determination of ancestry is found in the official reports, perhaps because only individuals of European ancestry were expected to be found in the cemetery. However, the facial features seen in the photograph and described in the reports are adequate to establish the subject as being of European ancestry.

The feet were positioned in extreme plantar flexion with the arms and hands fully extended. The position of the head and nose led the investigators to conclude that the face came into contact with the top of the coffin when it was closed, displacing the head and disfiguring the nose (6). The hair, 75 to 80 cm in length, was gathered at the rear of the head by an embroidered linen cap (16). Separate strands were curled atop each ear. A symbol embroidered upon the linen cap reportedly looked like the letter "J" with an exaggerated bottom loop, and like the letter "P" when rotated 180 degrees (6). Unfortunately, no photos or drawings of this item are included in the reports.

The soft tissues varied in color from gray to brown and were flexible and moist. The gross level tissues were firm and remained undamaged when the corpse was lifted from the coffin. White crystals were present on the surface of the skin, ranging in size from a few millimeters to a few centimeters in diameter. The investigators attributed these patches to autolytic processes begun before the preservative fully infiltrated the body. All tissues were impregnated with the preservative despite the apparent evaporation of fluid. There were no visible scars or other gross evidence of healed wounds.

<sup>7</sup> All reports list Professor Capitan as "J. Capitan," but the School of Anthropology history lists a Professor *Louis* Capitan as the contemporary of Professors Papillault and Herve (41). Further, no other member of the Parisian Anthropological Society with the surname Capitan exists (42).



FIG. 3—The remains of John Paul Jones, photographed by F. Monpillard on 11 April 1905, after three days' exposure to air. Note the white masses of tyrosin present on the skin (circled). Photo NH78749 courtesy of the Naval Historical Center.

Due to the flexion of the feet, Dr. Papillault estimated the stature (1.71 m) as follows:

... I had to take the distance comprised between the vertex and the inner ankle bone and add 8 centimeters, representing the rest of the stature—that is to say, the length which separates the joint of the ankle bone from the sole of the foot—according to an average of 100 corpses hitherto measured by me. —Papillault (16, pp. 88, 89)

#### *Information and Busts Used for Identification*

The scientists were given written descriptions and artwork portraying the likeness of Paul Jones created during his lifetime to aid in identification. Buell's treatise on the life and exploits of Commodore Paul Jones (17) was the most recent source of infor-



FIG. 4—Bust used for identification (a) Bust on display in Paul Jones' crypt, U.S. Naval Academy, Annapolis. Signed by Jean-Antoine Houdon, 1780. (b) Bust on display in the National Academy of Design, New York. Photos courtesy of the Naval Historical Center.

mation concerning his general appearance. Unfortunately, it was not yet known that Buell's information was highly suspect and possibly fictitious (9,38).

Two busts and a medal portrait were used for comparison purposes. A reproduction of the New York Academy of Design's bust, signed by Houdon and a documented result of a 1780 sitting with Paul Jones, was borrowed from the Tracadero Museum of Paris, (Figs. 4a, 4b). The second (Figs. 5a, 5b) was an unsigned bust from the collection of the Marquis de Biron and purported to



FIGS. 5(a, b)—Bust from the de Biron collection. Note single epaulette on subject's right shoulder. (Left shoulder is adorned by the subject's hair). Photos courtesy of the Naval Historical Center.

be that of John Paul Jones. Copies of Paul Jones' congressional medal were also made available for field use. The medal, commissioned in 1787 from Parisian artist August Dupre, was modeled after Houdon's 1780 bust (1). Paul Jones himself commissioned a portrait by medal-maker Jean-Martin Renaud in 1786 when he learned of the proposed Congressional award (1). Thomas Jefferson, however, preferred the work of Dupre and commissioned him for the project. Benoit André was Paul Jones' secretary who translated

TABLE 3—Comparison of anthropometric measures of bust and corpse.\*

Dimension	Houdon Bust (1780)	Corpse
Total face length	19.5	19.5
Upper face length	12.7	12.9
Lower face length	7.5	7.4
Upper lip length	2.4	2.5
Lower lip and chin length	4.6	4.6
Minimum frontal width	10.4	10.2

\* All measures in cm.

Jones' *Mémoire* (18) into French for formal presentation to Louis XVI. André used Renaud's sketches to illustrate his 1798 version of the *Mémoire* (19). Benjamin (10) criticizes the identification process for omitting Renaud's depiction. It seems that these sketches were not readily available to the investigators in 1905, for André's book went through only a single printing and is quite rare (20). Morison describes the image:

Renaud depicted Jones as he appeared in 1786 when he had become a little fleshy from good living in Paris and had dressed his hair in the latest style, with an enormous club behind and two rolls over the ears. —Morison (1, p. 353)

