Skeletal Biology of the Ancient Rapanui (Easter Islanders)

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2 Review of Polynesian and Pacific skeletal biology

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Introduction

This chapter summarizes previous work in skeletal biology of the Pacific. Although evidence from other areas in physical anthropology is included, the major focus of this survey will be what studies of human skeletons reveal about the origins, health, and lifestyle of the indigenous inhabitants of the Pacific. While interest in the origins of Pacific Islanders, particularly Polynesians, continues to command attention, more recent studies in skeletal biology and bioarchaeology focus on health, disease, and lifestyle of Pacific Islanders. Studies in dental anthropology and molecular genetics, using skeletons from Easter Island, are omitted here but will be fully discussed in other chapters in this volume.

Following a brief summary of the geography and prehistory of the Pacific, we review initial observations and descriptive reports in physical anthropology using human skeletons (primarily crania) collected during the age of scientific expeditions to the Pacific in the late eighteenth and early nineteenth centuries. Contemporaneously were more ambitious comparative analyses using crania found in museum collections; studies that unfortunately were mired in the typological paradigm of the time. Paralleling these early craniometric studies were the first anthropometric studies of the living inhabitants of the Pacific undertaken in the early decades of the twentieth century. The decades following World War II saw the first systematic archaeological excavations in the Pacific, which resulted in more extensive osteological investigations involving prehistoric human skeletons. More recently, work in the Pacific has focused on Lapita and post-Lapita skeletons (e.g., Vanuatu, New Guinea, and Fiji) and skeletons recovered during archaeological excavation and monitoring activities associated with Cultural Resource Management (CRM) work.

A plethora of early studies involved skeletons from the Pacific, but the possibilities of studying human skeletons in many parts of the Pacific are now drastically reduced due to issues surrounding repatriation and concerns of the indigenous groups. Despite these challenges, new information about the past inhabitants of the Pacific continues to emerge.

Pacific Islands: Geography, prehistory, and linguistics

Although based on a faulty perception of Pacific Island culture history (Kirch, 2000), for the sake of simplicity, this review will refer to Dumont d'Urville's (1832) tripartite division of the Pacific: Melanesia, Micronesia, and Polynesia. Following recent work in archaeology and historical linguistics, this review further recognizes the importance of the distinction between Near Oceania (New Guinea, the Bismarck Archipelago, and the Solomon Islands) and Remote Oceania (Micronesia, Vanuatu, Loyalty Islands, New Caledonia, Fiji, and Polynesia) in understanding the prehistory of the Pacific (Green, 1991).

Human occupation of Near Oceania began when the first humans crossed Wallace's Line from Southeast Asia approximately 40–50,000 years ago (Kirch, 2000). The initial human colonization of Remote Oceania, occurring in the time interval 3200–2800 BP, is associated with an eastward expansion of Austronesian-speaking people associated with the Lapita Cultural Complex identified by its distinctive dentate-stamped pottery, horticulture, and sophisticated navigational skills (Kirch, 2000; Petchey et al., 2010). From its immediate origins in the Bismarck Archipelago, perhaps as early as 3350 BP, the Lapita culture spread through the Solomon Island chain and other islands in Eastern Island Melanesia, and eventually out to Tonga and Samoa in Western Polynesia (Petchey et al., 2010). After a pause of as much as 1,000 years, these Pacific navigators went on to settle the rest of the islands of Remote Oceania, not reaching some of the more marginal islands in the triangle (e.g., Easter Island, Hawai‘i, and New Zealand) until 800 years BP (Hunt and Lipo, 2006). A recent study (Hung et al., 2011) suggests that the first human expansion into Remote Oceania preceded the Lapita expansions by one to two centuries with the colonization of the Mariana Islands via the Northern Philippines.

The majority of the evidence from historical linguistics, archaeology, and physical anthropology indicates that the ultimate origin of the indigenous inhabitants of Near and Remote Oceania was in Southeast Asia. However, the timing and other details regarding the appearance and dispersal of the Lapita cultural complex remain much-debated topics. Several competing models have been advanced in recent decades to explain the exact tempo and mode of the initial colonization of Remote Oceania and Polynesia. One of these, the so-called “Express Train” model, argues that the ancestors of Polynesians ultimately originated from an expansion of Austronesian-speaking agriculturalists that left mainland Asia or Taiwan approximately 4,000 years ago (Bellwood, 2005). These Austronesian-speaking people moved rapidly through Island Southeast Asia and Near Oceania with little or no genetic admixture with the indigenous groups they encountered along the way. This expansion is associated with the development of the Lapita cultural complex in the Bismarck Archipelago and colonization of the rest of Remote Oceania within the last 3,000 years.

Alternative models suggest maritime contacts, some as early as 12,000 BP (Solheim, 2006), between the peoples of Southeast Asia and Near Oceania, creating what others have termed spheres of interaction along a “voyaging corridor” as
detailed in the “Entangled Bank” model (Hurles et al., 2003a; Irwin, 1992; Terrell, 2004; Terrell et al., 2001). These models suppose a long history of cultural and genetic interactions among the ancestors of Polynesians and the already established inhabitants of Southeast Asia and Melanesia. The “Slow Boat” model, based primarily on Y chromosome data, proposes the ancestors of Polynesians emerged within Island Southeast Asia and moved slowly eastward into Remote Oceania and Polynesia with significant admixture between them and the peoples of Near Oceania (Oppenheimer and Richards, 2001; Richards et al., 1998).

A more extreme, but less frequently cited model, argues for the indigenous development of the Lapita cultural complex in Near Oceania with no input from outside this region (Allen, 1984). Roger Green’s mobile founding migrant category of models (Green, 1994, 2003) argues for interaction between the immigrant Austronesian speakers and the indigenous peoples of the Bismarck Archipelago. More detailed discussions of these and other models are available elsewhere (e.g., Donohue and Denham, 2010; Green, 2003; Matisoo-Smith and Robins, 2004; Petchey et al., 2010; Pietrusewsky, 2006a).

**First impressions/early paradigms**

First impressions of the indigenous inhabitants of the Pacific are found in writings of explorers, naturalists, missionaries, and other early European visitors to the Pacific that appeared in the late seventeenth and early eighteenth centuries.

**Explorers**

Representative of these initial descriptions of Pacific Islanders is one penned by Johann Reinhold Forster, a naturalist on Cook’s second Pacific voyage (1772–75):

*We chiefly observed two great varieties of people in the South Seas; the one more fair, well limbed, athletic, of a fine size, and kind benevolent temper; the other blacker, their hair just beginning to become woolly and crisp, the body slender and low, and their temper, if possible, more brisk though somewhat mistrustful. The first race inhabits Tahiti, and the Society Islands, the Marquesas, the Friendly Islands, Easter Island, and New Zealand. The second race peoples New Caledonia, Tanna and the New Hebrides, especially Malicolo.* (Forster, 1778: 228)

Likewise, in his journals, Captain James Cook, one of the most renowned Pacific explorers, described the Maori of New Zealand as “…strong, rawboned, well made, Active People, rather above than under the common size especially the Men” (Cook, 1955: 278). Similar descriptions of the physiques of other Pacific peoples are common in these early texts (e.g., Bougainville, 1772; Roggeveen, 1770).

