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Early Skeletons from Tranquillity, California

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By J. Lawrence Angel

Introduction

New World discoveries of human remains associated with those of extinct animals have been disappointing in two ways: First, contemporaneity of men and Pleistocene mammals has had to be inferred rather than stratigraphically proved; second, the human remains have been within the wide range of recent American Indian physical types. The Midland woman (Wendorf, Krieger, Albritton, and Stewart, 1955) forms an exception to the first half of this rule and the Tranquillity material forms a partial exception since close similarity in fluorine, carbon, nitrogen, and water content between *Camelops*, *Equus*, *Bison*, and the human bones (Heizer and Cook, 1952) makes the inference of contemporaneity a strong one. All the human bone from Tranquillity turned over to me for study is heavy, partly mineralized, and purple-brown to black in color. Hewes (1946) notes that ". . . almost all bone, including artifacts of this material, has remarkably increased density, increased hardness, and a purplish-gray to nearly bluish-black color; mineralogically the replacement is collophane, a form of calcium phosphate."

Tranquillity, Calif., is in the Central San Joaquin Valley about 24 miles west of Fresno (between Kerman and Mendota). The Tranquillity site is 2½ miles northeast of the town, in the floor of the valley in a zone where changes of drainage between the Kings and San Joaquin Rivers systems have formed long sloughs. A bypass canal for the main slough formed a small slough, about 50 x 500 feet in size, through erosion caused when a levee was added on the north side of the canal in 1937–38. This erosion exposed and partly disturbed occupation remains and burials on a soil level slightly above the Fresno hardpan, on the hardpan, and lower (burial and one pit). Gordon W. Hewes and William C. Massey and their wives discovered and excavated the site in 1939–42 for the University of California, and Linton Satterthwaite and Malcolm Lloyd excavated further in 1944 for the University Museum of the University of Pennsylvania. Except for materials with the burials, the floodwater which exposed the site also moved practically all of the artifacts found, even fragments of mortars and metates (Hewes, 1943, 1946). Chester Stock and R. A. Stirton identified the animal bones, including the extinct species.

The skeletons were carefully excavated under difficult soil conditions by Gordon Hewes (1943, 1946) and by Linton Satterthwaite. This care has preserved every discoverable fragment derived from over 30 individuals, of whom 3 male and 4 female adults are usably complete. I had the chance to study all the skeletal material in 1944 through the kindness of Dr. G. C. Vaillant and Dr. L. Satterthwaite, of the University Museum in Philadelphia, and of Dr. A. L. Kroeber, Dr. T. D. McCown, E. W. Gifford, and G. W. Hewes, of the University of California Museum of Anthropology in Berkeley. The California group (UCMA) sent their material to the University Museum (UM) in Philadelphia for study. I am most grateful to these anthropologists for making the material available. For advice and criticism, I also thank Drs. T. D. Stewart, R. F. Heizer, and R.W. Newman in addition to Hewes and Satterthwaite.

Dr. Satterthwaite has postponed reporting his results until a carbon-14 or a geologic date is available since he feels that a break in the hardpan layer from recent erosion in the slough at Tranquillity prevents perfect proof of contemporaneity of *Camelops* with human bones on opposite sides of this recent break. My report was to have been appended to Satterthwaite's. I am publishing it now separately for two reasons: first, I think that contemporaneity of the extinct mammal and human bones has been virtually proved by Heizer and Cook (1952) and I note that Wormington (1957), Beals and Hoijer (1959), and others, accept this as highly probable; second, it seems to me that contemporaneity is the simplest explanation according to Hewes' (1946) report. I hope that publication will stimulate interest in obtaining absolute datings, preferably by carbon-14 on newly excavated charcoal, for this and other California sites which culturally seem to antedate the Early horizon as defined by Kroeber (1938), Heizer (1949), Wedel (1941), and others.

