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REPORT OF SEGREGATION:
Tarawa Sequence 98

Version 1

DPAA LABORATORY

13 March 2018

The assemblage associated with Tarawa Sequence 98 consists of skeletal elements listed in Table 1 (depicted in Figure 1). Three elements from this assemblage share the same mitochondrial DNA (mtDNA) sequence including two teeth (tooth #9 and tooth #11) and a right tibia. The remaining elements are consistent with a single individual and have been associated with the sampled elements through shared provenience, sound anatomical articulation, pair matching, osteometric sorting, trauma, morphology, and the refitting of fragmented elements. According to data charts generated by the Armed Forces DNA Identification Laboratory (AFDIL), as of 20 February 2018, these are the only elements in the Tarawa Project assemblage associated with this mtDNA sequence.

Origin of remains:

1) The elements accessioned as CIL 2017-072 were originally buried in Cemetery 33, Betio Island, Tarawa Atoll, Republic of Kiribati (formerly Gilbert Islands), shortly after the Battle of Tarawa in November 1943. The remains were disinterred from Cemetery 33, designated as Unknown X-082, and moved to Lone Palm Cemetery on Betio Island on 22 March 1946, during cemetery consolidation efforts by the American Graves Registration Services (AGRS).[1] The remains were disinterred from Lone Palm Cemetery on 20 December 1946,[2] and reinterred at the Schofield Mausoleum # 1, Oahu, Hawaii, on 13 January 1947.[3] Under continued cemetery consolidation efforts, the remains were moved to the National Memorial Cemetery of the Pacific (NMCP) on 23 March 1949.[4] The remains were disinterred from the NMCP and accessioned into the DPAA Laboratory on 27 February 2017 for analysis and identification.

2) Elements accessioned as CIL 2013-186 were purportedly excavated from Cemetery 33, Betio Island, Tarawa Atoll, Republic of Kiribati, by History Flight, Inc., and received at the DPAA Laboratory (then JPAC-CIL) on 19 September 2013.[5] These elements were

[1] WD QMC Form 1042. REPORT OF INTERMENT, dtd 26 March 1946. X-082 file.
[2] QMC FORM 1044. REPORT OF DISINTERMENT FOR IDENTIFICATION, dtd 20 December 1946. X-082 file.
[3] WD QMC Form 1042. REPORT OF INTERMENT, dtd 13 February 1947. X-082 file.
[4] QMC FORM 1194. DISINTERMENT DIRECTIVE, dtd 15 October 1947. X-082 file.
[5] History Flight Excavation Report on the recovery of Pfc Randolph Allen, dtd 19 January 2014.