**Craniology and printed catalogs**

The first studies of skeletons, mainly crania, began to appear shortly after the commencement of the great scientific exploring and collecting expeditions to the
Pacific (Pietrusewsky and Douglas, 2012). Among these early descriptive reports are William Turner's (1884) study of crania collected during the voyage of H.M.S. Challenger (1873–76) and Emil Zuckerkandl's (1875) description of crania from various regions of the world, including the Pacific, collected during the Austro-Hungarian scientific Novara-Expedition (1857–59). An additional source of early descriptions of human skeletal remains from the Pacific was printed catalogs of anatomical collections in museums and private collections, primarily in Europe (e.g., Davis, 1867; Flower, 1879). These catalogs, some of which offered anatomical material for sale, provided tantalizing information on details of cranial morphology, including some measurements, and unusual anatomical and pathological features present in the collections. Information found in these catalogs, especially the measurements, provided comparative data for the earliest reconstructions of human history using racial classifications.

The anthropological collections in Germany and surrounding regions were particularly well described by a series of catalogs published in the early issues of Archiv für Anthropologie, which were part of a large-scale project, Die anthropologische Sammlungen Deutschlands, initiated by Schaffhausen (1878) as well as other similar endeavors (e.g., Schlaginhaufen, 1910; Schmelz and Krause, 1881; von Luschan, 1907). These detailed descriptions included age, sex, geographical origin, completeness, a standard number of cranial measurements, and notation of any unusual features observed.

Comparative studies of skulls appear around the same time, typically using cranial measurements and indices, to compare Polynesians with other groups from around the world (e.g., Allen, 1898; de Quatrefages and Hamy, 1882; Pruner-Bey, 1864–1867; Retzius, 1864; Spengel, 1876; Udhe, 1861; Weisbach, 1890). Most of this initial work emanated from Europe, although antecedent physical anthropologists in the USA were also represented. An early description of Polynesian crania by an American was that by Jeffries Wyman, an anatomist and pioneer anthropologist who eventually taught anatomy at Harvard University and was the first curator of Peabody Museum of Archaeology and Ethnology. Wyman (1868) described in noteworthy detail a series of Hawaiian crania from the island of Kaua'i, including observations of auditory exostoses, peg-shaped teeth, and other aspects of cranial and dental morphology. He introduced an innovative comparative approach that included systematic observation and recording of cranial pathology in the Pacific.

Another American pioneer was Harrison Allen who provided thorough descriptions of 65 Hawaiian skulls from several collections in Philadelphia, Harvard, and Princeton (Allen, 1898). Unlike his contemporaries, who were preoccupied with race, Allen's comprehensive study of Hawaiian skulls included an astonishing number of observations of paleopathology, such as osteoporosis, periodontal disease, craniosyntosis, external auditory exostoses, linear enamel hypoplasia, etc. By employing a descriptive and comparative methodological approach, Allen was one of the first investigators to speculate that some of the observed features were the result of nutritional deficiencies, disturbances during growth and development, and/or cultural modification.
The first detailed examinations of skulls and complete skeletons from the Pacific were made by Halliday Scott, an anatomist and the first Dean of Otago Medical School in Dunedin, New Zealand (Scott, 1893). In addition to reports of metric and non-metric variation in 130 Maori and Moriori skulls, Scott's osteological study included detailed observations of 13 Maori and five Moriori skeletons. Scott made notes of dental pathology (e.g., dental caries and dental abscessing) and was the original observer of features such as rocker jaw and squatting facets in Polynesian skeletons. Again, as was typical of the time, Scott's interpretations of Cranial morphology, which rested on cranial indices, were expressed in terms of racial mixing.

**Anthropometry and somatology: Racial typology**

Paralleling these studies of Pacific crania were the first studies of living Polynesians. Following the inaugural Pacific Science Congress in 1920, the B. P. Bishop Museum (Honolulu) and the American Museum of Natural History (New York) launched the Bayard Dominick Expeditions, the earliest and most ambitious effort to document anthropological data, including anthropometric and somatological data on the living inhabitants of Polynesia (Sullivan, 1921). This expedition resulted in published data on the inhabitants of the Society Islands, Samoa, Tonga, the Marquesas, Hawai‘i and the Cook Islands (e.g., Shapiro, 1930, 1942; Shapiro and Buck, 1936; Sullivan, 1923, 1927).

Because of its insular environment, reconstructions of the human biological history of the Pacific relied primarily on the identification of racial types, resulting from successive waves of migrants and subsequent mixing (e.g., Dixon, 1920; Sullivan, 1924). Skulls, as well as living people, were classified, or "typed," into groups based on the possession of discrete packages of traits representing skull/head shapes, including the ubiquitous cephalic, or cranial, index. The existence of these discrete packages of traits was interpreted as evidence for separate origins and migrations of people representing once pure races. Roland B. Dixon, for example, discerned at least four distinct racial elements, or types, among the inhabitants of the Hawaiian Islands, each having been introduced as a result of a series of separate migrations (Dixon, 1920, 1923).

This preoccupation with racial typology and the lack of appropriate mathematical procedures resulted in extensive compilations of descriptive data that contributed very little to understanding the biological variability of the inhabitants of the Pacific Islands and their origins. Recognition of the shortcomings of the racial typological classification approach, development of more advanced statistical procedures, and adoption of a population genetics approach to understanding past biological relationships ushered in a more modern era in physical anthropology.

W. W. Howells was the first researcher in Pacific physical anthropology to take advantage of this new paradigm. Using his own and other data on living people found in the literature, Howells (1970) applied principal components analysis to anthropometric variables recorded in 151 Pacific Island samples, resulting in the first comprehensive assessment of biological variability in this region. Howells'
analysis identified three major groupings: 1. an Australian branch, 2. a highly varied Micronesian branch to which some Micronesian series are attracted, and 3. a Polynesian branch. Similar conclusions were achieved using somatological features, such as skin color, hair form, nose form, facial profile, etc. (Howells, 1979, 1997; Howells and Schwidetzky, 1981). Studies such as this led to the recognition of a specific "Polynesian phenotype."

Pacific relationships and Polynesian origins

Polynesian phenotype

Physical anthropologists, beginning with work by Shapiro and Buck (1936) and Marshall and Snow (1956), commented on the distinctiveness of the Polynesian skull form and physique. Howells described Polynesian skulls typically as being large with pronounced muscle markings, distinctive shapes, vertical faces, flat nasal bridges, well-developed brow ridges, high cheekbones, wide cranial bases, and mandibles described as "rocker jaws" (Howells, 1973c: 228–29, 1979; Howells and Schwidetzky, 1981). Rocker jaw refers to the condition observed in mandibles, which due to the convexity of the inferior border, causes them to rock back and forth like a rocking chair when placed on a level surface. Various aspects of Polynesian skull and head form, including the rocker jaw condition, are the result of uniquely Polynesian pattern of facial growth originating during puberty which causes the lower jaw to rotate inferiorly and posteriorly (Houghton, 1977; Schendel et al., 1980). One consequence of this unique growth is the wide angle between the body and ramus of the mandible and a convex inferior border.