The Early cultural horizon lasts at least until 2,000 B.C. (Heizer and Baumhoff, 1956) but its beginning is less certain, although Heizer's guess of 5,000 B.C. based on (Californian) *Olivella* shell beads in the Leonard rock shelter site in west central Nevada seems now much more probable than Sauer's guess of 13,000 B.C. (Kroeber, 1938). Heizer (1952) notes further that the Tranquillity site presumably antedates this and may belong to the transitional warming-up period after the "end" of the Würm–Wisconsin glaciation's final (Mankato) phase, in spite of his observation that some (unspecified) Tranquillity artifacts resemble those of the Middle horizon. I cannot follow this latter part of his argument, since comparison of published descriptions by Hewes (1946) and Heizer (1949) suggests that the Tranquillity artifacts (flaked projectile points, knives, bone points, mano and metate, mortar and pestle, blades, drills, scrapers, charmstone, quartz crystal, *Olivella* beads, asphalt, bone daggers and spatulae, evidence for stick and tule shelters) represent a somewhat substandard version of those of the Early horizon and that the only major difference is in Tranquillity's semiflexed rather than extended and prone burial position. Tranquillity culture is certainly interpretable as an earlier version of the Early horizon as established 50 to 100 miles to the north, and in the south at Buena Vista Lake (Wedel, 1941). Tranquillity should, in this case, long antedate the wet phase of high lake levels and it is possible that later (i.e., Early and Middle horizon) sites lie beneath the southern San Joaquin Valley silt. Certainly Heizer's (1952) suggestion of an early or pre-Anathermal date for Tranquillity and for early man in California fits the results of recent excavations of the University of Wisconsin in the Aleutian region which give Laughlin (1963) a date of 6,000 B.C. for the microlith producing site on Anangula and 9,000 B.C. for the last phases of the Bering platform which would have served as a dry migration route. Hester's (1960) synthesis of carbon-14 dates for the extinction of Pleistocene mammals likewise suggests a late Pleistocene to earliest postglacial date for the Tranquillity site; during the dry postglacial phase of climate the San Joaquin Valley could have served as a refuge area for such herd mammals as camel, horse, and extinct bison before and perhaps even after 6,000 B.C. when they became extinct on the Plains.

Ecology and Health

At present the annual rainfall is only 6 inches (Hewes, 1946), with a salt desert shrub vegetation around the water courses and sloughs, where willows and cottonwoods (but no oaks) grow sparsely. In the postglacial dry phase the climate would have been comparable to this, with the water in the tule swamps serving as a supply for herds of Plains ungulates and other fauna.

The Tranquillity hunters plausibly ate flesh of game stalked in and around the tule swamps and killed with spears having obsidian, chert, or bone points and thrown with the atlatl. Besides camel, horse, and bison, Hewes (1946) lists tule elk, antelope, coyote, fox, badger, jackrabbit, mole, and gopher, noting that the larger mammals were probably brought as a result of hunting activities, and that the paucity of birdbones is surprising. The *Camelops* remains include two mandibles, an astragalus, and tooth fragments; the horse remains are teeth only; and the *Bison* remains include teeth and an orbital fragment. These (heads and feet) may represent food and flint-flaking tools carried home, since long bones would be left at the site of butchering. These remains of extinct mammals antedate some of the human burials—one *Camelops* jaw was cemented to the Fresno hardpan as it formed, while burials were cut through hardpan or down to the equivalent level and hence made from a level at or above hardpan, and tools occurred directly on the hardpan. However, the simplest explanation of all the bones of large mammals is that hunters brought them to this site which may have been occupied over a considerable period.

Numerous oval manos and some metate fragments suggest that vegetable food (seeds ?) was an important part of the diet. Mortars and pestles point in the same direction, perhaps indicating preparation of roots or other softer food; this is outside the presumable acorn area.

There are no actual remains of baskets, though impressions in burned clay of tule leaves and fibers suggest matting. Hewes (1946) notes impressions of sticks and poles as suggesting structures, and a pit which probably contained hearth ashes. The whole picture is of a small village whose occupants lived both by hunting and food gathering in a tule marsh oasis variably rich in game and plant food.

There is plenty of evidence that they led strenuous lives. All four preserved vertebral columns show fully developed hypertrophic arthritis in cervical and lumbar regions and one shows a healed fracture at waist level plus herniation of the disk nucleus into the body of the fourth lumbar vertebra. This degree of wear and tear of the disks and ligaments at the age of 25–40 is typical of hardworking populations (Gejvall, 1960, ch. VIII; Nathan, 1962; Stewart, 1958) and one or two decades ahead of our vertebral column aging. There is no arthritis of hip, knee, or ankle (n=10). There is one arthritic foot, two slightly arthritic shoulder joints (n=8), and one arthritic hand (n=7) as well as a well-healed wrist fracture. But 6 of 13 people have arthritis in the elbow joint (pl. 2), usually including eburnation after friction removal of cartilage over the capitulum. This is the "ball" against which the concave upper surface of the head of the radius rubs both during flexion and extension of the elbow and pronation and supination of the hand and forearm. What repeated and stressful action combines those movements? One thinks at once of a baseball pitcher or javelin thrower, except that this equally strains the shoulder and clavicular joints. Dr. Henry Collins (personal communication) has pointed out that use of the atlatl by Eskimo or Aleut allows the hunter to throw without extending and abducting the shoulder: the extra lever arm gives a strong throw from elbow extension alone (plus a forearm twist) and such a throw is considerably quicker. A hunter in a kayak or stalking an animal through tall rushes must shoot the second he sees his quarry and he can do so with the spear thrower (or bow or rifle), but not with a shoulder-action spear throw. The spear thrower, of course, puts extra stress on the arm muscles and elbow. Hence it seems logical to describe this special pathological change as "atlatl elbow." Laughlin (1963), Stewart, Merbs, and others have noted it among the Alaskan Eskimo and Aleut. It is less frequent in female skeletons. But it does occur in two out of four Tranquillity females even though the arthritic lipping is slight. Possibly seed-grinding has some effect. It is equally likely that a genetic weakness or avascularity of the joint plays a part in small and isolated populations. This is given point by the frequency of a similar elbow avascular necrosis in baseball playing Japanese, as opposed to Westerners (Nagura, 1960).

