

Assessing Columbia County's Pennsylvania State Police Knowledge in Distinguishing Human vs. Nonhuman Bones: A Radical Case for Adding Basic Mammal Osteology to State Police Academy's Curriculum in Crime Scene Investigation

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Abstract

Objective: In this study, the researcher asked 18 Pennsylvania State Police (PSP) officers in Columbia County to distinguish human from nonhuman bones. Based on the results, a radical case is made for adding mammal osteology field training as part of the state police academy's curriculum in crime scene investigation (CSI).

Method: One to 16 stations of mammalian bone elements were set on a table in the researcher's lab. A simple survey consisting of questions numbered 1 to 16 was created to reflect the stations with mammalian bone elements. An Institutional Review Board (IRB) review and approval was warranted because human subjects (i.e., PSP officers) were asked to participate in this study. The participants moved sequentially from station to station with unlimited time to observe the bones and marked their choice on the survey sheet: human or animal.

Result: The results showed that the PSP officers performed poorly. The total average percentage of the bones they managed to distinguish human vs. animal correctly was 25% and incorrectly 75%. These average percentages were based on the number of individuals who distinguished the bones correctly or incorrectly (at each bone station) divided by the 16 stations. Most participants could not distinguish bones of the vertebra, shoulder, chest, ribs, hand, pelvis, legs, foot, and toes.

Conclusion: Incorporating mammal osteology into CSI state police academy's curriculum would save investigative time and limited resources (particularly for officers stationed in rural areas) and keep the chain of custody within the same agency. Overall, the turnaround time for analysis could be reduced from weeks to days (as opposed to sending evidence out for consultation).

Keywords: Mammal osteology • Human osteology • Human vs. nonhuman • Pennsylvania State Police • Adult mammalian bones • Subadult mammalian bones • Size and shape • Forensic anthropology • Police academy • Crime scene investigation

Introduction

One of the first questions forensic anthropologists must ask themselves when bones are recovered in the forensic context is the following: are the bones human or nonhuman? Although forensic anthropologists can quickly distinguish human from nonhuman bones despite the anatomical difference in size and shape (compared to other animals), nonspecialists often mistake nonhuman bones for human bones (especially in the absence of the skull and claws) [1-3]. If nonhuman bones end up in the medical examiner's system, then the consequences could be substantial in terms of investigations going in the wrong direction, limited resources (in some departments) being wasted, and time that could have been spent on cases with true human remains lost. In most cases, however, nonhuman bones are not needlessly investigated

because the impulse of all police personnel when they find bones is to consult forensic anthropologists at universities, medical examiner/coroner offices, and museums [4-20]. For example, medical examiner/coroner offices and forensic anthropologists who hold full-time positions at Harris County Institute of Forensic Sciences, Houston, Texas; City of New York Office of Chief Medical Examiner, New York, New York; Fort Worth Office of the Chief Medical Examiner, Fort Worth, Texas; District of Columbia Office of the Chief Medical Examiner, Washington, DC, were consulted—in office and out—85%, 88%, 89%, and 96%, respectively, of their total activity in 2015 [21] (Table 1 and Figure 1).

When police officers find bones, forensic anthropologists are not always available to be on-site or see the bone(s) *in situ*. Consequently, CSI state police officers with some experience in identifying animal remains (this specialized training is nonexistent in the police academy curriculum) may make a preliminary identification and later confirm that identification with the forensic anthropologist. Depending on the region of the country and availability of a forensic anthropologist and the condition of the bone(s) (i.e., fragmented and/or burned bones where emailing digital photographic images would not be sufficient), this consultation process could take a month or more, and the chain of custody goes outside of the police services to a civilian practitioner where evidence—albeit, rarely—could be misplaced. Consequently, continuity with the chain of custody within the same agency would reduce delays, which could be critical to the investigation. According to criminal investigators, the first 48 to 72 hours are the best chance to follow leads before people's memories start to fade [22,23]. In short, the consultation process—although important—slows the investigative process (Table 2).

