ESSENTIALS OF FORENSIC ANTHROPOLOGY

Especially as Developed in the United States

T. D. STEWART, M.D.

Anthropologist Emeritus
National Museum of Natural History
Smithsonian Institution

With a Foreword by

Ellis R. Kerley, Ph.D.

President
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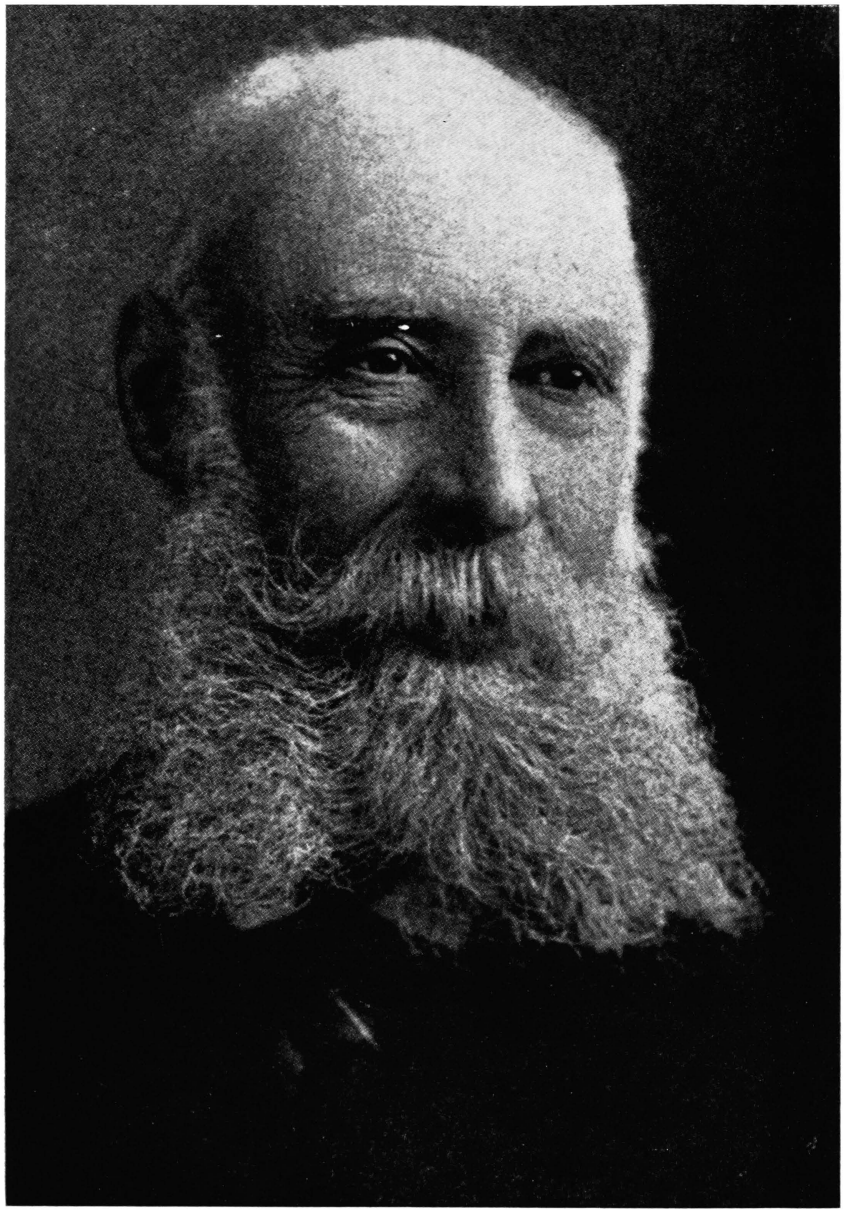

Frontispiece. Thomas Dwight, M.D., LL.D. (hon). From Warren, *Anat Rec,* 5:491, 1911. Courtesy of *Anat Rec.*

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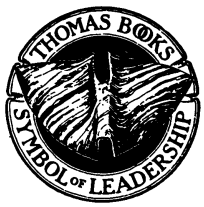

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To the memory of

Georges Fully (1926-1973)

Calvin Wells (1908-1978)

FOREWORD

IT IS A RARE pleasure to find something that fills a void as completely and satisfyingly as this volume fills the long standing need for a comprehensive and up-to-date discussion of forensic anthropology, particularly one written by someone who has been a leader in that field for over three decades. The material in this book is drawn from all facets of forensic anthropology, but, equally important, it is drawn from Dr. Stewart's own vast experience and participation in shaping the course that this exacting discipline has taken and is pursuing.