Table 1. Remains associated with Tarawa Sequence 98.			
Skeletal Element	**Designator**	**Association**	**Purported Origin**
Cranium	2017-072/X-082/101	Ac, Ar, Mo, Re, Tr	Cemetery 33; NMCP
Cranial fragments	2017-072/X-082/102	Ac, Mo, Re, Tr	Cemetery 33; NMCP
Tooth #9§	2013-186/2014H-0507/84A	mtDNA, Ar, Pr	Cemetery 33
Tooth #11§	2013-186/2014H-0507/87A	mtDNA, Ar, Pr	Cemetery 33
Maxillary fragment with 5 teeth	2013-186/HF T-23/107	Ar, Pr	Cemetery 33
Mandible with 9 teeth	2017-072/X-082/103	Ac, Ar, Mo, Tr	Cemetery 33; NMCP
Tooth #27	2017-072/X-082/02A	Ac, Ar	Cemetery 33; NMCP
Hyoid (body and left wing)	2017-072/X-082/104	Ac	Cemetery 33; NMCP
Ossified thyroid cartilage	2017-072/X-082/105	Ac	Cemetery 33; NMCP
Ossified cricoid cartilage	2017-072/X-082/106	Ac	Cemetery 33; NMCP
Vertebrae (C1 and C2)	2017-072/X-082/801	Ar, Ar, Mo	Cemetery 33; NMCP
Vertebrae (C4–T3)	2017-072/X-082/802	Ar, Ar, Mo	Cemetery 33; NMCP
Vertebrae (T4–T12)	2017-072/X-082/803	Ar, Ar, Mo	Cemetery 33; NMCP
Vertebrae (L1–L5)	2017-072/X-082/804	Ar, Ar, Mo	Cemetery 33; NMCP
Sternum	2017-072/X-082/701	Ac, Mo	Cemetery 33; NMCP
Left ribs (1-12)	2017-072/X-082/702	Ac, Ar, Mo	Cemetery 33; NMCP
Right ribs (rib 8 absent)	2017-072/X-082/703	Ac, Ar, Mo	Cemetery 33; NMCP
Left clavicle	2017-072/X-082/601	Ac, Pm, Mo	Cemetery 33; NMCP
Right clavicle	2017-072/X-082/602	Ac, Pm, Mo	Cemetery 33; NMCP
Left scapula	2017-072/X-082/603	Ac, Pm, Mo	Cemetery 33; NMCP
Right scapula	2017-072/X-082/604	Ac, Pm, Mo	Cemetery 33; NMCP
Left humerus	2017-072/X-082/201	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Right humerus	2017-072/X-082/202	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Left radius	2017-072/X-082/203	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Right radius	2017-072/X-082/204	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Left ulna	2017-072/X-082/205	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Right ulna	2017-072/X-082/206	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Right carpals*	2017-072/X-082/301	Ac, Ar, Mo	Cemetery 33; NMCP
Right carpals†	2013-186/HF T-15W/304	Ar, Mo, Pr	Cemetery 33
Right metacarpals (1-5)	2017-072/X-082/302	Ac, Ar, Mo	Cemetery 33; NMCP
Manual phalanges**	2017-072/X-082/303	Ac, Mo	Cemetery 33; NMCP
Left innominate	2017-072/X-082/901	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Right innominate	2017-072/X-082/902	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Sacrum	2017-072/X-082/903	Ac, Ar, Mo	Cemetery 33; NMCP
Left femur	2017-072/X-082/401	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Right femur	2017-072/X-082/402	Ac, Ar, Pm, Mo, Tr	Cemetery 33; NMCP
Right femoral fragment	2013-186/HF T-15W/409	Mo, Re, Tr	Cemetery 33
Left tibia	2017-072/X-082/403	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Right tibia§	2017-072/X-082/01A-B	Ac, Pm, Mo, mtDNA	Cemetery 33; NMCP
Left fibula	2017-072/X-082/405	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Right fibula	2017-072/X-082/406	Ac, Ar, Pm, Mo	Cemetery 33; NMCP
Left patella	2013-186/HF T-15W/408	Ar, Pm, Mo, Pr	Cemetery 33
Right patella	2017-072/X-082/407	Ac, Pm, Mo	Cemetery 33; NMCP
Left foot	2013-186/HF T-15W/501	Ar, Pm, Mo, Pr	Cemetery 33
Right foot	2013-186/HF T-15W/502	Ar, Pm, Mo, Pr	Cemetery 33

Table 1 (continued). Remains associated with Tarawa Sequence 98.			
Skeletal Element	**Designator**	**Association**	**Purported Origin**
Unsided pedal phalanges (15)††	2013-186/HF T-15W/503	Pr	Cemetery 33
Pedal sesamoids (2)	2013-186/HF T-15W/504	Pr	Cemetery 33
Miscellaneous bone fragments	2017-072/X-082/1000	Ac	Cemetery 33; NMCP

Associations: Ac = Accession, Ar = Articulation, Pm = Pair match, Mo = Morphology, mtDNA = shared mtDNA sequence, Pr = Provenience, Re = Refit, Tr = Trauma.
δElements sampled for DNA testing.
**Consists of triquetral, capitate, and hamate.*
†Consists of scaphoid and lunate.
***Consists of a proximal manual phalanx (first ray), a proximal manual phalanx, and an intermediate manual phalanx.*
†† Consists of eight proximal pedal phalanges, 5 intermediate pedal phalanges, and two distal pedal phalanges.

likely never recovered from Cemetery 33 during the original cemetery consolidation efforts.