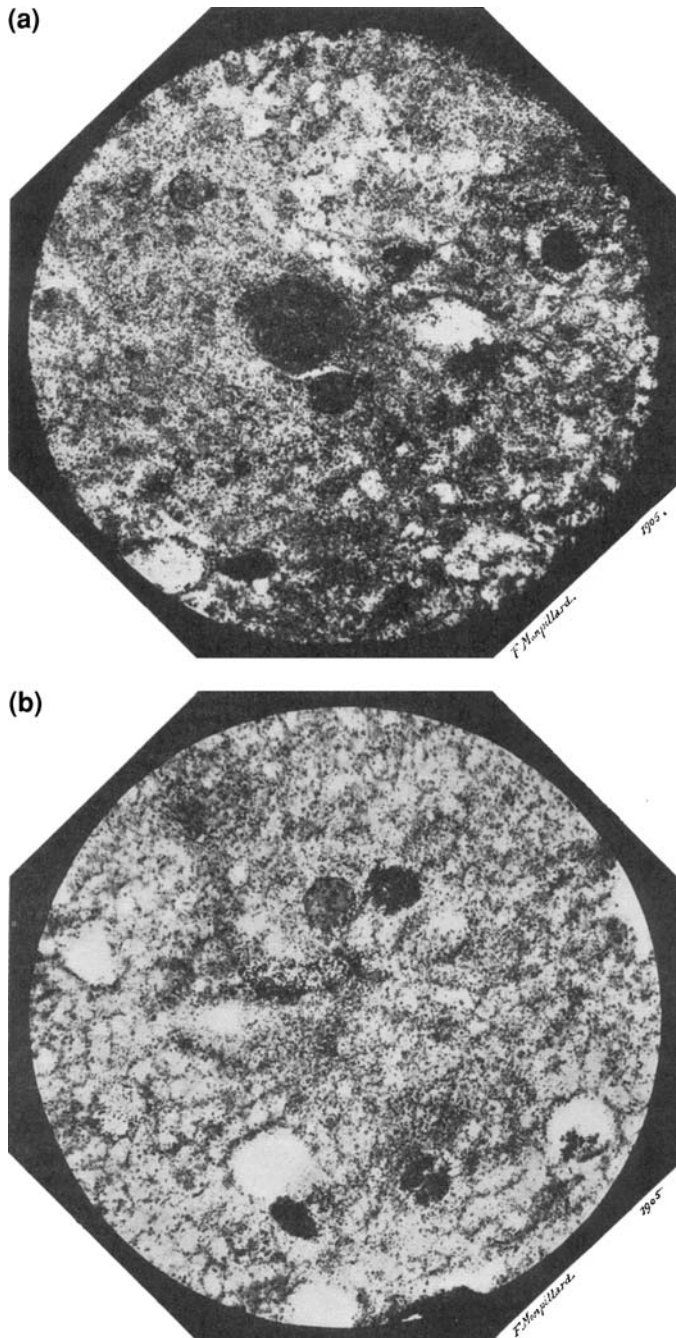
The Renaud image was the basis for the 1786 wax miniature Paul Jones sent to his friend Mrs. Belches of Edinburgh, Scotland (1) and that was in the Scottish National Museum of Antiquities as of 1913 (9). However, as explained below, it was the Houdon bust that he preferred to send to his compatriots and that was preferred by Thomas Jefferson for the actual medal.

The investigators qualitatively compared general facial features between the Tracadero bust and corpse, reporting a similar lack of facial hair, mild brachycephaly, prominent cheek bones and superciliary eminences. "Maturity" was suggested by the presence of white hairs among the darker ones and evidence of dental wear (6). Despite the shrinkage of the tissues, measures of facial proportions taken from the bust and corpse were similar, yielding differences under 2 mm, the acceptable range of interobserver error (16) (Table 3).

#### Internal Exam

The abdominal viscera were accessed through a posterior incision to minimize aesthetic damage to the corpse. The brain was left in situ due to expected degradation. Capitan (15, p. 84) described the kidneys as "small, hard, and contracted" and "more reduced still in volume than they should have been." He concluded "the kidneys, on a simple microscopical examination, had the appearance of kidneys affected by interstitial nephritis." This was supported by the more intensive microscopic examination by Cornil (Figs. 6a, 6b), who states "the case in point is interstitial nephritis, with fibrous degeneracy of the glomeruli of Malphigi. . ." (21, p. 94). This diagnosis was based upon the presence of thickened Bowmann's capsules and renal arteries in addition to numerous glomerular lesions and fibrous nodules.

Plural adhesions were found in the upper lobes of the lungs (15). Cornil (21) notes a pulmonary lesion comprised of "distended" alveoli with "small round cells" and decomposition artifacts (Figs. 7a, 7b). A stain test indicated no evidence of tuberculosis bacteria (21). Because bacteria associated with decomposition prior to preservation were observed, the tuberculosis bacilli should have been observed if they were present and active at the time of



FIGS. 6(a, b)—Kidney with sclerosis of glomeruli, fibrous formations and nodules, thickened Bowman's capsules consistent with advanced interstitial nephritis. Photos courtesy of the Naval Historical Center.