Philip Houghton, who has written extensively on Polynesian physical form, portrayed Polynesians as possessing tall stature, robust long bodies, relatively short legs, and bowed limb bones, etc. (Houghton, 1980, 1996b). The biological variation observed in Polynesians is relatively homogeneous, an observation that cannot be made for the inhabitants within the geographical boundaries of Melanesia and Micronesia.

The distinctive features of Polynesian skulls, teeth, and skeletons were interpreted by Houghton as adaptations to the cold ocean environment, the consequence of long periods of ocean voyaging, living on small islands, and sea-related activities such as voyaging and fishing (Houghton, 1990); though others (e.g., van Dijk, 1991) disagree, pointing to alternative casual factors such as cultural and sexual selection. A recent multivariate analysis of measurements recorded in crania from the Pacific and elsewhere failed to support these or other attempts (e.g., Katayama, 1996) to explain Polynesian cranial morphology as a result of cold adaptation (Stefan, 2005).

Biological distance studies

Because of the demonstrated correlation between phenotypic and genotypic similarities and the demonstrated genetic basis for skeletal and dental variation, measures of
biological distance have generally been determined through the application of quantitative methods to metric and non-metric categories of skeletal and dental variation (Buikstra et al., 1990). More recent applications include ancient DNA (aDNA) and other biochemical and geochemical traits. Groups of people that share more features in common are considered to be more closely related than groups of people that do not share these same features (Larsen, 2002).

Studies of cranial form, most notably cranial measurements (or craniometrics) that quantify morphology, continue to play a central role in biological distance studies, including those that focus on the Pacific. While morphological variation, especially quantitative variation, is subject to non-genetic or environmental influences, craniometric variation is generally assumed to reflect genetic similarity resulting from neutral evolutionary forces. The strong geographic patterning (e.g., Howells, 1973a), selective neutrality of phenotypic (craniometric) variation (e.g., Relethford, 2009), and the amenability of continuous variation to multivariate statistical analysis have ensured the continued use of traditional landmark measurements and newer geometric morphometric data in biodistance analyses. There is now an emerging consensus that craniometric data can be used as a proxy to genetic data, hence the popularity of this category of variation in biodistance studies.

**Initial craniometric studies**

Corresponding to initial developments in the field of statistics, much of it resulting from the work of Karl Pearson and others at the Biometric Laboratory, University College, London, physical anthropologists were eager to apply more advanced statistical procedures to craniometric data for reconstructing population history. A precursor of multivariate statistics was Pearson’s Coefficient of Racial Likeness – CRL (Pearson, 1928), which Pearson and his followers began to apply to studies of skulls for investigating population history. Another measure of biological distance was Penrose’s Size and Shape statistics (Penrose, 1954). Both the CRL and Penrose’s Size and Shape statistics had a number of inadequacies when used as measures of group divergence. Most notably, neither statistic sufficiently allowed for the intercorrelation of the variables (measurements), the number of measurements used, the differences in sample size, or a way to test for significance.

While never intended as a measure of biological distance, researchers, including those interested in the Pacific, began to apply these two measures of divergence to their data. Von Bonin’s study of crania, including 90 crania from Easter Island, from museums in London and Leiden (von Bonin, 1931), was one of the first studies that applied CRL to craniometric data from the Pacific. A few years later, the largest quantitative comparison of Oceanic skulls to date was published (Wagner, 1937). As well as using data from the literature, Wagner recorded measurements in 35 Maori crania that were part of the osteological collections in Norway. Although aware of its shortcomings, Wagner used CRL to evaluate the biological relationships of Polynesians and other Pacific groups. Among his findings was the marginal placement of
Easter Island and Moriori skulls. Interpreting the results of this analysis, Wagner noted, among other things, that the Chatham Island Moriori were closer to the Marquesans and Society Islanders than they were to the New Zealand Maori, despite the geographical proximity of the Maori and Moriori (Wagner, 1937: 129).

Even with these and more recent warnings (e.g., Buranarugsa and Leach, 1993), studies that use Penrose’s Size and Shape statistics for understanding biological relationships of Pacific Islanders continued to appear in the literature (e.g., Houghton, 1989c, 2008; Katayama, 1987, 1994).

Modern multivariate methods

The earliest statistical methods, predominantly descriptive or univariate statistics, while appropriate for analyzing measurements, were not effective for understanding individual or population variability (Howells, 1969: 312). The statistics of populations and the treatment of individual specimens in the context of their parent population commenced with the introduction of multivariate statistical procedures.

Multivariate statistical procedures comprise a family of related mathematical procedures that allow the simultaneous analysis of multiple variables (i.e., cranial measurements) recorded in individuals from one or more groups (Pietrusewsky, 2008b, 2014). Generally, the variables must be random and inter-related with one another such that their different effects cannot be interpreted individually in a meaningful manner. Measurements, because they are continuous variables, are ideally suited for this kind of statistical treatment.

Mahalanobis’ generalized distance (Mahalanobis, 1936; Mahalanobis et al., 1949) overcame statistical shortcomings of CRL and Penrose’s Size and Shape statistics. Mahalanobis’ generalized distance, which corrects for inter-correlation of variables and allows the handling of large numbers of variables simultaneously and tests for significance, remains the premiere statistic for measuring biological distance based on metrical and phenotypic data.

Other multivariate statistical procedures used by skeletal biologists and physical anthropologists include factor analysis, principal components analysis, and discriminant function analysis. Various clustering methods and multidimensional scaling techniques provide a useful means of visualizing the results of multivariate procedures. Comparable methods, although not as sophisticated as those used to analyze measurement data, are available for the analysis of non-metric data such as Smith’s Mean Measure of Divergence (MMD) statistic (Sjøvold, 1977).

Recent multivariate craniometric studies of Pacific crania and an example

With a renewed interest in skeletal biology in the Pacific that began in the 1960s, the very first biological distance studies that applied multivariate statistical procedures to data recorded in Pacific crania appeared (e.g., Pietrusewsky, 1969b, 1976, 1977). These were soon followed by many more studies that examined the
relationships and origins of Polynesians and circum-Polynesian groups. In addition to the utilization of cranial metric and non-metric variation, other biological distance studies use dental metric and non-metric data. The use of infracraniual non-metric traits in biological distance studies in the Pacific is extremely rare (e.g., Donlon, 2000).

**Pacific relationships and Polynesian origins: An example**

An example of a biological distance study that applied multivariate statistical procedures to craniometric data for investigating relationships among Pacific and Asian groups is that by Pietrusewsky (2005). In this example, stepwise discriminant function analysis and Mahalanobis' generalized distance were applied to 27 cranial measurements recorded in a total of 2,805 male crania representing 63 male cranial samples from the Pacific, Australia, Southeast Asia, and East Asia. The names and approximate locations of the cranial series are given in Figure 2.1. Figure 2.2 is a plot of the 63 male group means on the first two canonical variates that result
from applying stepwise discriminant (or canonical) function analysis to 27 cranial measurements. The diagram of relationship (or dendrogram) that results from applying the UPGMA clustering technique to Mahalanobis’ distances for the 63 male groups is presented in Figure 2.3.
Figure 2.3 The diagram of relationship that results from applying the UPGMA clustering algorithm to Mahalanobis’ distances based on 27 measurements. (Source: Pietrusewsky, 2005; figure reproduced with the permission of Routledge Curzon [Taylor & Francis Group, UK]).