With the establishment of a Physical Anthropology Section of the American Academy of Forensic Sciences, forensic anthropology achieved status as a recognized specialty, and, with the increasing number of courses in forensic anthropology being offered at universities, the need for a current text has become urgent. This book is more than just an excellent textbook, it is a well-documented history of forensic anthropology, a mirror for forensic anthropologists, and for anyone interested in the medical, legal or anthropological aspects of skeletal identification it is a fascinating and informative book.

Dr. Stewart received his Doctorate in Medicine at Johns Hopkins and pursued his professional career in physical anthropology at the Smithsonian, where he became the Director of the National Museum of Natural History. In addition to working extensively with the thousands of human skeletons in the research collections there, he has been engaged in forensic anthropological consultations for the FBI, the Armed Forces and various medical examiners over the last thirty-five years and has conducted research for the Army Graves Registration Service in Japan during the Repatriation Program of the Korean War. He is highly respected among his colleagues for his extensive knowledge of all aspects of the human skeleton and for his thorough and imagina-

tive research. Author and editor of several books and numerous research reports, Dr. Stewart has been honored repeatedly by his colleagues. He is past President of the American Association of Physical Anthropologists, Viking Fund Medalist and Honorary Member of the American Academy of Forensic Sciences, as well as a member of the National Academy of Sciences.

This book is a major and definitive contribution to the growing literature of forensic anthropology. It explains in detail just what a forensic anthropologist contributes to the investigation of death and how he or she goes about reconstructing the biological nature of an individual from the skeleton. Any forensic scientist might profit from the wisdom contained in the chapter dealing with evidence and testimony. Any lawyer or medical examiner could learn a lot about identification by reading this book. For the forensic anthropologist this book summarizes the entire field and its methodology in great depth and is a most valuable and readable volume.

It is a pleasure to recommend a book written by an old friend —especially when it is an excellent book, well written by one who is most eminently qualified to make an important contribution to the subject. This is such a book.

ELLIS R. KERLEY, Ph.D.

INTRODUCTION

FORENSIC ANTHROPOLOGY is that branch of physical anthropology which, for forensic purposes, deals with the identification of more or less skeletonized remains known to be, or suspected of being, human. Beyond the elimination of nonhuman elements, the identification process undertakes to provide opinions regarding sex, age, race, stature, and such other characteristics of each individual involved as may lead to his or her recognition.

This definition takes into account certain practices in the forensic field growing out of the fact that identity depends primarily on the soft parts and only secondarily on the skeletal parts. Coroners and/or medical examiners (today usually forensic pathologists), whose duty it is in the first instance to investigate unexplained civilian deaths,* are trained primarily to deal with fleshed remains. When confronted with remains, the flesh covering of which no longer yields identification clues, these investigators realize that the only possibility of getting the desired information is through study of the skeleton. At this point they often call upon forensic anthropologists for help on account of the latter's greater osteological expertise.

In some instances, of course, the remains that coroners and/or medical examiners refer to forensic anthropologists may have been completely skeletonized when discovered. Also, remains that were partly flesh covered when found sometimes are skeletonized before being sent to the forensic anthropologists. Anyway, the point is that, although the bones themselves are the main concern of forensic anthropologists, and all remnants of flesh attached to them obscure the osteological details, forensic anthropologists do deal with remains that are *more or less* skeletonized.

Of all the human dead that require forensic investigation, those whose soft parts have deteriorated to the extent that they

*The Armed Forces operate separately and they, too, employ forensic pathologists.

can be considered more or less skeletonized are a small minority. For this reason forensic anthropology has never been, and most likely is not soon to be, an overworked profession. Indeed, so far as most forensic anthropologists are concerned, the word "branch" in the above definition can be replaced by "sideline," for it is still rare for a physical anthropologist to have fulltime employment in the forensic field. In this respect forensic anthropologists and forensic odontologists are much alike; both apply in forensic cases the knowledge gained from, and used in, their regular occupations.