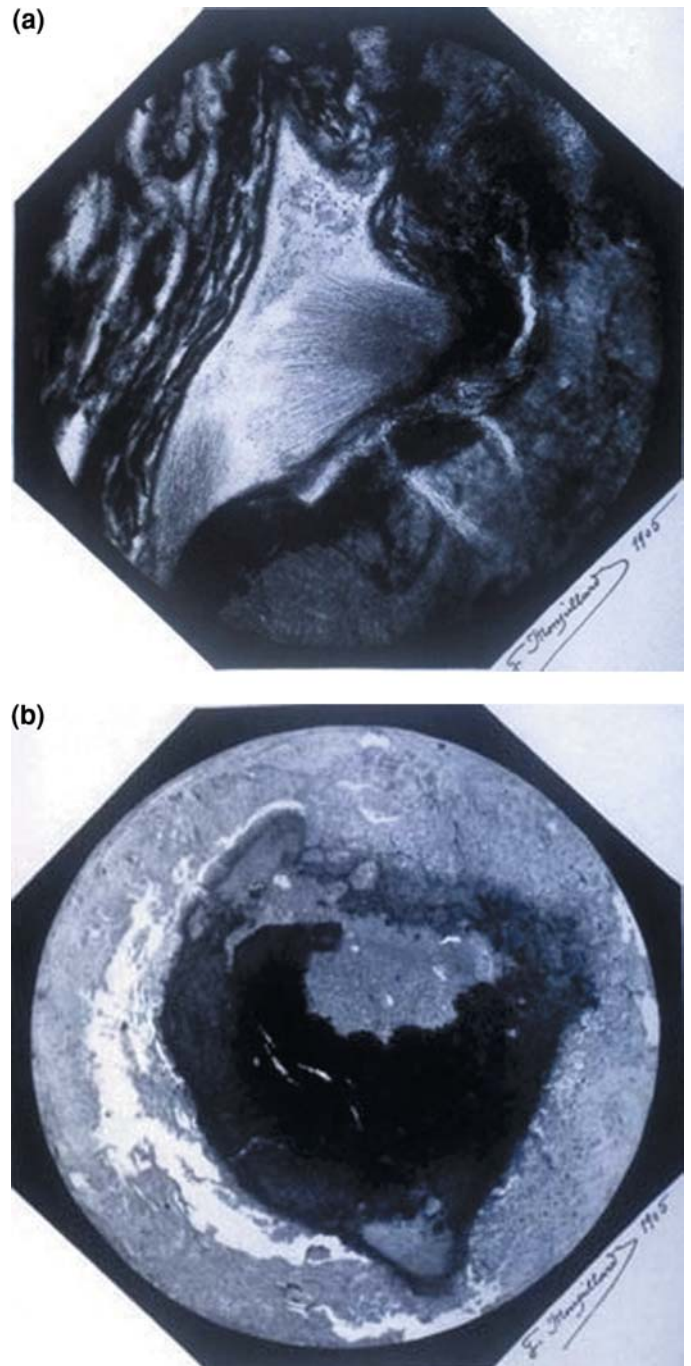


FIG. 7—Left lung. (a) Tyrosin crystals, nonreactive to Ziehl's stain. (b) Focal bronchopneumonia. Photos courtesy of the Naval Historical Center.

death. There is no mention of tubercular cavitations in the gross or microscopic descriptions of the lungs that would be expected with advanced tuberculosis. Cornil concluded that the lesion was fibrous scarring resulting from pneumonia.

Although shrunken by the preservative, the gross and microscopic characteristics of the heart were normal and exhibited no left ventricular hypertrophy (15,21). Likewise, the gall bladder, spleen, and liver appeared normal (21), although Capitan (15) reports that the spleen was larger than expected given the degree of shrinkage observed in the other viscera. The stomach and intestines were contracted and empty (15) and no abnormalities were noted.

#### Photographic Superimposition

Stewart's *Commemoration* (14) includes photographs of the Houdon bust and corpse overlaid in a "composite" to illustrate "the remarkable agreement between the plaster bust and the human head," an early use of photographic superimposition. This photographic evidence was not available to the investigators in 1905, but was designed to illustrate the observed similarities alongside the official reports in the 1907 *Commemoration* volume (14). A closer view of Fig. 3 is provided for comparison (Fig. 8) to this composite (Fig. 9). Although the photograph of the corpse was taken after three days of air exposure (Table 2) and the lips are unnaturally



FIG. 8—The head and face of John Paul Jones following autopsy and positive identification. Detail of Fig. 3.

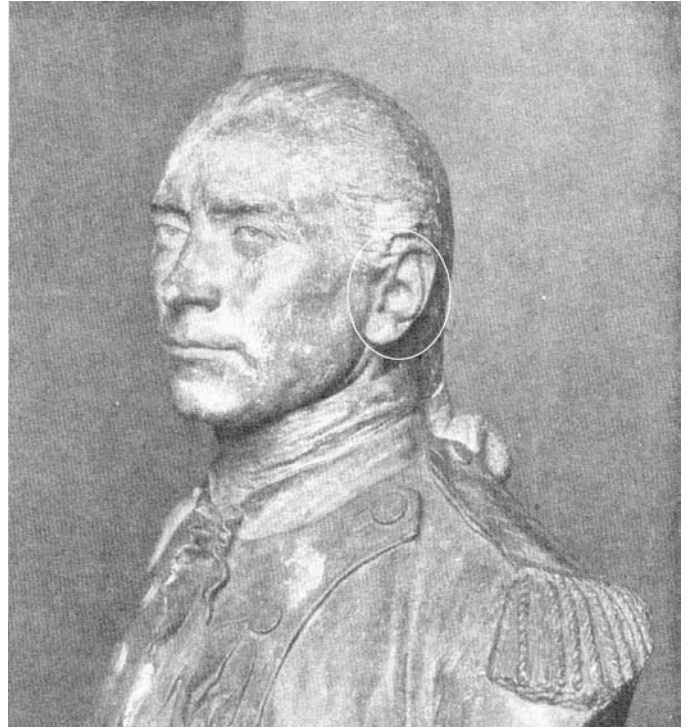


FIG. 10—Detail of John Paul Jones' "peculiar" ear noted by Hervé. Photo courtesy of the Naval Historical Center.



FIG. 9—The composite photo overlay of the Houdon bust and the corpse, created for the 1907 Commemoration volume (14). Photo NH 48749 courtesy of the Naval Historical Center.

contracted, the position of the mouth, teeth, eyes, and zygomatic processes of the cheeks of the corpse and Houdon bust conform well. The misalignment of the nose due to the coffin lid's pressure is perhaps minimized by the three-quarters angle that Monpillard chose for the photograph.

Hervé noted the "peculiar" shape of Paul Jones' left ear lobe (Fig. 10), stating that it was of an uncommon shape (6). Papillault merely mentioned the trait was shared by the bust and corpse, and relied upon the craniometric measures for his evaluation. Unfortunately, the "peculiar" earlobe noted by Hervé is not visible in the photos of the corpse.