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Table 1. Forensic services (in police departments) with a forensic anthropology/mammal osteology lab section and agencies available for consultation.

Forensic Services by State	Yes/No Forensic Anthropology/ Mammal Osteology Section	Forensic Anthropology university departments(U), Natural History Museums(NHMs), and Medical Examiner's Offices(MEs) available to consult in state ^c
Alabama Department of Forensic sciences ^c	no	1
Alaska Department of Public Safety—Forensic Services ^c	no	1
Arizona Department of Public Safety—Forensic Services ^c	no	1
Arkansas State Crime Laboratory ^c	no	1
California Bureau of Forensic Sciences ^c	no	3
Colorado Bureau of Investigation ^c	no	2
Connecticut Division of Scientific Services ^c	no	1
District of Columbia Department of Forensic Sciences ^c	no	2
Florida Criminal Justice Investigations and Forensic Science Program ^c	no	2
Georgia Division of Forensic Sciences, Bureau of Investigations ^c	no	2
Hawaii Police Department of the City of Honolulu [∞]	no	1
Idaho Bureau of Forensic Services, Idaho State Police ^c	no	2
Illinois Department of State Police, Division of Forensic Services ^c	no	2
Indiana Department of State Police—Forensic Services ^c	no	1
Kansas Bureau of Investigation —Forensic Services ^c	no	2
Kentucky State Police Forensic Laboratory ^c	no	2
Louisiana State Police Crime Laboratory ^c	no	1
Maine State Police Crime Laboratory ^c	no	1
Maryland Department of State Police Crime Laboratory ^c	no	3
Massachusetts Department of State Police Crime Laboratory ^c	no	2
Michigan Department of State Police Crime Laboratory ^c	no	3
Mississippi Department of Public Safety—Forensic Services ^c	no	1
Nevada State Police Forensic Public Safety—Forensic Services ^c	no	2
New Hampshire State Police Forensic Services ^c	no	1
New Jersey Division of State Police—Forensic Services ^Δ	yes	0
New Mexico Department of Public Safety—Forensic Services ^c	no	2
New York Division of State Police Crime Laboratory ^c	no	2
North Carolina State Bureau of Investigation—Forensic Services ^c	no	2
Ohio Bureau of Criminal Identification & Investigation Forensic Services ^c	no	3
Oklahoma State Bureau of Investigation—Forensic Services ^c	no	2
Oregon Department of State Police Crime Laboratory ^c	no	1
Pennsylvania State Police Bureau of Forensic Services ^c	no	2
South Carolina Law Enforcement Division- Forensic Services ^c	no	1
South Dakota Forensic Laboratory ^c	no	1
Tennessee Bureau of Investigation—Forensic Services ^c	no	2
Texas Department of Public Safety—Forensic Services ^c	no	3
Utah Bureau of Forensic Services ^c	no	1
Vermont Department of Public Safety—Forensic Services ^c	no	1
Virginia Department of Forensic Science ^c	no	3
Washington Bureau of Forensic Laboratory Services ^c	no	2
West Virginia State Police Forensic Services ^c	no	1
Wisconsin Department of Justice Forensic Services ^c	no	1

[∞]Medical examiner and investigators consult with forensic anthropologists at the Defense POW/MIA Agency (DPAA), Hawaii

^cAvailable for consultation in state: NHMs, U, or MEs=1; NHMs and U, NHMs and MEs, or U and MEs=2; NHMs, U, and MEs=3

^ΔHave forensic anthropology section=4

In this study, 18 Pennsylvania State Police (PSP) officers in Columbia County were asked to distinguish human from nonhuman bones. Based on the results, a radical case is made for adding mammal osteology field training as part of the state police academy's curriculum in crime scene investigation (CSI). Subsequently, state police officers in the CSI track would graduate with advanced knowledge (compared to the average police officer) in distinguishing human vs. nonhuman bones so that valuable resources and time would not be expended on bones later identified as animal bones.