As seen in these diagrams, two major divisions of the inhabitants of the Pacific and neighboring regions of East and Southeast Asia are indicated: one includes cranial series representing the indigenous inhabitants of Australia, Tasmania, and geographical Melanesia, while the second includes cranial series from East/North Asia, Southeast Asia, and Remote Oceania. The sharpness of the distinction suggests separate origins for the people living in these two regions: The first coincides with the initial peopling of Australia and Near Oceania and the second event accounts for the earliest human colonization of Remote Oceania.

With the exception of New Zealand, the Polynesian cranial series and one series from Guam occupy a separate branch within a greater East/Southeast Asian division. Together these cranial series are well removed from the division that includes all the cranial series from Melanesia and Australia, a relationship that is more consistent with an ancestral homeland in Southeast Asia rather than one in adjacent geographic Melanesia. These results further demonstrate a close connection between several of
the Polynesian cranial series and those from Island Southeast Asia, most notably the Lesser Sunda Islands, Sulawesi, and the southern Moluccas in eastern Island Southeast Asia. The connection between New Zealand and the Southern Moluccas in the dendrogram of distances reinforces this association. Contrary to interpretations made by Brace and colleagues (e.g., Brace et al., 1990), there is no support for a close biological connection between Polynesians and the Ainu series from Japan in these results nor in other multivariate comparisons by other researchers (e.g., Hanihara, 1992a, 1993). Small and uneven sample sizes, a limited number of measurements confined to the facial region, and differences in methodology may explain Brace’s Jomon-Pacific cluster.

The sharp differentiation between Polynesian and Melanesian cranial series, found in these results, suggests that the colonization process may have been relatively rapid and with little or no admixture between the ancestors of the Polynesians and the indigenous inhabitants of Melanesia or the Bismarck Archipelago region of the Pacific. Further, the craniometric results provide little support for a homeland in Taiwan or adjacent regions of Chinese mainland. Very similar results were obtained in biological distance studies using dental metric and non-metric data (Hanihara, 1992b; Scott and Turner, 1997). While the evidence from cranial data does not fit any of the current proposed models entirely, there is agreement with those models, based mostly on genetic (Merriwether et al., 1999; Oppenheimer and Richards, 2001; Su et al., 2000) and archaeological (Kirch, 1997) evidence, that suggest an ancestral homeland for Polynesians and the earliest inhabitants of Remote Oceania in Island Southeast Asia. Other biological distance studies (e.g., Pietrusewsky and Ikehara-Quebral, 2001) have examined internal relationships of Polynesia and possible connections with North and South American cranial series.

**Polynesian relationships: A second example**

Pietrusewsky and students have examined relationships within Polynesia extensively. An example of this work is a study by Pietrusewsky and Ikehara-Quebral (2001) that applies stepwise discriminant function analysis and Mahalanobis’ generalized distance to 29 cranial measurements recorded in 592 male crania representing nine Polynesian and four Native American groups. As shown in Figure 2.4, there is marked differentiation between the Polynesian and Fijian cranial series and the North and South American cranial series. The Eskimo cranial series is the most isolated. This same relationship is repeated in the dendrogram of distances (Figure 2.5) with three of the four Native American cranial series forming an isolated cluster well removed from the cluster containing the Polynesian and Fijian series. Once again, the Eskimo series is the most peripheral series.

**Easter Island (Rapa Nui) and the Marquesas**

A multivariate analysis of craniometric data by Stefan (1999) demonstrated little support for significant differences between known tribal regions of
Figure 2.4 Plot of 13 male Polynesian and Native American group means on the first three canonical variates that result from applying stepwise discriminant function analysis to 29 cranial measurements. (Source: Pietrusewsky and Ikehara-Quebral, 2001; figure reproduced with the permission of the Easter Island Foundation, Los Osos, CA.)

Figure 2.5 The diagram of relationship that results from applying the UPGMA clustering algorithm to Mahalanobis' distances. (Source: Pietrusewsky and Ikehara-Quebral, 2001; figure reproduced with the permission of the Easter Island Foundation, Los Osos, CA.)
prehistoric/protohistoric Easter Island (Rapa Nui). Rather, the results of this study suggested that the early inhabitants of Rapa Nui were homogeneous, a conclusion that was reiterated in analyses using cranial non-metric traits (Chapman, 1999; Furgeson and Gill, 2005). The results of Stefan’s craniometric analysis further demonstrated different levels of heterogeneity between male and female Easter Islanders (Rapanui) suggesting males may have been more mobile than females. Overall, analyses of cranial metric and non-metric variation do not support the existence of widespread strict tribal endogamy but rather lineage endogamy and restricted exogamy of the prehistoric inhabitants of Rapa Nui (however, see Gill, 2000b and Gill, Chapter 8 in this volume for more about this issue).

In a later analysis of metric and non-metric data recorded in crania from the Marquesas Islands, Stefan and Chapman (2003) demonstrated regional differences between Northwestern and Southeastern regions of this island group.

**Origins of Easter Islanders (Rapanui)**

Despite being one of the most differentiated Eastern Polynesian series, there is general consensus among researchers that Easter Island crania are related to other Eastern and Central Polynesian cranial series (e.g., Clow et al., 2001; and the examples given in this chapter; Pietrusewsky and Ikehara-Quebral, 2001; Stefan, 2000). Other studies (e.g., Chapman, 1999; Pietrusewsky, 2005, 2006a, b, 2008b; Stefan, 2000, 2001) have also identified close biological connections between crania from Easter Island and the Gambier Islands prompting some (e.g., Stefan, 2000, 2001) to hypothesize that the first inhabitants of Easter Island may have originated from Gambier Island. In a more recent multivariate analysis of cranial measurements, Easter Island crania were found to group with New Zealand Maori and then together these cranial series clustered with Gambier Island (Pietrusewsky, 2008a). Broader multivariate comparisons, like those reviewed in this section, generally suggest that the ancestors of the earliest inhabitants of Easter Island as well as the ancestors of Polynesians originated in the East rather than from North and/or South America. Nonetheless, because of Easter Island’s relative isolation in the extreme Eastern Pacific and this island’s proximity to the South American coast, contact between the first inhabitants of Easter Island and South America remains a possibility (e.g., Matison-Smith and Ramirez-Alliaga, 2010) (see Gill, Chapter 8 and Hagelberg, Chapter 11 in this volume for more on this issue).