#### *John Paul Jones' Medical History*

Historical records indicate that John Paul Jones suffered from chronic illnesses, beginning with his service in the West Indies in 1770. These recurrent maladies could be attributed to an infectious disease such as yellow fever or malaria, or to acute viral and bacterial infection(s). This is particularly true for periods at sea, when poor diet, cramped quarters, and poor hygiene increased infection risk. The first suggestion is supported by a pattern of cyclical illness beginning with his service in the French West Indies, where malaria and yellow fever are common (Table 1). Tuberculosis, advanced pneumonia, and renal failure secondary to progressive kidney damage are among the conditions consistent with the symptoms Paul Jones suffered in the weeks preceding his death. All but tuberculosis are consistent with the postmortem examination of the corpse contained in coffin 3.

#### *The Unanimous Decision*

Circumstantial evidence suggests that investigators indeed located the remains of America's greatest naval hero in the St. Louis Cemetery. Descriptions of his place of burial, physical features, funerary treatment, and medical history were all consistent with the unidentified corpse in coffin 3. The identification committee unanimously concluded that remains in coffin 3 were unquestionably those of John Paul Jones.



## Critiques of the Identification

In the years following the identification and burial of Paul Jones, some have criticized the assumptions and conclusions of the original search and analysis. An unattributed work (22) in the *Literary Digest* describes a number of concerns circulating in the press at that time regarding the identification of the remains. Although not privy to the full report that was to come in Stewart's *Commemoration* (14), Benjamin (10) plays devil's advocate and questions the scientific thoroughness of the identification process. For example, he questions the fact that such a hero would be buried with no marker and without his family keeping a record of his burial place. He claims there is no proof that Houdon "habitually measured his subject and reproduced facial dimensions exactly," and posits that the match between the bust and corpse is evidence suggesting that the corpse *could not* be Paul Jones rather than the opposite. Hart<sup>8</sup> and Biddle (23), provide a scathing critique of the methods used to identify the remains, defending Houdon's talent as being more than a technician's mechanical transcription of nature. Even Morison's award-winning biography (1) questions the scientific merit of the investigation with regard to stature estimation. Because no other authors have addressed these contentions, we do so in this report.

### *Reliance on Buell's Physical Descriptions of Paul Jones*

Biographies of John Paul Jones are plentiful, but the newest reference at the time of the corpse's discovery was the 1901 two-volume book by Buell (17). Porter and the identification team relied on this work for much of the superficial information concerning Paul Jones' stature, hair color, eye color, and skin tone. In the years since, scholars have found a number of inconsistencies in Buell's work and identified sources that seem to have been fabricated (9,38). While the use of this faulty research in the identification might reasonably call the identification into question, we propose that this is not the case because similar information can be found in other, more valid sources. Postmortem changes in color make any conclusion with regard to skin, eye, and hair color the weakest evidence of identity in this case. Despite this caveat, all 18th century descriptions and paintings of John Paul Jones describe him as having coloring typical of a lighter-haired Caucasian male from the British Isles, as one would expect of a Scotsman (hair color ranging from red to dark brown, eye color ranging from blue to green/hazel). The scientists determined that the remains were consistent with such an individual, but presented no further estimation of antemortem characteristics. Instead, the use of anthropometrics and autopsy findings formed the basis of the identification.

### *Stature*

Morison (1, p. 17) states, "... the people employed by General Porter were so eager to establish the identity that they made no correct measurement of the corpse." Because he cites the investigators' estimate as 5 ft 7 in., we assume this statement means that he disagrees with the methods described by Papillault (16), rather than the possibility that he was unaware that measures had been taken.

Morison estimates the Commodore's height to be approximately 5 ft 5 in. (1.65 m) based upon contemporary descriptions of the sailor as being small in stature, and the fact that the small-statured

John Hancock referred to the sailor as "little Jones".<sup>9</sup> He prefers this estimate over the estimate of 5 ft 7 in. accepted by the investigators, but fails to acknowledge that reported stature from any source may be ambiguous. Reported stature is often imprecise, even on official documents such as modern driver's licenses (24), and is most assuredly arbitrary given the anecdotal nature of historical reports of Paul Jones' stature. However, persons over six feet tall (1.83 m) and under six feet tall are easily distinguished. This suggests that the only other unidentified corpse in the St. Louis Cemetery contained in a lead coffin (coffin 5) and lacking a legible nameplate was more than 5 in. (12 cm) too tall to be John Paul Jones. The corpse in coffin 3 had an estimated stature of 1.71 m, reasonably within the range of error for both Morison's estimate (1.65 m) and the investigation team's estimate of Paul Jones' stature.

### *Absence of Battle Scars*

The letters of John Paul Jones do not document any injuries from battle. Despite this lack of direct evidence, some (e.g., 10,23) interpret the following 1792 comments to be evidence of bodily injury:

M[onsieur] de Sartine . . . did not say to me a single word nor ask me if my *health had suffered from my wounds* and the uncommon fatigue I had undergone . . .

—Benjamin (10, p. 122, italics his)

This letter was written a few months before his death while Paul Jones was living in relative obscurity in Paris, confined to his room much of the time, and incessantly sending letters to all manner of important contacts in an attempt to influence international affairs and gain employment. Having reviewed John Paul Jones' life and career, we suggest that he would not hesitate to make explicit mention of injury received through service to his country. Given his failure to mention actual bodily injury in his personal correspondence and reports, we propose that the wounds of which he speaks of at this point in his life were emotional. The corpse's lack of scars is therefore consistent with the documented history of John Paul Jones.

### *Validity of the Two Houdon Busts*

Reports at the time describe both the Tracadero and de Biron busts as being the work of Jean Antoine Houdon. Hart and Biddle (23) produced evidence suggesting that the de Biron bust is not the likeness of the Commodore, but accept the validity of the Tracadero bust. We agree with their contention and provide a brief history and discussion of the two busts in order to illustrate the validity of measures from the Tracadero bust and their role in the identification.