Based on skeletal and DNA analysis, the following assessments have been made:

1) Minimum number of individuals (MNI) is one based on the lack of the duplicated elements within Tarawa Sequence 98. The elements within this sequence are consistent with a single individual through shared provenience, sound anatomical articulation, pair matching, osteometric sorting, trauma, morphology, and the refitting of fragmented elements.

2) The elements from this assemblage that have been sampled for DNA testing include two teeth (tooth #9 and tooth #11), and a right tibia. The mtDNA sequence associated with this assemblage is a rare sequence in the AFDIL population database (n=3/10,428).

3) Physical articulations were made between elements that match Tarawa sequence 98. Sound physical articulations were found with the cranium and mandible, and between the cranium and the first cervical (C1) vertebra. C1 has sound anatomical articulation with C2. The vertebral column ranging from C4 to the fifth lumbar (L5) vertebra has reliable articulation between vertebrae, and with the sacrum. The ribs articulate well with their corresponding thoracic vertebrae. The humeri appear to articulate well with the scapulae. The humeri articulate with their corresponding radius and ulna. The carpals and metacarpals present for Tarawa Sequence 98 have sound physical articulation to each other and to the right radius. The sacrum articulates with the innominate bones, which then articulate with the left and right femora. The left patella and left tibia articulate well with the left femur. The foot elements have sound anatomical articulation with their corresponding tibiae. In addition, the left talus exhibits modification, flattening, and elongation along the tibial articular surface which may correspond with the healed antemortem fracture of the distal left tibia.

4) The elements that visually pair match within Tarawa Sequence 98 are from accession CIL 2017-072 (X-082) and include the clavicles, scapulae, humeri, innominate bones, femora, tibiae, and patellae. Visually these elements share a similar morphology and appear to be of similar size. The humeri were compared statistically, which further supports the association of these elements due to their similar size (see Table 2).

5) Osteometric sorting was undertaken to further compare the right humerus and left femur from CIL 2017-072 (Lynch 2017). Specifically, the results provide an R-squared value of 0.909 and a p-value of 0.359. The regression analysis (presented in Figure 2) indicates that the femur cannot be statistically segregated from elements associated with Tarawa Sequence 98 and therefore are of sufficiently similar proportion to have originated from a single individual.

6) Several elements associated with Tarawa Sequence 98 came from CIL 2013-186. These elements share a common provenience and were recovered from Trenches 23 and 15W by History Flight, Inc. in the purported area of Cemetery 33. Tooth #9 and Tooth #11 are from CIL 2013-186 (Trench 23) and they share the same mtDNA sequence as Tarawa Sequence 98. These teeth articulate with the respective alveolus in a maxillary fragment containing five additional teeth. Two right carpals, the scaphoid and lunate, came from CIL 2013-186, were excavated from Trench 15W, and articulate with the radius, triquetral, and capitate from the NMCP disinterment, CIL 2017-072. A fragment of the right femur that came from CIL 2013-186 (Trench 15W) and refits with the proximal femur of CIL 2017-072. The foot elements are from the History Flight, Inc. field recovery and were excavated within boots from Trench 15W. The elements of the left and right feet came from CIL 2013-186 (Trench 15W) and articulate amongst themselves and with their respective tibia and fibula from CIL 2017-072. The unsided foot phalanges share the same provenience as they were recovered in situ and removed from the boots from which they were found. The siding provenience of the foot phalanges was lost upon transport from the field to the laboratory. The entire CIL 2013-186 Trench 15W and 23 assemblages was examined because of these associations through shared provenience, however, no additional elements could be incorporated into Tarawa Sequence 98.