**Lapita skeletons**

The first studies of human skeletons associated with the Lapita Cultural Complex (3600–2500 BP) began to appear in the mid-1980s (Houghton, 1989c; Pietrusewsky, 1985, 1989a, b). Because bearers of the Lapita culture have been linked to the initial human colonization of Remote Oceania during the interval 3200 to 2800 BP, skeletons associated with the Lapita culture are regarded as important sources of information for investigating the origins, health, and lifestyle of the earliest
Subadult health

Skeletal biologists have often neglected subadult skeletons in the past because of preservation issues, but increasingly rigorous data collection has expanded the available information on this important demographic segment. Hanson (1990) examined paleopathology in a small sample of pre-Latte and Latte subadult burials from the island of Rota in the Northern Mariana Islands. Evidence for dental pathology (dental caries, dental enamel hypoplasia, and hypocalcification) and two types of skeletal lesions (periostitis and porotic hyperostosis) in ten subadults ranging in age from neonatal to 48 months was presented. The observed co-occurrence of dental enamel defects and severe dental caries with skeletal pathologies in these subadults suggested a combination of factors such as the fluoride content of food and drink, increased risk of food/water contamination brought about by a limited water supply, introduction of solid foods in the infants' diet, and/or a nutritionally inadequate weaning diet.

More recently, Buckley (2000) undertook a differential diagnosis of lesions observed in 17 subadult skeletons aged 6 months to 3 years from the To-At-1 and To-At-2 prehistoric burial mounds in the Tongan Islands. The author reported evidence of possible traumatic injury to the periosteum, infectious disease (e.g., weaning diarrhea, yaws), and nutritional deficiencies (e.g., scurvy and possibly hypervitaminosis A) in the subadult skeletons from these two archaeological sites.

Musculoskeletal indicators of stress/occupation

Stress fractures of the lower back (spondylosis) and well-developed insertions for muscles, such as occipital superstructures in the crania, in prehistoric Chamorro from the Mariana Islands are interpreted as evidence that the early inhabitants of the Marianas lived relatively strenuous physical lives. In his examination of 176 skeletons from the Hyatt site on Tumon Bay, Guam, Arriaza (1997) reported spondylosis frequencies of 29.4% (5/17) and 14.3% (3/21) for males and females, respectively. Although not significantly different, the overall frequency for lower back trauma in both sexes was high. Heathcote et al. (1996), in addition to providing a protocol for scoring three posterior cranial superstructures, reported that marked expressions of these traits were found in male crania from the Mariana Islands and Tonga. Both spondylosis and occipital superstructures are linked to seafaring cultures and the strenuous activities involved in stoneworking among the prehistoric inhabitants of these Pacific islands, activities that undoubtedly required considerable upper body strength and agility.

Symposium on the bioarchaeology of the Mariana Islands

Because of the nature of CRM work, there have been very few broad surveys of health from the Pacific. An exception was an international symposium on the bioarchaeology of the Mariana Islands at the annual meeting of the American Association of
Physical Anthropologists in Oakland, California in 1995. Ten papers from that symposium were later published as a special issue of the American Journal of Physical Anthropology in 1997 (Hanson and Pietrusewsky, 1997). The papers represented a broad spectrum of skeletal biological research in the region including studies of mortuary behavior, skeletal biology, health and lifestyle in the Mariana Islands, paleodiet, childhood stress, cultural modifications of teeth, lower back trauma, and two multivariate studies that examined cranial variation in the Mariana Islands and surrounding regions.

**Inter-island differences**

More recent investigations of health and lifestyle in the Mariana Islands (e.g., Pietrusewsky et al., 2010, 2011) have identified possible inter-island differences that may reflect differences in environment and/or resource availability caused by natural disasters or other factors on smaller islands. Some of the differences in dental health observed in the skeletal series from the Mariana Islands have been further linked to the fairly ubiquitous cultural practice of chewing areca (betel) nut, at least during the Latte period.

**European contact**

Few studies have utilized skeletal samples from the Pacific to address the biological effects following initial contact between Pacific Islanders and Europeans. Pietrusewsky and Douglas (1994) examined the health of pre-contact (pre-1778) and historic burials from Hawai‘i, using a variety of skeletal and dental indicators of health including mortality and fertility data, adult stature, dental enamel hypoplasia, cribra orbitalia, trauma, degenerative joint disease, dental pathologies, and evidence of infection. Despite sampling issues, this study presented evidence of an anticipated deterioration in health of Hawaiians following contact with Europeans.

A study by Owsley et al. (1994) examined the biological effects of European contact on Easter Island using nearly 500 complete and partial skeletons. The study, while limited to a summary of traumatic injury, periosteal inflammation of the lower limb bones, and cranial morphology, documents some of the effects of interaction with Europeans.

**Paleodiet and subsistence**

Isotopic analysis of several burials from the first two field seasons of excavation at the Teouma Lapita site in Vanuatu indicated a diet consisting of marine resources supplemented with plants grown on local basaltic soils (Bentley et al., 2007). This same study further indicated that four of the individuals sampled were probably immigrants.

The number of studies designed to investigate paleodiet and subsistence are becoming more frequent in studies of Pacific skeletons (e.g., Kyle et al., 2009; Valentin et al., 2006; Valentin et al., 2010).
inhabitants of Remote Oceania and Polynesia. Thus far there are five sites (two in the Bismarck Archipelago region of Near Oceania and three in Eastern Melanesia in Remote Oceania) with skeletons associated with the Lapita culture (Table 2.1). Four additional sites, two each in New Caledonia and Fiji, have skeletons that immediately post-date the Lapita culture. Human skeletons from three sites once believed to be of Lapita age (e.g., Koné WK0-013A, New Caledonia; Wakea, Fiji; Pea Village, Tonga) have been determined to post-date the Lapita phase by a considerable margin (Petchey et al., 2010).

Of the five sites with Lapita burials, two date from the middle to late Lapita. The skeletons associated with the Lapita culture are generally poorly preserved and incomplete. Five of the nine sites with skeletons are represented by a single individual each. Very few of the skeletons have intact (or restored) crania, making craniometric comparisons using multivariate statistical procedures exceedingly difficult or impossible.

Initial summaries demonstrated a suite of dental, cranial, and infracranial skeletal traits (e.g., shovel-shaped incisors, rocker jaws, flattened upper femoral shafts, oval-shaped fovea, costoclavicular sulci, tall stature, etc.) in the Lapita and immediately post-Lapita skeletons; features that are common in most Pacific Island and Polynesian skeletons. Other traits (e.g., small tooth sizes, broad mandibles, and lack of strongly marked muscle attachments) observed in these skeletons appear much less characteristic of Polynesians.

Limited multivariate analyses, using mostly mandibular measurement data recorded in the Lapita skeletons and other Pacific Island samples (e.g., Pietrusewsky, 1985, 1989a, b), have not produced a consistent pattern of biological relationship. The Lapita skeletons invariably occupy isolated positions in these representations. Given the imperfect preservation of the Lapita skeletons and the fact that many postdate the Lapita horizon, it is not surprising that many show affinities with more modern inhabitants of Eastern Melanesia (Pietrusewsky, 2006a, b; Pietrusewsky et al., 1998). Until larger and better-preserved samples of Lapita crania and skeletons become available, determining biological relationships between the skeletons associated with this cultural horizon and the rest of the Pacific is not likely to change. The recent discovery of the early founding Lapita-age cemetery at the Teouma site on Vanuatu has substantially increased the number of Lapita skeletons, perhaps as many as 80 individuals. Future work with these skeletons will likely provide important new information on the earliest inhabitants of Remote Oceania.