### *The Tracadero Bust*

The Tracadero bust is so named because it was borrowed from the Tracadero Museum in Paris when the unknown corpse was discovered. It is signed and dated by Houdon and is considered a genuine portrait of John Paul Jones because of contemporary references to sittings for the artist in 1780. Paul Jones presented copies of this bust to both Thomas Jefferson and George Washington, and placed orders for at least eight (and perhaps as many as 16) more to present as gifts (23,25). These gifts suggest that Paul Jones was

<sup>8</sup> Charles Henry Hart was an attorney by trade, but he was a 19th century Renaissance man. He gained membership in a number of historical, scientific, literary and artistic societies and authored books on a wide variety of topics. He was considered an esteemed authority in the field of fine art (25).

<sup>9</sup> Morison (1) does not give the supporting citation for this quote.

pleased with the likeness. Thomas Jefferson, who also likely saw the Renaud sketches commissioned by Paul Jones for the Congressional medal, thought that Houdon's bust was a true likeness of the Admiral and suggested that it be used as an illustration in Sherburne's biography of John Paul Jones (8):

... Houdon's bust of his is an excellent likeness. why [sic] have they not taken a side face of him from that? such an [sic] one would be perfect. . . —Chinard (25, p. 51)

James Madison also found the bust to be "an exact likeness, portraying well the characteristic features" (25, p. 66).

#### *The de Biron Bust*

A second bust was placed at the investigators' disposal for identifying the unknown remains:

To furnish the anthropologists with the required data there was obtained . . . permission to make all the desired measurements of the Houdon bust of Paul Jones, a little more than three-quarter size, owned by Marquis de Biron, a very artistic work representing the Admiral in court dress with the hair curled in rolls upon the temples. These rolls were identical with those found on the body. —Porter (6, p. 66)

Hart and Biddle (23) state that the De Biron bust is an unsigned work that was merely attributed to Houdon without appropriate provenance. They cite a 1907 letter they received from the Marquis de Biron that states the second bust was:

purchased by the late Marquis de Biron, from an artist, who had bought it at a public sale . . . *as a bust of an unknown man and not as a portrait of Paul Jones*, wholly for its artistic merit as a terra-cotta by Houdon"

—Hart and Biddle (23, p. 136; italics in the original).

It is possible that this bust was sculpted by Houdon, for the artist did not consistently sign or date all of his works and did not keep good records of his commissions (26). Because of his poor record-keeping and fame, there is a tendency to attribute unknown late 18th century portrait busts to Houdon whenever attribution is unclear (26). Although Houdon made a practice of making numerous renderings of his subjects (most notably the French philosopher Voltaire), the existence of a significantly different representation of the same individual is unlikely. Houdon's multiple renderings of a subject all featured identical facial structures, varying only in dress or the amount of the body represented (e.g., bust versus full figure).

The greater validity of the Tracadero bust as a representation of Paul Jones was apparently accepted by the investigators at the time of the identification. Papillault states that while he accepts the two busts as depictions of the same person, he found the Tracadero bust to be more reliable due to profound differences in artistic intent. He notes that the de Biron bust depicted a thinner individual and suggested that, in an attempt to flatter the subject, the artist

diminished the robustness of the face, effaced the bumps of the forehead, and his touch, indifferent to truth, no longer made life throb beneath the infinitely varied modeling of the surface. —Papillault (16, p. 89)

Papillault concludes that the life-sized Tracadero bust better represents the artist's desire to be "faithful" to the subject. Because of this perceived difference in artistic intent, and because the de Biron bust was three-quarters life size, the identification team limited their focus to the Tracadero bust. The single exception is the

statement that the side hair curls on the corpse and de Biron bust were identical (16).

Further evidence that the de Biron bust was fully discounted as an accurate representation of John Paul Jones is found in Stewart's later personal description of the search for Jones' grave (11). The memorandum is type-written with handwritten additions, deletions, and corrections by Stewart himself, and his signature adorns the last page. Among the additions on page 5 is a single line stating, "The de Biron bust is of course a different figure." While the reasons for which the investigators accepted only the Tracadero bust were intuitive, the repudiation of the de Biron bust presented by Hart and Biddle (23) and (summarized in the following pages) supports this intuitive decision with fact.

#### *Anthropometric Comparison of Bust and Corpse*

Both Benjamin (10) and Hart and Biddle (23) criticize the use of an aesthetic rendering in a scientific investigation and claim the identification is invalid. We counter this argument by presenting the words of the artist himself. Houdon described himself *firstly* as an anatomist and *secondly* as an artist. In his letter requesting nomination for the Legion d'Honneur award in 1803, he claimed, "the constant occupation of my whole life has been the study of anatomy applied to the fine arts" (27, p. 257, citing 28). This anatomical focus is evident from his famous early sculpture *L'Ecorche*, which depicts a human male stripped of skin, exposing the underlying muscles. Indeed, his reliance on a scientific method using compass measurements of angles and distances between anatomical points on the face led many of his contemporaries to regard him as unimaginative and uninventive (29).

In order to better replicate nature, Houdon employed life masks during his 1778 sessions with Voltaire, and followed this practice again during his 1785 sessions with George Washington (26). While there is no direct evidence that Houdon used a life mask for his portrait of Paul Jones, it is possible that he did because it was his common practice:

It remains true that he had an obsession for the meticulous study of nature and normally made life-masks or, for Rousseau, Mirabeau, and one or two recently deceased notables, death-masks. —Arnason (26, p. 47)

Thomas Jefferson, the subject of a Houdon portrait bust (1789) and a friend of the artist (30), stated that the purpose of Houdon's visit to Virginia was to cast the "necessary" mold to make Washington's portrait (26, p. 76). Life masks of many members of French society were among the items found in Houdon's studio after his death in 1828. Réau (29) states that many of these masks were destroyed or damaged, so there is perhaps little hope of identifying such a mask for Paul Jones, if it existed. It is surprising that this possibility was not mentioned by Hart and Biddle (23), since Hart was so familiar with the use of life masks in fine art that he authored a book on the subject entitled *Browere's Life Masks of Great Americans* (31).