7) Elements from this sequence display varying taphonomic signatures. The majority of the remains are from accession CIL 2017-072 (X-082) and are mottled light-brown to dark-brown in color with remnants of white preservative powder present. The elements from CIL 2013-186 consist of maxillary fragment containing five teeth plus teeth #9 and #11 which were sampled for DNA, carpals from the right hand, a refitting right femoral fragment, and a left patella, which are light brown-gray in color and have a dry appearance with minor erosion. In addition, foot elements present from CIL 2013-186 have minor erosion, dry appearance, and are stained dark brown because they were excavated from boots in the field. These varying taphonomic signatures make taphonomy an unreliable means of segregation.

8) The remains are in a good state of preservation. Postmortem damage is present along the iliac crest of the innominates and femoral heads. Minor postmortem damage is seen along areas of thin cortical bone and at long bone epiphyses. The cranium is highly fragmented due to perimortem trauma. A limited number of biological determinations

are possible including sex and age. Ancestry estimation is limited due to the fragmented nature of the cranium.

9) Biological determinations are as follows:

   a. Male. The subpubic region of the innominate bones exhibit a lack of a subpubic concavity (score of 3), no ventral arc (score of 3), and a blunt ischiopubic ramus ridge (score of 3) following Phenice (1969). The traits of Phenice (1969) have a 96% level of accuracy in the determination of sex. The left and right greater sciatic notches are rather narrow (scores of 4) Buikstra and Ubelaker (1994). The scores for the greater sciatic notches have a 93% probability of being male (Walker 2005). Following Buikstra and Ubelaker (1994), the traits of the skull used to determine sex include the supraorbital margins (scores of 3), nuchal crest (score of 4), mastoid process (scores of 5), and mental eminence (score of 4). The scores for the skull and pelvis are consistent with a male individual.

   b. 23 to 39. Age at death was estimated from the medial epiphyses of the left and right clavicles, and from pubic symphysis morphology. The left and right clavicles exhibit different stages of development. The left medial clavicle epiphysis exhibits recent fusion (Stage 3) following McKern and Stewart (1957), which is consistent with an age range of 20–30 years. The right medial clavicle epiphysis exhibits full fusion (Stage 4) following McKern and Stewart (1957) and is consistent with an individual greater than 23 years of age. The scoring of the pubic symphysis was done following McKern and Stewart (1957). The left and right pubic symphyses differ in their morphology in regards to Component I, the dorsal demi-face. The plateau of the left pubic symphysis exhibits vestiges of billowing that extends over most of the dorsal demi-face (Stage 4). Whereas billowing has disappeared completely on the surface and the entire dorsal demi-face has become flat and slightly granulated in texture on the right pubic symphysis (Stage 5). The left and right pubic symphyses exhibit the same morphology for Components II and III. Component II exhibits an extensive ventral rampart, but gaps are still present along the earlier ventral border most evident in the upper two thirds (Stage 4). Component III is a Stage 2 morphology, the dorsal rim is complete and the ventral rim is beginning to form. The morphology of the left and right pubic symphyses provided composite scores of 10 and 11, respectively. According to McKern and Stewart (1957) the composite score for the left pubic symphysis is consistent with an individual with a mean age of 26.05 years and a range of 22.31 to 29.79 years. While the mean age for the composite score of the right pubic symphysis is consistent with an individual 29.18 years of age and a range of 22.52 to 35.84 years. The estimated age range is 23 to 39 years of age based on the age range of the right pubic symphysis. There is no skeletal evidence to support the individual is younger than 23 years of age.

   c. Probable European. Morphoscopic traits and cranial measurements are not present due to possible perimortem trauma. The platymeric index of the sub-trachanteric morphology of the left femur indicates the individual has a eurymeric morphology with a platymeric index of 88.5. This morphology suggests the

individual is Black or White (Westcott 2005). A two way discriminant function analysis comparison of the post cranial remains between Black males and White males using *FORDISC 3* (Jantz and Ousley 2005). The results indicate the individual groups closest to White males with a Posterior Probability of 0.924, F-typicality of 0.601, and cross validation of 94.4%. Discriminant function analysis of the post cranial remains is limited because data is only present for Black and White individuals.