Health, disease, and lifestyle of Pacific Islanders

Early osteological studies

Beginning in the 1950s, the first systematic archaeological excavations including the exhumation of human skeletons in the Pacific were underway. While the initial attention focused mainly on Polynesia, other regions of the Pacific, for example New Guinea, Melanesia, and the Mariana Islands, were eventually explored. Studies
<table>
<thead>
<tr>
<th>Site</th>
<th>Location</th>
<th>Completeness of skeletal remains</th>
<th>No. individuals</th>
<th>Dates (in years)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watom (site SAC)</td>
<td>Reber-Rakival, Watom Island, East New Britain Province, Papua New Guinea</td>
<td>Partial remains of 8 adults (6 male, 2 female) excavated by Specht, Green, and Anson and 6 burials excavated by Buckley and Anson in 2008 and 2009 (Buckley pers. comm.)</td>
<td>~14</td>
<td>Burial 1: 3000–2800 BP; burial 3 (2800–2200 BP) (Petchey et al., 2010)</td>
<td>(Green and Anson, 1987; Houghton, 1989c; Petchey and Green, 2005; Petchey et al., 2010; Pietrusewsky, 1989b; Specht, 1968)</td>
</tr>
<tr>
<td>Talepakemalai (ECA site)</td>
<td>Eloaua Island, Mussau Island, Emananus, and Mussau (or St. Matthias) Islands of the Bismarck Archipelago, Papua New Guinea</td>
<td>Fragmentary skeletal and dental remains representing several individuals from five (open, rockshelter, and small cave) hidden sites</td>
<td>No complete individuals</td>
<td>circa 1600–500 BC</td>
<td>(Kirch et al., 1989)</td>
</tr>
<tr>
<td>Teouma</td>
<td>Efate Is., central Vanuatu</td>
<td>Approximately 80 burials (34 burials directly dated)</td>
<td>~80</td>
<td>3200–3000 BP</td>
<td>(Bedford et al., 2006; Bedford et al., 2009)</td>
</tr>
<tr>
<td>Koné (site 13B)</td>
<td>Foué Bay, West coast Grande Terre, Koné, New Caledonia</td>
<td>Partial remains of at least 4 burials discovered in a pit in 2003</td>
<td>~4</td>
<td>Lapita-age</td>
<td>(Sand, 2010; Valentin et al., 2004)</td>
</tr>
<tr>
<td>Nuitabale</td>
<td>Moturiki Island, central Fiji</td>
<td>Skeleton of a 50–60-year-old female</td>
<td>1</td>
<td>Post-2650 cal BP (Petchey et al., 2010)</td>
<td>(Kumar et al., 2004; Nunn et al., 2007)</td>
</tr>
<tr>
<td>Koné (site 13B)</td>
<td>Foué Bay, West coast Grande Terre, Koné, New Caledonia</td>
<td>Substantially complete skeleton of a 35–45-year-old female: Burial WKO-013B</td>
<td>1</td>
<td>0–500 BC</td>
<td>(Dedane and Kasarherou, 1988; Pietrusewsky et al., 1998)</td>
</tr>
<tr>
<td>Koné (site 13) burial</td>
<td>Foué Bay, West coast Grande Terre, Koné, New Caledonia</td>
<td>Partially complete skeleton of a 30–40-year-old male</td>
<td>1</td>
<td>circa 2800 BP</td>
<td>(Valentin, 2003; Valentin and Sand, 2000, 2001)</td>
</tr>
<tr>
<td>Site</td>
<td>Location</td>
<td>Completeness of skeletal remains</td>
<td>No. individuals</td>
<td>Dates (in years)</td>
<td>References</td>
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<tr>
<td>Olo site (Y2–25)</td>
<td>Yalobi Village, Waya Island, Yasawa Group, Fiji</td>
<td>Relatively complete and well-preserved skeleton of a 40-50-year-old male</td>
<td>1</td>
<td>circa 2700 BP</td>
<td>(Pietrusewsky et al., 1997a; Pietrusewsky et al., 1997b)</td>
</tr>
<tr>
<td>Qaraniupuqa (site 197)</td>
<td>North coast Lakeba Island, Lau Group, Fiji</td>
<td>Charred and fragmented bone (burial 197-1-M-9)</td>
<td>1</td>
<td>2389±30 BP</td>
<td>(Best, 1977, 1984; Petchey et al., 2010)</td>
</tr>
<tr>
<td>Koné (site 13A)</td>
<td>Foué Bay, West coast Grande Terre, Koné, New Caledonia</td>
<td>Substantially complete and well-preserved skeleton (missing skull) of a 13-15-year-old juvenile</td>
<td>1</td>
<td>circa 1000 AD</td>
<td>(Valentin, 2003; Valentin and Sand, 2000, 2001)</td>
</tr>
<tr>
<td>Wakea (site 196)</td>
<td>North coast Lakeba Island, Lau Group, Fiji</td>
<td>Incomplete skeleton (burial 196-28-B8) &amp; secondary burial</td>
<td>2</td>
<td>671±30 BP; post-dates Lapita phase considerably</td>
<td>(Best, 1977, 1984; Houghton, 1989b; Petchey et al., 2010)</td>
</tr>
<tr>
<td>Pea Village (site To-1)</td>
<td>Pea Village, Tongatapu, Tonga (burial AK in pit AK, trench III)</td>
<td>Partially complete skeleton of a 30-35-year-old male and portions of a second male (30-35 years old)</td>
<td>2</td>
<td>After 2000 BP</td>
<td>(Houghton, 1989a; Petchey et al., 2010; Poulsen, 1987; Spennemann, 1987)</td>
</tr>
<tr>
<td>Sigatoka (site VL16/1)</td>
<td>Sigatoka, South coast Viti Levu, Fiji</td>
<td>Insufficient human bone material for testing and dating (Petchey et al., 2010)</td>
<td>~52 from main part of dune</td>
<td></td>
<td>(Best, 1987)</td>
</tr>
<tr>
<td>Natunuku (site VL1/1)</td>
<td>Natunuku, North coast Viti Levu, Fiji</td>
<td>A partially complete skeleton of an adult male</td>
<td>1</td>
<td>circa AD 200</td>
<td>(Pietrusewsky, 1985, 1989a; Shaw, 1975)</td>
</tr>
</tbody>
</table>
of these skeletal collections, until recently curated in museums and universities throughout the Pacific, resulted in publication of detailed analyses in skeletal biology and paleopathology. Although descriptive in nature, these early studies provided a baseline for understanding the health and lifestyle of the Pacific’s first inhabitants and provided much-needed context for later more issue-oriented research. Initial studies of skeletons from the Pacific include those by Murrill (1968), Pietrusewsky (1969a, 1976), Snow (1974), and Houghton (1980).