The uncanny similarity in proportions between the corpse and Tracadero bust may be suspect because Paul Jones had aged a dozen years and suffered from a long series of illnesses in the time since his sitting for Houdon. One would expect that the Admiral lost weight and that his countenance might have changed in the dozen years between the 1780 sitting and his death. One doubter claims that the fact that the measures were similar for the bust representing the live Paul Jones and the shrunken corpse should have led to the conclusion that the two *could not* be the same individual (22).

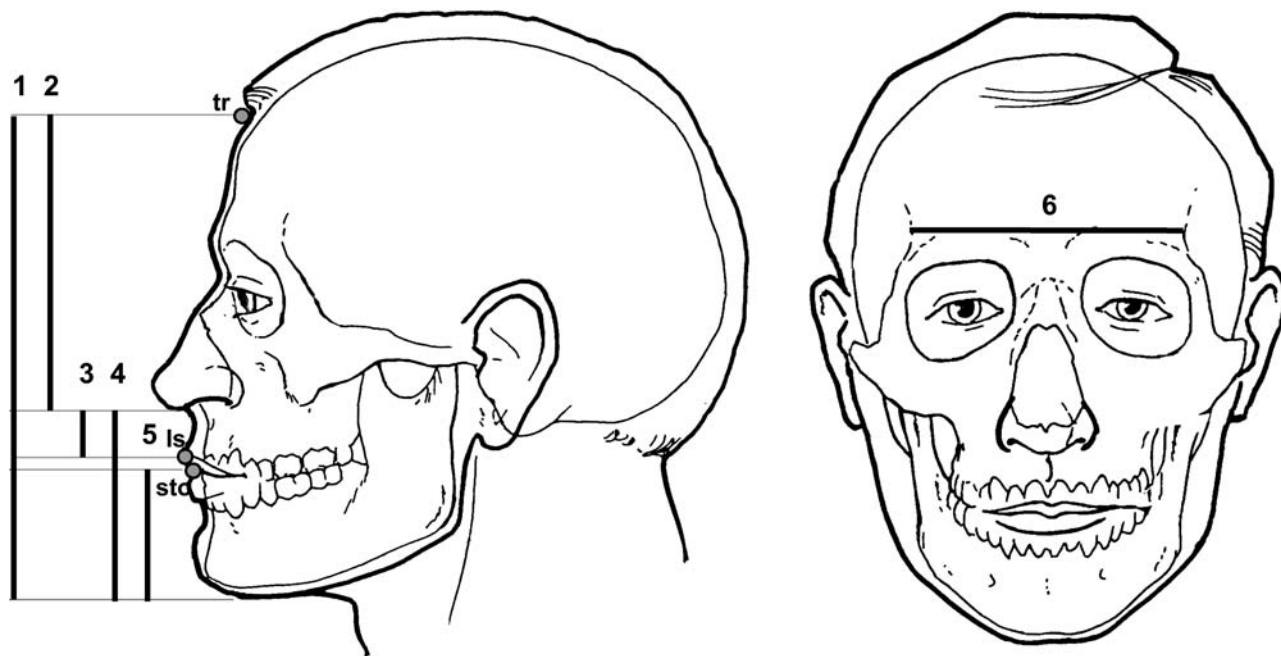


FIG. 11—Anthropometric proportions measured on the corpse and Houdon bust. 1. Total face length: trichion to gnathion. 2. Upper face length: trichion to subnasale. 3. Upper lip length: subnasale to labrale superiorus. 4. Lower face length: subnasale to gnathion. 5. Lower lip and chin length: stomion to gnathion. 6. Minimum frontal width: left frontotemporale to right frontotemporale. Gray circles indicate labeled points that may have been affected by tissue shrinkage: trichion (*tr*), labrale superiorus (*ls*), and stomion (*sto*). Figure adapted from Clauser et al. (40).

Anthropometry is based upon measurements between stationary landmarks, and are most frequently bony landmarks or margins between facial structures. This allows replicable measurements to be made despite changes in soft tissues due to age or illness. Figure 11 illustrates the facial proportions measured on the unknown corpse and Houdon bust. These were interpreted from the translation of his lay-descriptions in the Stewart volume because the scientific descriptions were not listed. While it is possible that trichion (*tr*), labrale superiorus (*ls*), and stomion (*sto*) could have been affected by changes in the hairline and skin plasticity due to aging, illness, and preservation, it is unlikely that an experienced anthropologist such as Dr. Papillault would have measured distorted features. The measurements were taken prior to the photographs, most likely while the tissue was still moist from the preservative. Additionally, the use of facial proportions is among an artist's most important tools for modeling from life. Given Houdon's propensity for taking measurements of his subjects, it seems reasonable to accept that these proportions should be similar between the bust and the corpse, if in fact it was Paul Jones.

Hart and Biddle (23) also criticize the morphological comparison on the basis of the nasal bone, arguing that the nose is "Roman" and convex, not concave. This assessment was based on the Monpillard's photos of the corpse, not first-hand observation. The distortion of the cartilaginous portions of the nose by the coffin lid and the three-quarters view of the turned head are extenuating factors affecting their argument. They claim that the nasal bone (root) is convex, contra the concave nasal root exhibited by the Houdon bust. Hart and Biddle (23) corresponded with Horace Porter concerning this issue and describe the exchange in their critique. Porter's written assurance that cartilaginous structures were not relied upon for the identification did not dissuade the authors' claim that the corpse's nasal structure was inconsistent with the known characteristics of Paul Jones. Hart and Biddle (23) also misinterpret Papillault's report that states, "The root of the nose

does not recede behind the frontal plane, as is often the case" (16, p. 90). This statement indicates that the nasal bone continues in a straight plane downward from the frontal bone. Comparison with the side view of the 1780 Houdon bust is consistent with this description.