Generally speaking, the regular occupation of most physical anthropologists involves one or another activity directed towards gaining greater biological perspective on mankind. And since the study of physical man through time is possible only by means of surviving skeletal remains, the physical anthropologists who pursue this line of study necessarily acquire extensive knowledge of skeletal anatomy. Furthermore, the anthropological study of a skeleton from the past is very like the forensic study of a skeleton from the present, for the object of study in each case is an unknown who must be identified as to sex, age, height, etc. Regardless of purpose, physical anthropologists sharpen their interpretative skills by practicing on collections of documented skeletons derived from dissecting rooms.

Forensic odontologists, to whom in a preceding paragraph I likened forensic anthropologists, are concerned in their regular occupation mainly with the maintenance of normal-appearing and normal-functioning dentitions in living people. Thus, in contrast to the anthropologists, the dentists look to the present much more than to the past and to the living much more than to the dead. However, my reason for mentioning this other profession is to make the point that those anthropologists and dentists who enter the forensic field are rivals to the extent that they both are concerned with the dentition. That this is so is due to the fact that in life the teeth are the only viewable and therefore easily reachable part of the skeleton, a distinction that they lose after death when the body becomes skeletonized.

Fortunately, there is a tacit understanding in this matter of

jurisdiction that satisfies both groups: The anthropologists have to take into account the natural state of the teeth, especially when this aids them in making their traditional determinations, but they recognize the necessity of deferring to the odontologists when most forms of unnatural alteration or restoration are present. The exceptions are the ethnic mutilations and decorations which anthropologists are more accustomed to dealing with (see Ortner, 1966; Stewart and Groome, 1968).

In actual practice, then, identification of human remains for forensic purposes necessarily is dominated by forensic pathologists, but is shared as circumstances dictate, with other forensic specialists. The dependence of forensic anthropologists upon coroners and/or medical examiners for a role in forensic identification is reflected in books on legal or forensic medicine. In most of these books, skeletal identification rates only one chapter (cf. Boyd and Trevor, 1953; Kerley, 1973; Krogman, 1949; Stewart, 1954a 1968, 1973). In one exception (Krogman, 1962) the subject is treated in book length, but is still labeled as forensic medicine.

One of my reasons for writing the present book was to emphasize through the title the recent breakaway of forensic anthropology from medicine to be considered in more detail in the first chapter. Another reason was to extend the coverage of the abovementioned general publications to include other aspects of the field besides skeletal identification *per se*. In none of those publications does this coverage take into account the legal responsibilities of forensic anthropologists or trace the development of the identification procedures they employ. The importance of historical orientation in this instance rests on the verification it has to offer of anthropology's long peripheral relationship to medicine.

In keeping with the emphasis on history throughout this book I have selected the likeness of Thomas Dwight (1843-1911) to grace the frontispiece. So far as I can discover, Dwight was the first American to make major contributions to the field. He also participated in forensic cases, the number and nature of which appear to be unknown (Warren, 1911, p. 533). For these reasons, and especially on account of the nature of his contributions, he

fully deserves, in my opinion, to be designated the *father of forensic anthropology in the United States.*

Dwight was concerned primarily with a factor that underlies every determination in forensic anthropology, namely, *human variability.* The existence of this variability places limits on one's ability, when dealing with skeletons, to state in precise terms such things as sex, age, race, and stature. The resulting lack of precision in these matters precludes consideration of forensic anthropology as an exact science. In tribute to Dwight, this idea will be emphasized again and again throughout this book.

T.D.S.

ACKNOWLEDGMENTS

PRIMARILY this book is the outgrowth of my forensic activities. They started soon after my appointment in 1942 as Curator of Physical Anthropology in the National Museum of Natural History when agents of the FBI's headquarters laboratory across the street from the Museum began asking me to identify bones collected under forensic circumstances. Toward the end of the war then in progress, the FBI agents were joined by officials from the Army's Memorial Division, also headquartered nearby. The latter sought my counsel on identification problems connected with the repatriation of the war dead. Also, in succeeding years several state medical examiners and/or coroners sent in skeletal remains now and then for identification. Although these forensic activities rarely took up much of my time and remained a side line to my regular curatorial duties, they provided me with useful insights into what physical anthropology has to offer in the forensic field.