Rupert Murrill’s (1968) detailed descriptions of 33 adult skeletons from Easter Island recovered during Thor Heyerdahl’s archaeological expedition to Polynesia in 1955–56 was the first study of skeletons excavated from Easter Island and Polynesia. In addition to summarizing metric and non-metric variation and paleopathology in these skeletons, Murrill devoted nearly half of his report to a discussion of the origins and affinities of the Easter Islanders. Although the sample size is small and some sex estimates have been challenged (Baker and Gill, 1997), Murrill’s quantification of metric and non-metric variation and detailed descriptions of paleopathology set a standard for future work in the field.

One year later, Pietrusewsky published the results of his study of 99 human skeletons from two prehistoric burial mounds (To-At-1 and To-At-2) on the island of Tongatapu in the Tongan Islands (Pietrusewsky, 1969a). In addition to summarizing the morphological features recorded in the largest skeletal series from Western Polynesia, this analysis provided a systematic description and summary of the dental and skeletal pathology, including evidence of degenerative joint disease, treponemal disease (yaws), and trauma. This research was likely one of the first to use a mainframe computer to analyze skeletal data from the Pacific, including the application of modern multivariate statistical procedures.

Charles Snow’s description of more than 1,500 Hawaiian skeletons, many the result of systematic excavation that began in earnest in 1938 and extended to 1957 at Mōkapu on the island of Oahu, was undertaken between 1951–57 at Bishop Museum in Honolulu. This osteological study, published posthumously in 1974 (Snow, 1974), is the earliest and most extensive study of Polynesian skeletons. In addition to providing summaries of metric and non-metric observations, Snow presented wide-ranging information on paleopathology and cultural modifications observed in these individuals.

In a monograph Pietrusewsky (1976) summarized the human osteology of two skeletal series from the Pacific: one from Nebira, Papua New Guinea, and the other from the Hane Dune site, Marquesas. The Nebira hilltop site, dated from AD 1230–1650, located in Southern Papua New Guinea approximately 10 km inland from the coastline, contained 38 burials of all ages. Age, sex, metric, and non-metric features and summaries of dental and skeletal pathology were provided. Among the observations were two individuals with evidence of treponemal disease in the long limb bones, one individual with fused vertebrae suggesting tuberculosis, and several examples of cranial vault thickening and cribra orbitalia attributed to iron deficiency anemia.

Approximately 42 skeletons from the coastal Hane dune site on Uahuku Island, Marquesas Islands were excavated by Y. H. Sinoto of the Bishop Museum in
1964–65. Pietrusewsky (1976) summarized metric and non-metric variation and skeletal and dental paleopathology. Examples of paleopathology reported in these skeletons included trauma in six individuals, fused cervical vertebrae, cribra orbitalia, spondylolysis, and one case of extreme acetabular degeneration. Observations of musculoskeletal stress markers such as auditory exostoses, mandibular torus, costoclavicular sulcus, and squatting facets were also recorded.

Following closely on the heels of these initial analyses of Pacific skeletal series was the work of Philip Houghton at the University of Otago. Houghton’s primary interest was in the human biology of the Pacific including phenotypic adaptations of Polynesians, discussed earlier under Polynesian phenotype, and the health of the prehistoric New Zealand Maori, which he chronicled in two published books (Houghton, 1980, 1996b) and numerous other publications. Houghton (and colleagues) made several significant contributions to understanding Polynesian head and skull form, including the “rocker” jaw condition.

**Issue-oriented studies**

More recent work in the skeletal biology of the Pacific reveals a continued interest in providing detailed descriptions of skeletons from different regions of the Pacific, but also more research-oriented studies addressing specific questions regarding population history, lifestyle, diet, adaptive shifts, and other aspects of the health of the people. Some of the specialized topics investigated include the health of the founding colonists of the Pacific, cannibalism, mortuary practices, trauma, infectious diseases such as yaws, leprosy, and malaria; subadult health, musculoskeletal indicators of stress, cultural modification of skeletons, regional surveys of health, paleodiet and subsistence, and biological responses to European contact. Given the limitations of space, this survey will include a few examples of this work.

**Health among the earliest inhabitants of the Pacific**

While the number of Lapita and post-Lapita (see Table 2.1) skeletons from the Pacific has increased, with one or two exceptions, most sites are represented by a single skeleton. The notable exception is the Teouma site on Efate Island in Vanuatu, presently the oldest (ca. 3100–3200 BP) Lapita cemetery site. A preliminary report based on 36 individuals, who very likely represent the first few generations of human inhabitants of this island group, provided a glimpse of the health and lifestyle of these colonizers (Buckley et al., 2006). Although the age and sex distribution of the sample is uneven, the study identified a relatively high frequency of musculoskeletal injuries and other skeletal evidence consistent with a physically active lifestyle. The authors also reported the possible presence of infectious diseases in the skeletons from the Teouma site but no conclusive evidence of yaws. Moderately high frequencies of moderate dental wear, dental caries, and periodontal disease suggested a mixed diet. Overall, the authors concluded that the individuals in this sample, while suitably adapted to their island environment, lived physically demanding lives and
were affected by a significant disease burden. Buckley (2007) further reported the occurrence of erosive arthritis in seven individuals from the Teouma site whose differential diagnosis included gout, a significant health problem in modern Pacific Islanders. Scott et al. (2010) also reported the first case of a Lapita-period cremation from this site.

The oldest skeletons from the Western Pacific to date are the skeletons of 25 individuals from Chelechol ra Orrak in Palau examined by Nelson and Fitzpatrick (2006). This large rock shelter was used as a cemetery for approximately 1,000 years beginning around 3000 BP. The skeletons, although highly fragmentary, reveal evidence for degenerative joint disease, dental pathology, porotic hyperostosis, periostitis, and spondylolysis, and a glimpse into the lives of the inhabitants of this Pacific island.

**Cannibalism and mortuary behavior**

Human cannibalism has long intrigued anthropologists, who have documented it in skeletons, both recent and ancient, around the world. Following the general perception that Fijians practiced cannibalism, it is not surprising that this would be a topic addressed by researchers. One such study of human skeletons recovered in 1947 from the Navatu midden site on Viti Levu led DeGusta (1999) to conclude that the modifications in these individuals were indeed consistent with cannibalism. The key component of this analysis was the demonstration that human bone from the midden was modified similarly to non-human bone from the same midden. An analysis of modified human bone from a second site, Navatu, on Viti Levu, however, did not support the cannibalism hypothesis (DeGusta, 2000).

In 2001, the incomplete prehistoric skeleton of an adolescent was excavated from an earth-oven feature at the Qaranicagi cave site on Waya Island in the Republic of Fiji (Pietrusewsky et al., 2007). The skeleton was only minimally modified by heat suggesting that it was placed on top of the ash after a fire had recently been terminated. Although cut marks characteristic of butchering and quartering were present, the unique context of the burial (no midden) did not support the hypothesis of cannibalism.

This study expanded the range of documented mortuary behaviors of prehistoric Fijians and demonstrates the necessity of evaluating each case of possible cannibalism in its own context, as well as the need for more standards that can apply in unusual contexts or where there is no dietary non-human bone to use for comparison.