Distinguishing human from nonhuman bones: A struggle for law enforcement

In the past 16 years, the PSP has asked this researcher to identify mammalian bones while in the field (i.e., recovery site), by digital photographic

images sent *via* email, by sending bone(s) *via* regular mail, or by bringing the bones directly to the researcher's office. Within this time period, numerous bones—identified as belonging to animals—have been collected and used as comparative samples in teaching, research, and forensic analysis. The large number of these animal bones shown in Figure 4 is a testament to law enforcement's struggle to distinguish human from nonhuman bones (Figures 2-4).

Subadult and adult mammalian bones

When police officers bring in small, long bones for the researcher to identify, they think the bone(s) might belong to a human child. Fortunately, the bone is typically identified as belonging to a small adult animal (e.g., coyote or fox). The word "adult" is italicized because—to the nonpractitioner—the

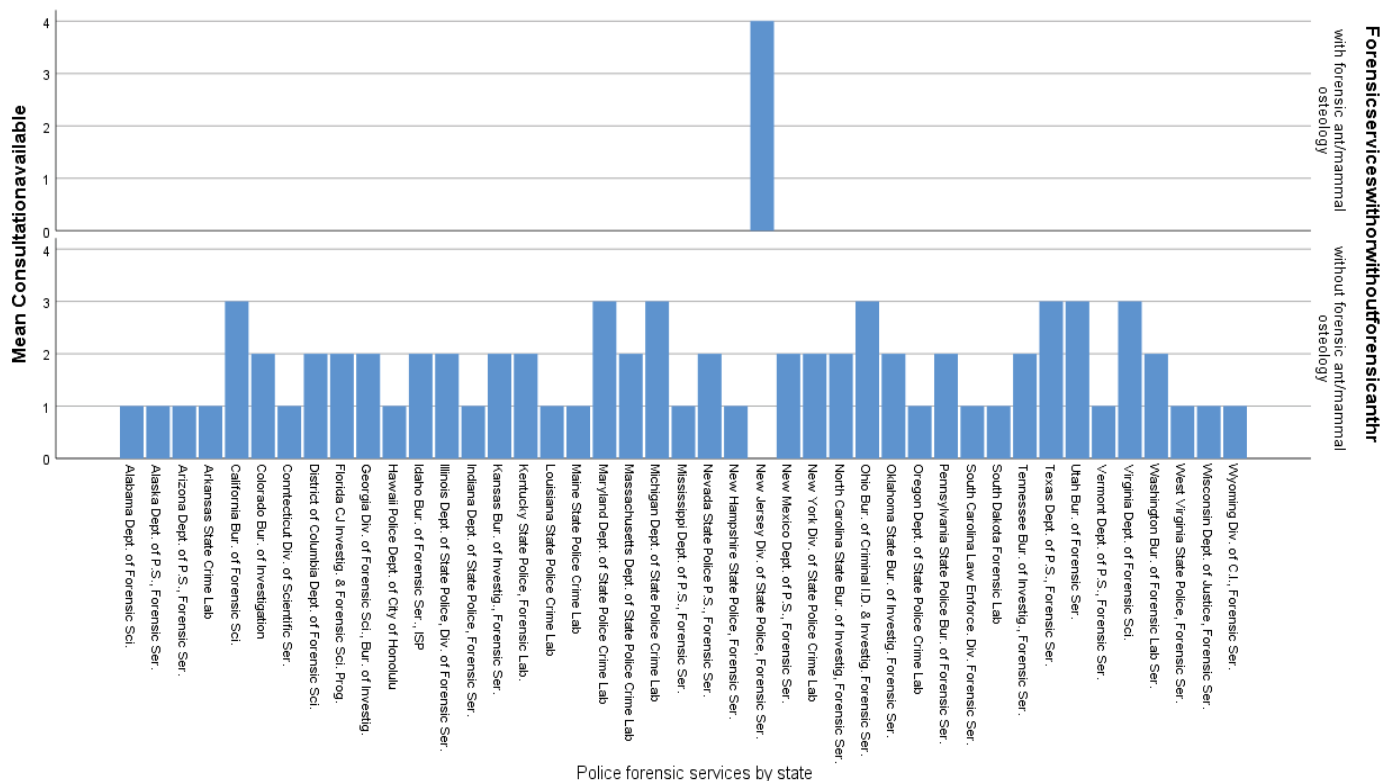


Figure 1. Forensic services (in police departments) with a forensic anthropology/mammal osteology lab section.

Table 2. State police academy crime scene investigation curriculum with or without mammal osteology.

State Police Academy	Yes Mammal Osteology	No Mammal Osteology
California State Police	-	no
Delaware State Police	-	no
Florida State Police	-	no
Georgia State Police	-	no
Illinois Department of State Police, Division of Forensic Services	-	no
Indiana Department of State Police—Forensic Services	-	no
Kentucky State Police Forensic Laboratory	-	no
Louisiana State Police Crime Laboratory	-	no
Maine State Police Crime Laboratory	-	no
Maryland Department of State Police Crime Laboratory	-	no
Massachusetts Department of State Police Crime Laboratory	-	no
Michigan Department of State Police Crime Laboratory	-	no
Nevada State Police Forensic Public Safety—Forensic Services	-	no
New Hampshire State Police Forensic Services	-	no
New Jersey Division of State Police	-	no