d. 71.0 to 76.0 inches. A stature of 73.5 ± 2.5 inches was estimated from the maximum and bicondylar lengths of the right femur (483 mm and 479 mm), and the maximum length of the left ulna (295 mm). The estimate was calculated using *FORDISC 3* with a 95% prediction interval and the Trotter M Stats White male dataset (Jantz and Ousley 2005).

10) Possible perimortem trauma is present on the cranium. The facial skeleton is highly fragmentary and many elements are absent, which prevents refitting the fragments. The left side of the cranial vault is mostly present, and was refit and stabilized using tape. Possible trauma is present on the rami of the mandible. Possible trauma is present on the right distal femur. Possible perimortem trauma is present throughout the ribs, but postmortem damage obscures the defects.

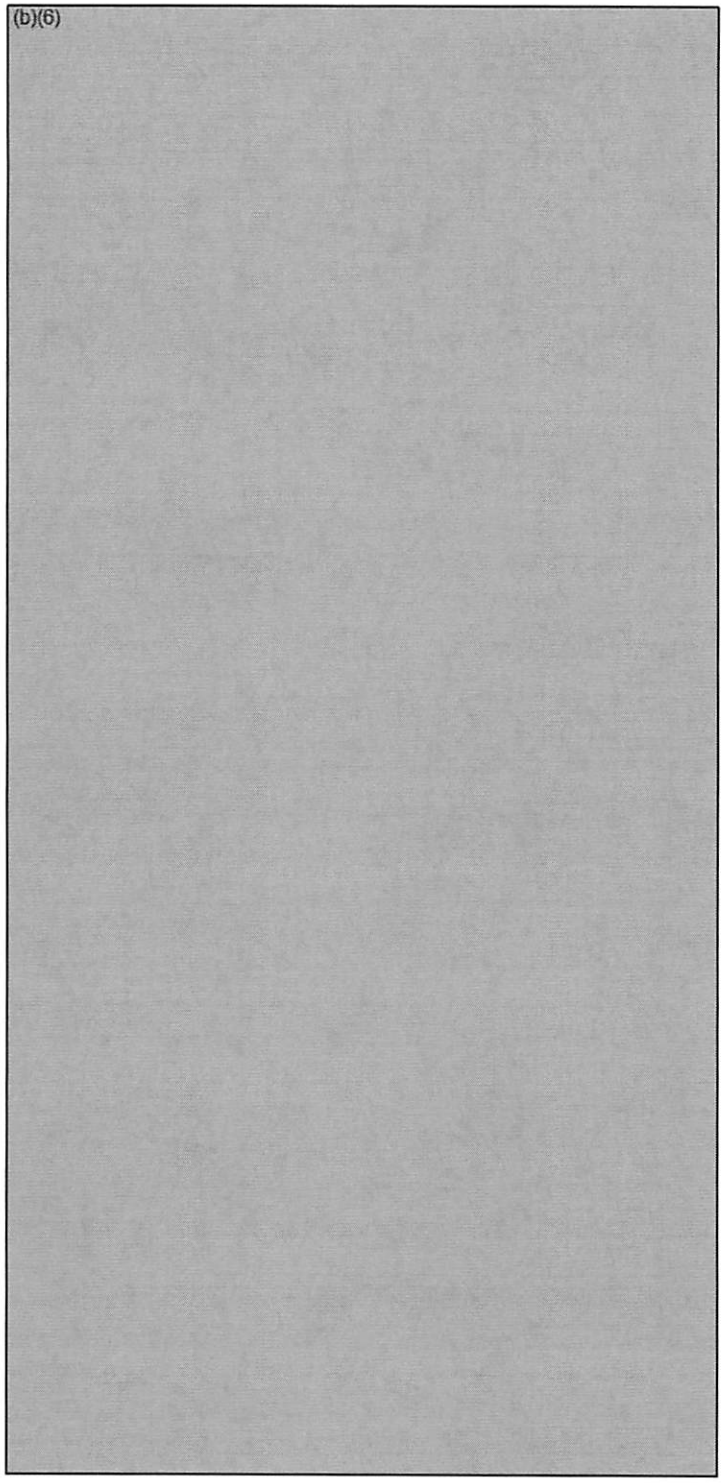

Figure 1. Remains associated with Tarawa Sequence 98. Associations between elements are depicted (yellow arrows indicate pair matches, red circles/arrows indicate articulations, red stars indicate association via osteometric sorting; V = visual, S = statistical, Re = Refit, and Pr = Provenience). Elements in petri-dishes are associated cranial and miscellaneous bone fragments. Tooth #27 is not depicted. Tape was found adhering to the right tibia. Scale is in decimeters.

Table 2. Tarawa Sequence 98, osteometric sorting t-test results for pair matching.							