As discussed earlier, the overall close agreement between measurements of the Houdon bust and unidentified corpse supports the presumed identification, especially in light of Houdon's meticulous use of measurements and life masks in his work. We also suggest that the photographic superimposition included in the *Commemoration* volume (14) supports the anthropometrics.

#### *Epaulettes and Military Awards*

Hart and Biddle (23) claim that the gentleman represented by the unsigned de Biron bust could not be John Paul Jones. We accept their conclusion and outline their evidence. The de Biron bust's subject wears a costume with a single epaulette on the right shoulder (Figs. 5a, 5b), which Hart and Biddle (23) claim is indicative of a junior rank in either the 18th century French or British Army. While the bust indeed has a single epaulette (1) it is worn on the figure's left side and the viewer's right side (if the photos in the Commemoration volume have not been reversed), and (2) the single epaulette was worn by a number of American and European forces following its introduction in the mid-eighteenth century. Despite these errors, Hart and Biddle (23) are correct in that this single epaulette provides evidence that this bust does not represent a man of rank equal to that of John Paul Jones, as explained below.

In response to the Continental Congress' naval and marine recommendations of 1776, a number of Continental Naval captains convened in March of 1777 and proposed their own uniform design. The selected uniform included a blue coat with gold lace, gold buttons, and two gold epaulettes (32,39). Based upon John Adams' diary entry of May 13, 1779, it is clear that Paul Jones chose to

adopt this uniform design:

... You see the Character of the Man in his uniform, and that of his officers and Marines, variant from the Uniforms established by Congress. Golden Button holes, for himself [Paul Jones]—*two Epauletts* [sic]—Marines in red and white instead of Green.

—Butterfield et al. (32, p. 370–1; italics added.)

This description is upheld by the fact that two epaulettes are present on the Tracadero bust. If the de Biron statue is presumed to be John Paul Jones after the 1780 sitting with Houdon, the single epaulette is inconsistent with Paul Jones' uniform of choice.

Hart and Biddle also argue that the de Biron bust lacks the military decorations that Paul Jones valued. The 1780 Tracadero bust exhibits a large medal representing the Order of Military Merit bestowed upon Paul Jones by King Louis XVI of France. Although conferred in 1780, the medal was forwarded to a French governmental representative in Philadelphia pending congressional approval for Paul Jones to accept an award from a foreign power. Approval was granted February 27, 1781, and the French representative presented the award at a spring gala, long after Paul Jones' sittings for Houdon. The medal that adorns the bust is therefore not the actual Order of Military merit, but represents, according to Hart and Biddle (23, pp. 127–8), Paul Jones' vain desire to record for posterity evidence of his military achievements.

Further evidence of this vanity is found in Paul Jones' (March 20, 1791) letter to Thomas Jefferson requesting aid in speeding congressional permission to accept the Order of St. Anne bestowed upon him in 1788 by Empress Catherine (8). Hart and Biddle (23) underscore the fact that Paul Jones wished speedy approval because he had recently ordered an additional bust from Houdon to present to the State of North Carolina that was to feature the Order of St. Anne on his American uniform in addition to his French Order of Military Merit. A later bust that did not depict all of his honors would not likely have pleased Paul Jones.

#### *Paul Jones' Sittings for Houdon*

Hart and Biddle (23) argue that the de Biron bust is of a man younger than the 33-year-old sailor portrayed by the Tracadero bust, presumably due to the greater slenderness, less rugged face, and lack of excess fat under the chin. If this is the case, either the 1780 sitting would have been Paul Jones' second meeting with the artist, or the de Biron bust was designed from sources other than a live sitting and would be of less consequence to the identification of the unknown corpse. Paul Jones' references to the 1780 sitting make no reference to an earlier sitting, which would have been unlikely in any case, given that Houdon primarily served German and Russian patrons in his early career and gained entry to French society only in 1775. While Paul Jones was a resident in France from at least 1777, Houdon sculpted portraits of Benjamin Franklin and Voltaire for his series of *grand hommes* in 1778 (26). Houdon was apparently invited to join the Masonic Lodge of the Nine Sisters, of which Franklin and Voltaire were both members. The artist applied and was accepted in February of 1779, six months prior to Paul Jones' application (August 16, 1779). Although Paul Jones was an accomplished Captain by this time, he was not yet famous in Parisian society, nor an obvious candidate for the *grand hommes* series. After Paul Jones' victory over the *Serapis*, however, his fellow Masons commissioned Houdon to sculpt the likeness of their heroic new member in 1780, making Paul Jones only Houdon's second American subject (26).

That John Paul Jones did not sit a second time for Houdon is also supported by his March 20, 1791 letter to Thomas Jefferson, which requests a copy of Houdon's bust be ordered for the governor of North Carolina with the addition of the Order of St. Anne (8). If there were a second Houdon bust, it would have presumably been necessary for Paul Jones to specify which bust was required.

#### **Validity of the Identification: The Question of Joint Probabilities**

We believe that our analysis sheds light on possible questions with regard to some of the soft tissue anthropometrics, but lays critiques of Houdon's scientific methods and use of Buell's (17) descriptions to rest. The photographic superimposition created for the 1907 publication of the official reports (14) provides additional evidence of agreement between the Houdon bust and facial characteristics of the corpse that support the anthropometrics. The preponderance of evidence indicates that the remains in question are those of John Paul Jones.