New York Division of State Police	-	no
Oregon State Police	-	no
Pennsylvania State Police	-	no
West Virginia State Police	-	no

bones of small adult animals and human infants/children are indistinguishable. But, to the practitioner, they are distinguishable by observing growth and developmental distinctions. For example, the immaturity in the bones of infants/children is expressed in their unfused epiphyses with their diaphysis as opposed to the fusion of these structures in the adult animal [24]. Therefore, in comparing the limb bones of a coyote or a fox with the limb bones of a human infant—although the bones are approximately the same length (with a slightly different shape in bony features)—the fused epiphyses of the coyote or fox and unfused epiphyses of the human infant are key factors in distinguishing them.

Size and shape in hamp bones (adults)

The general distinction between humans and nonhuman terrestrial

mammals is locomotion: humans are bipeds, and nonhuman terrestrial mammals are quadrupeds. It follows that biomechanics (i.e., range of motion, muscle loading, muscle contraction, muscle tension, muscle attachments, weight, bone compression, bone density) will all affect the size and shape of limb bones. For example, an elk or cow will have large and thick limb bones compared to humans. Although this fact is well-known to practitioners, non-practitioners may not know. Despite the large size of these animal limb bones, the major confusion is the gross similarities in these limb bones because humans and nonhuman mammals have the same bone elements (e.g., vertebrae, ribs, humeri, ulnae, pelves, femora, tibiae). In essence, humans, pigs, sheep, cows, deer, horses, foxes, coyotes, elk, cats, dogs, and bears have two humeri, ulnae, radius, femora, and tibiae [25-28]. Interestingly, practitioners have reported similarities between bears' skeletonized fore and

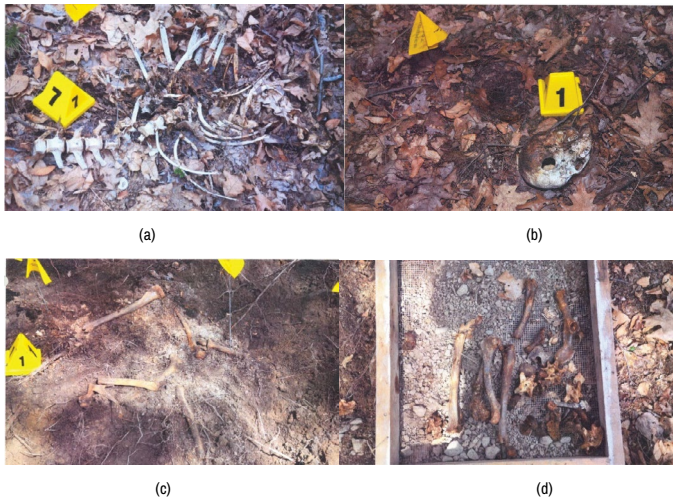


Figure 2. Animal bones commingled with a human skull at a recovery site in Columbia County, Pennsylvania.