Element Information		**Measurements**		**Summary Statistics**			**Result**
Designator	**Element**	**Measurement**	**Values (mm)**	**N**	**S.D.**	**P-value**	**Accept/Reject Association**
2017-072/ X-082/201	Left humerus	40, 41, 42, 43, 44	379, 68, 52, 24, 20	137	0.3492	0.4188	Cannot Exclude
2017-072/ X-082/202	Right humerus		376, 68, 52, 26, 22				

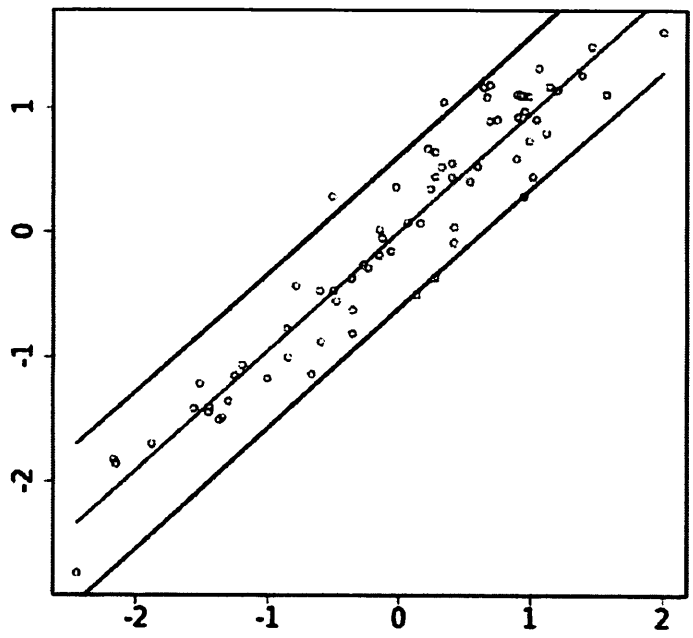

Figure 2. Osteometric sorting regression plot. The blue lines represent the 95% confidence interval (Lynch 2017). The individual associated with Tarawa Sequence 98 is not present in the plot due to their large stature.

Recommendations

In my opinion, the remains originating from CIL 2017-072 (Tarawa X-082) and associated with elements coming from CIL 2013-186 comprise one individual based on the lack of duplicated elements. The elements within Tarawa Sequence 98 share an mtDNA sequence and are consistent with a single individual through shared provenience, sound anatomical articulation, pair matching, osteometric sorting, trauma, morphology, and the refitting of fragmented elements. Therefore the identification potential is high and consolidation of the remains listed in Table 1 and depicted in Figure 1 is recommended into CIL 2017-072-I-01. Further analysis of the Tarawa Project commingled assemblage may produce additional elements that can be associated with this accession.

(b)(6)

PhD

Anthropologist

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