I would like to name the individuals in these organizations who made it possible for me to have eye-opening forensic experiences, but the list would be too long. Moreover, after all this time it would probably fail to include everyone, and the omissions, although unintentional, might be misconstrued.

Necessarily I have had to supplement my personal experience by drawing upon the work of other physical anthropologists who also have turned to forensic anthropology. The amount of literature cited—and I have not tried to be exhaustive—indicates how woefully incomplete this book would have been otherwise. Most pleasing to me is the fact that everyone I called upon for help responded promptly and generously. I have been only too happy, therefore, to indicate the source in each case of borrowing.

Lastly, it should be noted that this book is a product of my retirement years. As such it could not have been carried to com-

pletion this soon except for the Smithsonian Institution's liberal policy toward its retirees. To S. Dillon Ripley, Secretary of the Institution, I am indebted for being allowed to retain my office, my parking space, and many of the other privileges available to me in my active years. In this connection I am indebted also to my anthropological colleagues, and especially to J. Lawrence Angel, my successor, for respecting my need to maintain freedom from involvement in museum affairs during the writing period.

T.D.S.

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ESSENTIALS OF FORENSIC ANTHROPOLOGY

Section I

PRELIMINARY CONSIDERATIONS

As its title indicates, Section I deals with several rather diverse subjects that serve to prepare the reader for the detailed identification procedures to follow in Sections II and III. Since each identification procedure will be documented, especially as to the American input, an outline of the record of American involvement in the forensic field is needed at the very beginning, both to give perspective and to show that most identification procedures are old, and that only the improvements are new.

Forensic identification implies an obligation on the part of its practitioners to the legal system intrusted with the investigation of unexplained deaths. This obligation is fulfilled when a forensic anthropologist files a report of his examination of submitted remains and follows this up, if required, by testifying in court. This is why an explanation of the role of expert witness is important for understanding the proper handling of skeletal remains recovered in forensic situations.

The preliminary handling of the bones affords a forensic anthropologist an opportunity to distinguish between animal and human, to decide whether or not the human bones have been altered by exposure to fire, and to size up all signs having a bearing on the cause of, and duration of the time since, death. With these matters settled, a forensic anthropologist is ready to turn to the general and specific identification traits, the subjects of Sections II and III, respectively.

Chapter 1

HISTORICAL SETTING

BY BESTOWING upon Thomas Dwight the title of *Father of American Forensic Anthropology* (see Introduction), I have in effect consigned the whole history of this branch of physical anthropology in the United States to the 100-year period beginning in 1878 (the date of Dwight's prize-winning, medicolegal essay; the first sign of his entry into the field). A search of the anthropological literature onward from Dwight's time to the beginning of World War II (when American forensic anthropology entered its modern period) has revealed three other individuals variably engaged in what would now be considered as forensic anthropology. Only the highlights of the activities of these four pioneers and their successors will be given here because the fuller picture is covered in two readily-accessible publications (Stewart, 1977b, in press).

AMERICAN PIONEERS

Dwight, a Bostonian, spent nearly forty years as an investigator and teacher of anatomy. Although in his time physical anthropology was not an organized science in the United States, by 1919 Hrdlička could include him among those contributing significantly to the early history of American physical anthropology. It is clear now that these contributions were on the forensic side of the field.

During the last twenty-eight years of Dwight's career he held the Parkman Professorship of Anatomy at Harvard, having succeeded Oliver Wendell Holmes to that position (Warren, 1911). Many readers will recall that Dr. Parkman, for whom the Professorship was named, had donated to Harvard the land upon which the medical school building stood, and that it was in this building in 1849 that Dr. Parkman met his death at the hands of Professor Webster. In the ensuing memorable trial (Bemis,

1850), one of the witnesses for the prosecution was Professor Holmes.