Figure 3. Whole bones, bone fragments, and digital photos of bones brought in or emailed by Pennsylvania State Police.

hind paws to human hand and foot bones, the lower vertebrae of a horse's tail that look similar to human finger bones, and even deer vertebrae resembling human vertebrae in shape and size [29]. For the police, these animal bones would be suspected as possibly human bones and brought in for examination.

Materials and Methods

Eighteen active-duty PSP officers agreed to participate. Initially, 30 officers

the researcher had worked with in the past 16 years in some capacity were asked to participate, but 12 of them did not participate for various reasons (e.g., busy work schedules, retirements, resettlements, or nonresponses). Because human subjects (i.e., PSP officers) were being asked to participate in this study, an Institutional Review Board (IRB) review and approval was warranted by Commonwealth University. Generally, the IRB reviews research involving human subjects to ensure that these subjects are not placed at undue risk and that they give uncoerced, informed consent to participate in the research [30]. This research protocol was approved for the period of November 28, 2022, through November 27, 2023, under Exempt Category 2: research involving the use of educational tests, and the information obtained is not identifiable and does not put subjects at risk. The researcher created a simple survey consisting of questions numbered 1 to 16 corresponding to the 16 stations of mammalian bone elements set on a table in this researcher's lab at Commonwealth University, Department of Anthropology, Criminal Justice and Sociology. The participants moved sequentially from station to station with unlimited time to observe the bones and marked on the survey sheet: human or animal. They were allowed to touch the bones and obtain more information from the researcher as they made their choice. In the short time of this study (December 1 to January 15)—well within the research protocol period—there was no more than one participant present on any respective day of the exercise (Figures 5 and 6).

Results and Discussion

The results showed that the PSP officers performed poorly in this study.

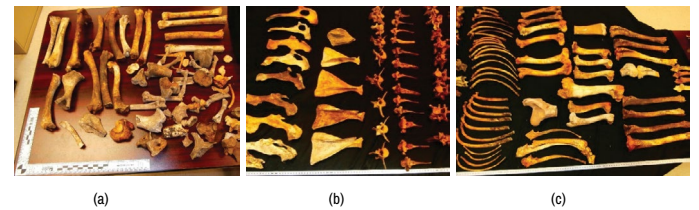


Figure 4. Animal bones accumulated over 16 years of collaboration with Pennsylvania State Police in Columbia County, Pennsylvania.