Perhaps the most important fact supporting the identification is that the foreigner's Protestant Cemetery is identified on the 1791 Verniquet map (13) and conformed with the excavated property down to the location and shape of the stone walls. The question then becomes, "Did they find the correct grave and corpse in the St. Louis Cemetery?" Taken point by point, the identification is upheld, although use of anthropometrics based upon the hairline and upper lip could be questioned. When one considers the joint probabilities involved in the series of events, the validity of the identification is supported, including the uncanny similarity between the proportions of the Tracadero bust and the corpse.

Koopmans (33, p. 163) defines a statistical joint probability for two variables as

$$P(X = x \text{ and } Y = y)$$

where P is the probability of observing both relationships inside the parentheses. With reference to the identification of John Paul Jones, one must consider the probability of a corpse in the correctly identified cemetery being: (1) contained in a lead coffin, *and* (2) falling within the range of the estimated stature of John Paul Jones, *and* (3) showing only evidence of medical conditions consistent with the maladies suffered by Paul Jones, *and* (4) closely resembling the sculpted image of Paul Jones, *and* (5) having no discernable scars, etc. Although these individual probabilities cannot be quantitatively assessed, we argue that any question of the remains belonging to someone other than John Paul Jones is not sustained given the evidence.

#### **Epilogue**

The body of John Paul Jones was returned to his original lead coffin, which was then placed in an oak outer coffin and returned to the United States with the pomp and circumstance due an American patriot. On April 24, 1906, President Theodore Roosevelt presided over the state funeral for Admiral John Paul Jones.

As a self-proclaimed admirer of John Paul Jones, architect Ernest Flagg included a crypt for John Paul Jones in his 1896 plan for the U.S. Naval Academy chapel, despite the fact that the Admiral's body had not yet been located. Plans for the crypt were shelved due to financial constraints (34). After the discovery of John Paul Jones, the U.S. Congress failed to appropriate funds for construction, and the Commodore's remains were placed in a small brick building on the grounds of the U.S. Naval Academy for several years. Funds for the chapel crypt were allocated in 1911 and the structure

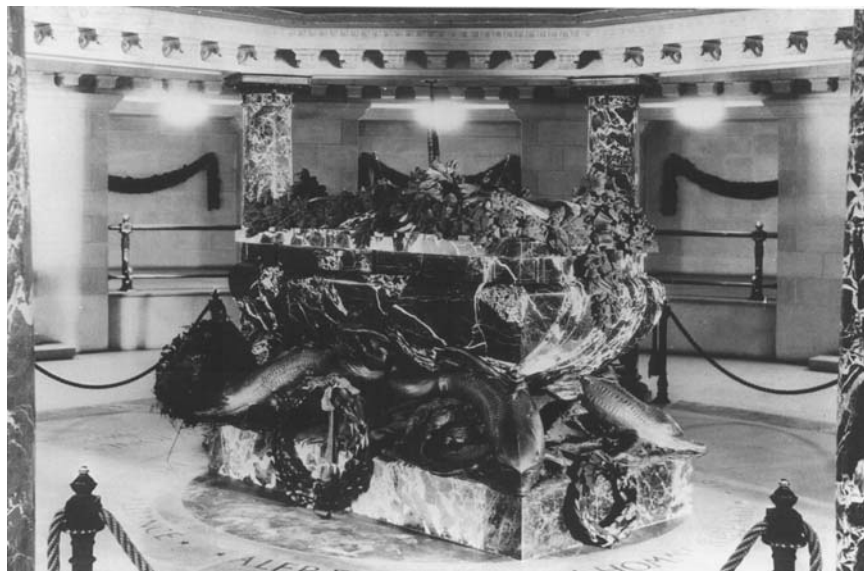


FIG. 12—The crypt of John Paul Jones. Located under the U.S. Naval Academy Chapel, Annapolis, Maryland. Photo by John Garwood.

was added under the main chapel according to a new design by architect Whitney Warren (35). The remains of John Paul Jones were interred on January 26, 1913, in a black and white Royal Pyrenees marble sarcophagus designed by Sylvain Salieres (Fig. 12), a gift of the French government (36). The crypt is staffed by a Marine Honor Guard and is open to the public seven days a week (35).

In a 1913 editorial to the *New York Times* (37), Park Benjamin counters his earlier contentions that the corpse in question was not in fact John Paul Jones (10). In this latter editorial, Benjamin suggests an epitaph for Paul Jones' newly completed crypt that sums up as well our conclusions concerning the identification of John Paul Jones:

Good friend, for Porter's sake, forbear  
To doubt the dust inclosed [sic] here.  
Blest be the man that got these bones,  
And curst be he that says "'tain't Jones."

*Note:* This topic has been featured in two presentations to the AAFS Last Word Society, the first by Field and colleagues (43) and the second by Rogers (44).

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Additional information and reprint requests:  
 Nikki L. Rogers, Ph.D.  
 Wright State University School of Medicine  
 Lifespan Health Research Center  
 Department of Community Health  
 3171 Research Blvd.  
 Kettering, OH 45420-4004  
 E-mail: [Nikki.L.Rogers@yahoo.com](mailto:Nikki.L.Rogers@yahoo.com)

# Erratum

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**Erratum/Correction of** Rogers NL, et al. The Belated Autopsy and Identification of an Eighteenth Century Naval Hero: The Saga of John Paul Jones. *J Forensic Sci* 2004 Sept;49(5):1036–1049.

It has come to the attention of the Journal that the photographic credit for Fig. 12 should read “*Photo NH 48776 Courtesy of the Naval Historical Center.*” It is incorrectly attributed to John Garwood as currently printed.

The Journal regrets this error. Note: Any and all future citations of the above-referenced paper should read Rogers et al. The Belated Autopsy and Identification of an Eighteenth Century Naval Hero: The Saga of John Paul Jones. [Published erratum appears in *J Forensic Sci* 2005 March;50(2)] *J Forensic Sci* 2004 Sept;49(5):1036–1049.