Dwight was only seven years old at the time of the trial. However, I sense more than a coincidence in the fact that Professor Holmes' successor first came to wide attention twenty-eight years after the trial through winning a prize for an essay on a medico-legal subject (Dwight, 1878). Very likely Dwight had heard the story of that trial recounted many times. Be this as it may, his essay shows remarkable insights into forensic matters at a time when other American anatomists were not looking at human skeletons with applied purposes in mind.

The essay was only the beginning of Dwight's work in forensic anthropology. Over the quarter of a century following the appearance of the essay he investigated a number of intriguing questions to which he had been able to give only tentative answers at first. Among those raised in the essay, or in his Shattuck Lecture (Dwight, 1894b), and elaborated on separately were: How best can stature be estimated from skeletal remains without resorting to the proportionality of the long bones? How indicative of sex, height and age is the sternum? What is the range and significance of variations in the human skeleton? Do the skull sutures close regularly enough to provide a reliable estimate of age? How indicative of sex are the size differences in the articular areas of the long bones? His answers to these questions appear at appropriate places in the chapters to follow.

George A. Dorsey (1869-1931), the next figure in this historical sequence, showed a notable awareness of Dwight's contributions. Probably while still an anthropology student at Harvard, he picked up from Dwight's Shattuck Lecture (1894b) an observation about the size of the articular surfaces of the long bones being good indicators of sex. This led him shortly afterwards (Dorsey, 1897) to test the observation on Indian skeletons in the Field Columbian Museum in Chicago where he had become Curator (Cole, 1931). As a result, he appears to have been the first to learn that the head of the humerus is a better indicator of sex than the head of the femur. Later (1905) Dwight confirmed this.

Dwight's influence on Dorsey appears also in references cited

in the latter's lecture on *The skeleton in medico-legal anatomy* (1899) given before the Medico-Legal Society of Chicago after the Luetgert murder trial was concluded (Wigmore, 1898). Severe criticism of Dorsey's testimony at the Luetgert trial by opposing anatomists (see discussion section in Dorsey, 1899) may have induced him to drop his forensic interest at that point.* Dorsey quit anthropology during World War I; this is why Figure 1 shows him in naval uniform.

H. H. Wilder (1864-1928), one of Dorsey's contemporaries, rates a place in the history of American forensic anthropology for a different reason. He was primarily a European-trained zoologist who came by an interest in physical anthropology late in his career while teaching at Smith College (Pratt, 1928). The aspects of physical anthropology that interested him most—dermatoglyphics and facial reconstructions on skulls—are, of course, very much a part of forensic identification. Not surprisingly, therefore, one of his books is on personal identification (1918, with Bert Wentworth as coauthor). The fact that this book contains no reference to the work of Dwight indicates, perhaps better than anything else, the extent to which by World War I forensic anthropology in America had failed to fulfill its earlier promise. Wilder's appearance is shown in Figure 2.

Wilder's career was overlapped by that of Paul Stevenson (1890-1971), a medically-trained American anatomist who spent twenty years in China prior to World War II. Because he was abroad for such a long time and published only two contributions to forensic anthropology (Stevenson, 1924, 1929), one of them in England, his position in the field must be regarded as fairly peripheral. Indeed, he may not have given much, if any, thought to the forensic applications of his findings. Figure 3 shows Stevenson late in his career.

The names of the two most important American physical anthropologists during the early decades of the twentieth century —Aleš Hrdlička (1869-1943) and Earnest A. Hooton (1887-1954)

*I corrected this impression in a paper read at the 30th Annual Meeting of the American Academy of Forensic Sciences (St. Louis, MO, February 23, 1978). This paper will appear in the *Journal of Forensic Sciences.*

Figure 1. George Amos Dorsey, Ph.D., LL.D. (hon.).

Figure 2. Harris Hawthorne Wilder, Ph.D.

—do not come readily to mind in connection with forensic anthropology. Although certainly both were asked by investigative agencies to make skeletal identifications, Hooton alone seems to have expressed an opinion on the subject in print. The opinion was not very flattering: ". . . modern physical anthropology has contributed comparatively little to the improvement of methods of individual identification . . ." (1943, p. 1613).

Figure 3. Paul Huston Stevenson, M.D., D.P.H.