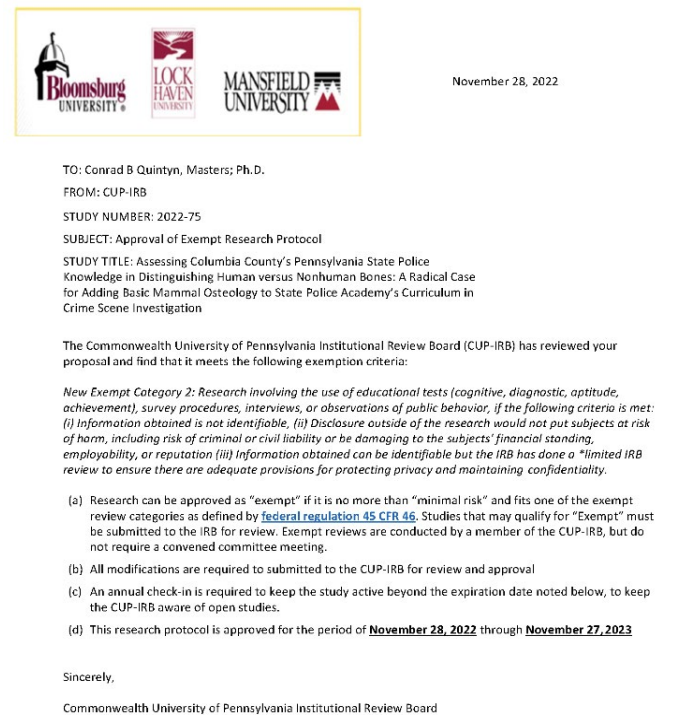


Figure 5. Commonwealth University Institutional Review Board (IRB) approval letter.

Study Title: Assessing Columbia County’s Pennsylvania State Police Knowledge in Distinguishing Human Versus Nonhuman Bones: A Radical Case for Adding Basic Mammal Osteology to State Police Academy’s Curriculum in Crime Scene Investigation

*By filling out the survey you are providing your informed consent to participate in this study.

*At all times, the participants have the right to withdraw from the project, ask questions, or obtain further information from the researcher.

THANK YOU VERY MUCH FOR HELPING US WITH THIS PROJECT!

CIRCLE 'HUMAN' OR 'ANIMAL'?

BONES

1. Human or Animal	2. Human or Animal	3. Human or Animal
4. Human or Animal	5. Human or Animal	6. Human or Animal
7. Human or Animal	8. Human or Animal	10. Human or Animal
11. Human or Animal	12. Human or Animal	13. Human or Animal
14. Human or Animal	15. Human or Animal	16. Human or Animal

IRB#: 2022-72
Commonwealth University of Pennsylvania and contact information of the CUP-IRB Chair, Doreen Jowi Ph.D, BU-IRB-Chair@bloomu.edu, 570-389-4217, should the potential participants desire to do so.



(a)

(b)

Figure 6. A survey consisting of questions numbered 1 to 16 corresponding to the 1 to 16 mammalian bone stations set on a table.

The total average percentage of bones they managed to distinguish human vs. animal correctly was 25% and incorrectly 75%. These average percentages were based on the number of individuals who distinguished the bones correctly or incorrectly (at each bone station) divided by the 16 stations. The participants were able to distinguish a human skull and mandible from the animal equivalent. And approximately half of the participants were able to distinguish some long bones of human arms/legs and animal fore/hind limbs. But most participants could not distinguish bones of the vertebra, shoulder, chest, ribs, hand, pelvis, legs, foot, and toes. This result was expected: Mammal osteology is not part of PSP officer training, hence the frequent consultation with forensic anthropologists at universities, medical examiner/coroner offices, and museums. If forensic anthropology/mammal osteology field training could be part of the state police academy’s curriculum in CSI, then state police officers in the CSI track would graduate with advanced knowledge in distinguishing human vs. nonhuman bones. In the long run, valuable resources would not be expended in a case of no consequence (i.e., bones recovered by police identified as animal bones). Additionally, the chain of custody does not have to go outside the police lab, and the turnaround time for analysis could be reduced from weeks to days (Table 3 and Figure 7).

This study is likely too limited to convince the commissioner of state police or his superiors to incorporate mammal osteology into the CSI state police academy’s curriculum. Nevertheless, the researcher presents a radical case for law enforcement in general and forensic anthropologists to consider. The goal is to begin the conversation while an expanded future study is designed to strengthen this case. There is no suggestion that forensic anthropologists at universities, medical examiner/coroner offices, and museums would no longer be needed for consultations by police organizations. These practitioners are, in fact, invaluable. Generally, what is implied is that police officers with advanced knowledge of mammal osteology add another layer to the numerous specialists involved in recovering and analyzing skeletal evidence.

Table 3. Count of the number of human and animal bones distinguished correctly and incorrectly by 18 Pennsylvania State Police officers.