Other recent studies examining mortuary practices in the Pacific include descriptions of vandalized bones from the Hawaiian Islands (Pietrusewsky and Ikehara-Quebral, 1996), bone spear points associated with skeletons from the Mariana Islands (McNell, 2002), and other studies that examine mortuary practices in the Cook Islands (Anton and Steadman, 2003) and Papua New Guinea (Stodder and Reith, 2011).
Trauma, interpersonal violence, and warfare

Very few studies of Pacific skeletal assemblages have specifically addressed trauma, interpersonal violence and warfare. Pietrusewsky et al. (1997a) reported a frequency of just 0.6% healed limb bone fractures in a survey of skeletons from the Mariana Islands, suggesting very little deliberate or accidental injury during prehistoric times. Likewise, although low relative to worldwide frequencies, the reported prevalence of healed bone fractures in prehistoric Hawaiians (1.6%) was significantly higher than the frequency observed in prehistoric Chamorro (Pietrusewsky et al., 1997a).

Using a biocultural approach, Scott and Buckley (2010) reported evidence for interpersonal violence and warfare in skeletons from two Pacific archaeological sites, Nebira (Papua New Guinea) and Namu (Taumako Island, Southeastern Solomon Islands). The Nebira individuals, particularly males, exhibited significantly more postcranial fractures compared to the Taumako skeletons. Although not severe, the fractures sustained at Nebira were consistent with accidental injuries. On the other hand, the authors suggested that conflict or warfare could explain the relatively high prevalence of healed cranial trauma observed in the Nebira series. The frequency of trauma between males and females within each sample, however, was about the same.

Evidence of treponemal (yaws) infection

The first study that documented yaws in the Pacific was Stewart and Spoehr (1952) examining skeletons from the Mariana Islands. Given that yaws was the only documented treponemal disease among Pacific Islanders prior to Western contact (Stewart and Spoehr, 1952), it is not surprising that skeletal biologists working in the Pacific have focused their attention on documenting and differentiating this treponemal disease from other treponemal diseases. For example, Rothschild and colleagues (Rothschild and Heathcote, 1993; Rothschild and Rothschild, 1995) documented treponemal infection in skeletons from Guam and examined the complicated issues of differential diagnosis of treponemal diseases in skeletons. Using dry bone criteria established by the authors, Rothschild and Heathcote (1993) reported an incidence of yaws in the Gogna-Gun Beach skeletons from Guam of 18.8%. Although received with some skepticism (Heathcote et al., 1998), this attempt to establish accepted criteria for the diagnosis of yaws (versus syphilis and bejel) was an important step toward the call for standardized descriptive terminology, recognition of a pattern of disease both in the individual and in the population, and also contributed to the discussion on the evolution and epidemiology of treponemal diseases worldwide.

Further standardization of methods for differentiating treponemal lesions observed in skeletons from the Pacific is found in the work of Buckley and Tayles (2003a, b). As well as introducing new methods for differential diagnosis, the authors reported skeletal lesions consistent with yaws in 14/226 individuals from the Namu burial site on Taumako Island, Southeast Solomon Islands.
Other

Other specialized topics that have been investigated in Pacific skeletons include kava use (Visser, 1994), cranial modification (Stodder, 2006; Stodder and Reith, 2011), tooth ablation (Pietrusewsky and Douglas, 1993), leprosy (Trembly, 1995), malaria (Buckley, 2006), rocker jaws (Houghton, 1977), and torticollis (Douglas, 1991).

Cessation of skeletal biology in the Pacific

Between August 1987 and December 1988, during the construction of a luxury hotel at Honokahua, Maui, approximately 1,029 Native Hawaiian skeletons were disinterred from an ancient burial ground. The events surrounding the excavation of the Honokahua cemetery precipitated the initiation and implementation of strict burial legislation in Hawai‘i that has effectively made it impossible to analyze and study human skeletons older than 50 years in the state.

A preliminary osteological report on 712 skeletons from this site (Pietrusewsky et al., 1991) provided the most recent detailed summaries of metric and non-metric variation, including paleopathology, in Hawaiian skeletons since Snow’s study of the Mokapu skeletons completed two decades earlier. Included among the observations of paleopathology in the Honokahua skeletons was evidence for hydrocephaly, clubfoot, congenital muscular torticollis (wryneck syndrome), degenerative joint disease, limb bone fractures, and infectious diseases such as tuberculosis and congenital syphilis. While tuberculosis and syphilis are not believed to have been present in Hawai‘i prior to the arrival of European explorers beginning in 1778, some of the burials at this site may date to the Protohistoric Period.

Conclusions and future prospects

Beginning with anecdotal reports by early explorers and the first descriptive accounts of crania and skeletons from the Pacific in the early decades of the nineteenth century, there has been a continued interest in studies of skeletal biology and bioarchaeology of the inhabitants of the Pacific. Focus on the biological relationships of Pacific peoples and their origins dominated the earliest research in this field, studies that were hampered by a flawed theory and methodology. Refinements in theory and methods, primarily drawn from quantitative genetics and population genetics, radically transformed and advanced our understanding of morphological (and especially cranial) variation, evolution, and population history. As demonstrated in this review, recent studies that apply multivariate statistics to craniometric and other kinds of data have made great advances in understanding the peopling of the Pacific, Polynesian origins, and the population structure of individual islands. Despite these advances, the observation of two major divisions of Pacific Islanders made by the first Europeans is at least partially corroborated.

Coinciding with the advent of archaeological excavations beginning in the mid-nineteenth century in the Pacific, comprehensive osteological analyses of larger
skeletal series were published. These early descriptive studies allowed the first summaries of skeletal and dental variation as well as paleopathology of prehistoric inhabitants of the Pacific. Later work in osteology and skeletal biology, which continues to the present, coincides with Cultural Resources Management (CRM) mitigation studies. Although interest in biological distance studies continues, recent work in the fields of skeletal biology and bioarchaeology has increasingly focused on more specialized issues that inform on the health and lifestyle of Pacific islanders. While studies of human skeletons, especially those from Remote Oceania, generally indicate they enjoyed relatively good health, there is also ample evidence that prehistoric Pacific Islanders suffered from childhood stress, iron deficiency anemia, limb bone fractures and other kinds of trauma, degenerative joint diseases, gout, and for the Western and central Pacific, infectious diseases such as yaws and malaria. These studies also reveal tantalizing mysteries including whether diseases such as syphilis, leprosy, and tuberculosis were present before the first European explorers and visitors.

The recent discoveries at the Teouma site in Vanuatu demonstrate that skeletal biologists have recognized the importance of Lapita and post-Lapita skeletons for understanding the colonizers of Remote Oceania and their ancestors in Near Oceania and beyond. Because of strict burial laws and repatriation claims, opportunities for studies of skeletons in some parts of the Pacific (e.g., Hawai‘i and New Zealand) are now largely nonexistent. Gaps in the record remain, such as in Western (Tonga and Samoa), Central (e.g., Cook Islands), and Eastern Polynesia (e.g., Society Islands, Marquesas) where less archaeological research has been done and relatively few skeletons are available for study.

Examination of archaeological human skeletons associated with the Lapita cultural tradition as well as skeletons from other parts of the Pacific (e.g., Mariana Islands) are expected to continue, often with the active support of the native inhabitants who wish to learn about their ancestors.

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References