MODERN PERIOD

The revival of forensic anthropology in the United States dates from 1939, the year when W. M. Krogman published his *Guide to the identification of human skeletal material* in the *FBI Law Enforcement Bulletin.* I feel justified in using this event to signal the beginning of a new period, not only because of the scarcity of significant anthropological developments in the forensic field during the preceding four decades, but because here for the first time to my knowledge was an identification article by an anthropologist appearing in a periodical devoted to forensic matters.

In 1939 Krogman had the advantage over his colleagues of having participated in the advanced research on growth and development being carried on at the Western Reserve University Medical School by, and under the direction of, T. Wingate Todd (1885-1938), one of the most energetic and imaginative anatomists of the time. The results of Todd's highly-respected work were so evident in Krogman's *Guide* that they gave it an aura of authority and infallibility new to the field. Partly for this reason and partly because the *Guide* had no competition, it came into wide use. I well recall my own reliance on it when I began identifying skeletal remains for the FBI in 1942 after I had become Curator of the Division of Physical Anthropology, National Museum of Natural History.

World War II

The maximum utilization of the *Guide* was in connection with the U.S. Army's program of identifying the skeletonized dead from World War II for repatriation and reburial. Because of the course of American involvement in the war, the program had two geographical divisions, European and Pacific. In the former, European personnel did the actual identification work under an arrangement worked out through consultation with H. L. Shapiro, Curator of Physical Anthropology at the American Museum of Natural History, New York (see Simonin, 1948; Snow, 1948a; Vandervael, 1952, 1953).

Only when the program shifted to the Pacific were American

anthropologists called upon to help in the identification work. More and more at this stage the selection of anthropologists was aided by Francis E. Randall (1914-1949) of the Anthropology Unit, Research and Development Branch, Office of the Quartermaster General. Charles E. Snow (1910-1967) of the University of Kentucky was the first physical anthropologist to serve in the Central Identification Laboratory in Hawaii when it was established in 1947.

By 1948 enough interest in this and other aspects of applied physical anthropology had developed to enable Randall to organize a symposium on the subject for the annual meeting of the American Association of Physical Anthropologists in Washington. As the program finally evolved, Randall was able to enlist only four speakers to cover the field of medicolegal applications: W. M. Krogman, H. L. Shapiro, Charles E. Snow, and T. D. Stewart. The papers of the last two were the only ones published in the Association's organ that year (Krogman's remarks were embodied in his 1949 publication).

At the time this symposium was held (April 3, 1948), the Army was seeking a replacement for Snow at the laboratory in Hawaii because of the expiration of his leave of absence from the University of Kentucky. The leading candidate for the position was Mildred Trotter, Professor of Gross Anatomy at Washington University, St. Louis, and a charter member of the American Association of Physical Anthropologists. Knowing this, I took the opportunity at the Washington meeting to urge her to take the position, citing statements that Snow and I had made in our symposium papers as part of my argument. The point of these statements was that stature estimation from the long bones still was based on a series of fifty male and fifty female French cadavers, many of them senile, measured by Rollet in 1888-89. The position in Hawaii, I argued, offered the opportunity to combine identification with research and provide a more reliable means for stature estimation based on a youthful American sample.

Later I realized that I should have advised Dr. Trotter also to make her acceptance conditional upon being granted permis-

sion in advance to do the research, because after she arrived in Hawaii she was told that she was there to identify the war dead and not to do research. Eventually, however, she was enabled to do the research, which at that stage consisted simply of securing accurate length measurements of the long limb bones of known individuals. The outcome of this research work (Trotter and Gleser, 1952) is discussed in Chapter 9.

Korean War

The next opportunity for American physical anthropologists to engage in human identification on a large scale came only five years later with the signing of the armistice on July 27, 1953, ending the Korean War. In anticipation of this event, officials of the Memorial Division, Office of the Quartermaster General, asked for my ideas about further research on the war dead. The fact that the concept of using the war dead for research directed toward improving identification techniques no longer met with resistance within the military, and that on the contrary it was now being advanced by the military, is a measure of the administrative break-through achieved by Dr. Trotter in Hawaii.