Bone elements (Stations)	No. of officers correct*	No. of officers incorrect
1 Skull	18 (100%)	0
2 Mandible (Jaw)	18 (100%)	0
3 Vertebra: atlas (1 st cervical) axis (2 nd cervical) cervical (3 rd thru 7 th) Thoracic and lumbar	1 (.06%)	17 (94%)*
4 Scapula (Shoulder blade)	3 (0.17%)	15 (83%)
5 Manubrium	2 (0.1%)	16 (90%)
6 Clavicle (Collar bone)	2 (0.1%)	16 (90%)
7 Sternum (Breast bone)	0	18 (100%)
8 Rib (particularly the thoracic)	0	18 (100%)
9 Humerus	8 (0.44%)	10 (56%)
10 Ulna Radius	8 (0.44%)	10 (56%)*
11 Carpal Metapodial(Metacarpal–forelimb) Phalanges (forelimb)	3 (0.17%)	15 (83%)*
12 Os coxa & sacrum (Pelvis)	4 (0.22%)	14 (78%)
13 Femur	4 (0.22%)	14 (78%)
14 Tibia	1 (.06%)	17 (94%)
15 Fibula	0	18 (100%)
16 Tarsals: Astragalus (Talus) Calcaneum Sesamoid Metapodial(Metatarsal-hind limb) Phalanges (hindlimb)	0	18 (100%)*
Total avg. % correct=25%		Total avg. % incorrect=75%

Note: *These bones were commingled these bones were commingled at the respective station.
∞Correct based on distinguishing one or more bones human and/or animal at a respective station. Naming the specific bone and where it belongs in the body was a bonus (not required).