I am not sure now whether my conversation with the officials of the Memorial Division took place before or after I wrote an invited editorial on *Research in human identification* for the August 28, 1953, issue of *Science*. In any case, the following paragraph from the editorial expresses what I had in mind:

> Additional research is needed, especially to improve the estimation of age after skeletal maturation. Present information on this subject [as provided in Krogman's *Guide*] comes from the population dregs of large cities which reach the dissecting rooms. Those unfortunate individuals have not always given their ages correctly; nor have they led healthy lives. Well-identified skeletons of healthy Americans from the middle period of life are seldom obtainable. This fact emphasizes the unique opportunity afforded by the military reburial program.

Following the establishment of the identification laboratory in Kokura, Japan, the Memorial Division arranged with the Smithsonian Institution for my services for the period from mid-September, 1954, to mid-February, 1955, to carry out the research

I had proposed. During that time, assisted by a small assigned staff, I recorded in detail the age changes in 450 skeletons (only 375 were satisfactorily identified). The results of this work, which will be dealt with in Chapter 8, constitute a report, prepared under my direction by Thomas W. McKern (1920-1974), in the *Technical Series of the Environmental Protection Branch, Quartermaster Research and Development Command* (McKern and Stewart, 1957).

During my stay in Japan the identification team there included two American physical anthropologists: Ellis R. Kerley, now of the University of Maryland, and Charles P. Warren, now of the University of Illinois at Chicago Circle. Two other physical anthropologists, Russell W. Newman of the Quartermaster Research and Engineering Center, Natick, Massachusetts, and Paul Baker, now of Pennsylvania State University, were engaged in another research project. They were seeking a means of estimating the weight of the body in life from dry-bone weight. Following the pattern being used in this chapter, consideration of the results of this work (Baker and Newman, 1957) will appear in Chapter 10.

Two further developments stemmed from the work in Japan: (1) A summer seminar in 1955 on *The role of physical anthropology in the field of human identification;* and (2) a re-examination of the Trotter and Gleser formulae for the estimation of stature from the long bones. The seminar was the eighth since the late 1940s funded by the Wenner-Gren Foundation for Anthropological Research of New York. None of the preceding seminars had dealt with forensic applications, but the growing involvement of American physical anthropologists in this field seemed to me to warrant one.

The Wenner-Gren being receptive to this argument, I arranged for the seminar to be held in Washington, September 6 to 9. The main program consisted of half-day panel discussions on the following five topics (with the chairpersons): (1) Qualifications for identification specialists (W. M. Krogman), (2) identification of small remnants of the human body (William S. Laughlin), (3) sex and age (J. Lawrence Angel and T. D. Stewart), (4) stature,

body build, and facial features (Mildred Trotter), and (5) educational and administrative aspects (T. D. McCown—1908-1969).

One of the concluding statements of the published report on this seminar (Stewart and Trotter, 1955, p. 884) is noteworthy:

> Like most scientists, [physical anthropologists] have been accustomed to working from the known toward general principles. If they have assumed too often that these general principles can be applied readily to the identification of an unknown individual, whatever disillusionment the discussion produced should be salutary. Also, it is likely that from now on certain researchs in physical anthropology will be carried out with a view to direct application in identification.

The World War II-derived Trotter and Gleser formulae for stature estimation were published just in time (1952) for use in identifying the American dead of the Korean War. Having a personal interest in these formulae, as explained above, I took the trouble while in Japan to compare the estimates that they yielded with the recorded statures in life for all of the 375 known individuals whose skeletons I examined. As plotted out, the estimated statures seemed to me to deviate unduly from the actual statures at the extremes of the range. This observation provided Dr. Trotter with an excuse to apply to the Quartermaster General for a contract to re-evaluate the reliability of the formulae from the standpoint of the different population sample represented by the Americans killed in the Korean War. The outcome (Trotter and Gleser, 1958) was that so far as whites and blacks are concerned, the 1952 formulae need no adjustment (cf. Trotter, 1970) and as a bonus tentative formulae were derived for Mongoloids and Mexicans, while the formulae for blacks were judged to be appropriate for Puerto Ricans.

Vietnam Conflict

American involvement in the Vietnam conflict, which began in the early 1960s, accelerated in earnest with the landing of the first troops in 1965, and for the next 8 years was accompanied by heavy American casualties, did not lead to any new research in identification. This was due to the nature of the fighting and to various technological advances that permitted the rapid recovery