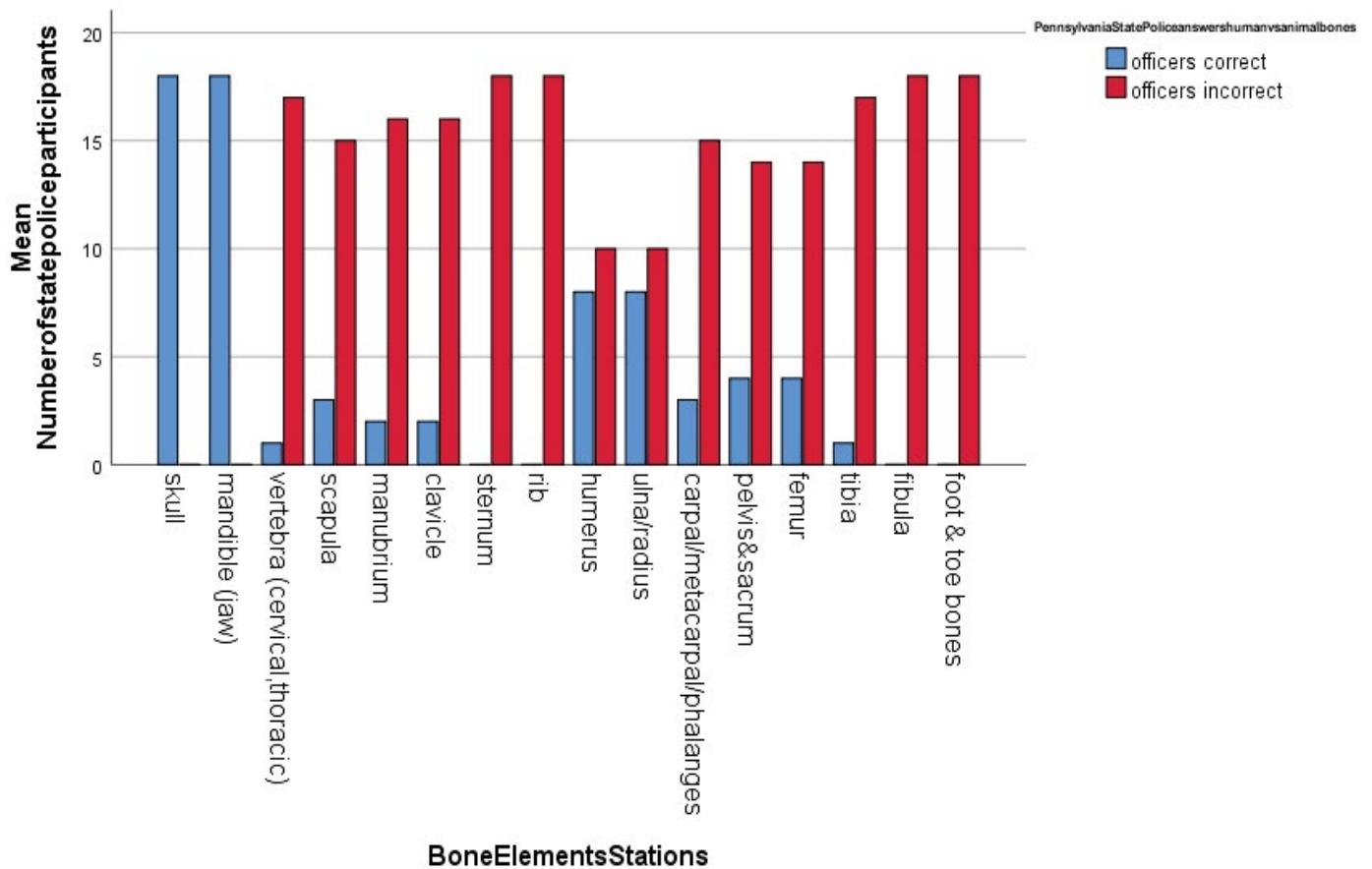


Figure 7. Results of human and animal bones distinguished correctly and incorrectly by 18 Pennsylvania State Police officers.

Conclusion

All terrestrial mammals have similar bones because of a common ancestor in the distant past. But, over time, the form and function of these bones (i.e., locomotion) have diverged, resulting in differences in size and shape: bipedalism in humans and quadrupedalism in terrestrial mammals. These differences in locomotion are important clues for the practitioner in distinguishing human from nonhuman bones; the nonpractitioner is unaware of these clues. The major confusion is simply the gross similarities in the bones (except the skull). It follows that consulting forensic anthropologists at universities, medical examiner/coroner offices, and museums becomes critical. This relationship is not likely to change anytime soon. But it would not hurt to incorporate forensic mammal osteology into CSI state police academy's curriculum. These officers with advanced knowledge in mammal osteology would save investigative time, reduce the waste of limited resources, and maintain the chain of custody within the same agency.

Future Directions

1. Schedule meetings with commissioner of state police and his superiors to discuss the advantages stated in this paper and cost effectiveness of adding mammal osteology field training as part of the state police academy's curriculum in crime scene investigation (CSI).
2. Submit a collaborative application (i.e., adding other investigators and students) for funding through the U.S. Department of Justice Grant Program in order to expand this study (and IRB) to PSP Troop Stations in 30 or more counties in Pennsylvania.
3. Provide options for state police officers to participate (in the human vs. animal exercise) virtually via Zoom or other online learning platforms. This option would increase the number of counties and participants

who might have declined because of busy work schedules, retirements, and resettlements. (It is noted that in-person participation would be preferred).

4. Disseminate new data to commissioner of state police and his superiors in addition to other police agencies and beyond.

Declarations

The Commonwealth University Institutional Board Review (IRB) for the Protection of Human Subjects Study Number: 2022-75: The IRB reviews research involving human subjects to ensure that subjects are not placed at undue risk and that they give uncoerced, informed consent to participate in the research. This research protocol was approved for the period of November 28, 2022, through November 27, 2023, under Exempt Category 2: research involving the use of educational tests, and the information obtained is not identifiable and does not put subjects at risk (Figure 5).

Conflict of Interest

None.

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