The Tranquillity people show other postural specializations in the frequency of flexion facets at the ankle (80 percent) and in retroversion of the tibia in two out of four cases. Together with the marked femoral pilaster and platymeria, these suggest active running in rough terrain. In five out of nine cases the olecranon fossa floor is perforated, a condition supposedly linked with elbow hyperextensibility. As expected, four of these five cases are female. This may relate to the general "economy of bone" which the Tranquillity skeletons show: the shafts of all long bones are flattened about to the degree seen in Old World Paleolithic and other hunting populations and often show a sinuosity and extra sharpness of muscle attachments which approach the bowing of sabre tibia seen in actual malnutrition. The suprasacral fossae seen in 80 percent of ilia may also reflect bone economy or, more likely, an inherited postural specialization. It is not possible to tell if the teeth show growth arrests in the enamel because of extreme wear. This tooth wear apparently amounted to 0.25–0.30 mm. per year loss of crown height in permanent teeth and is definitely greater than the 0.20 mm. annual rate seen in the Hotu late Upper Paleolithic skulls (Angel, 1952). Milk teeth wore faster (pl. 2), and lower teeth outlasted upper teeth. This wear points to a diet bulky in animal fibrous tissue and vegetable fiber, little softened by cooking and probably not rich, agreeing with the indication on economy of bone. Yet growth was by no means stunted, since the estimated male stature (170.5 cm.) is tall, exceeding that of modern California Indians in general.

Tooth wear of the degree just described tends to exceed the rate at which secondary dentine can be laid down and hence allows carious lesions to penetrate the pulp and root canal, giving rise to periapical abscesses and subsequent loss of affected teeth. There is also much chewing stress on roots and high incidence of paradontal disease. This was present in all Tranquillity mouths and likewise led to abscess formation. In the seven mouths available for study, 11.4 teeth per mouth were lost in life, 5.0 were abscessed, and 2.0 were carious. The caries rate is artificially lowered by loss of 13.3 teeth per mouth after death, leaving 7.3 teeth on which caries or wear can be judged. In making these calculations, the data from one palate (6073 UCMA) and two isolated mandibles (6075 a UCMA and 6334 plus B-31) have been doubled. Thus 16.4 teeth (over 50 percent) were diseased in each mouth, a rate almost as high as in our own population, though for very different reasons. Apparently no third molars were suppressed in this small sample. Except for the Burial 5 female with a medium overbite, an edge bite was the norm. These dentitions are much poorer than those of most groups and suggest that loss of chewing ability may have set an upper limit to lifespan in this group: those with the toughest teeth would have an advantage in longevity.

One male and one female show skull depressions from blows, and the male from Burial 6 (B-181-184) shows a skull perforation which might have occurred at the time of death.

The average adult lifespan was 31.5 years (34 in males, 29 in females). There are about 16 adult males and 9 adult females and 8 children and early adolescents. Skull fragments of one young infant, plus a child of 1 year (UM B-12) give little clue to the proportion of infant deaths. If these amounted to 2.5 × the child deaths, we could expect about 20 infant deaths. The adult deaths would be about 40 percent of the total, as expected in a population of this sort which might be healthier than early farming populations. This would imply three dead and two living children per woman, about the number expected over the 12–15 years of childbearing available before death at 29–30. Since there is much variation in lifespan we can assume that a minority of longer-lived women produced most of the children and that selection operated effectively here where food supply was just adequate for small hunting groups.

Skeletal Remains

DESCRIPTIONS

Time-consuming matching of fragments, careful repair of skulls and long bones, and minute study of all small fragments has allowed extraction of far more information than seemed possible at first; only Burials 4 and 5 were at all well preserved. Alvar served as adhesive. Measuring technique and observation standards are basically those of the "Harvard school" led by Dr. E. A. Hooton. Measurements follow Martin (1928) and the average modern northwest European male is the elusive standard for morphology.

Burial 1 (UCMA 6071) is the skeleton of a male, perhaps 35–45 years old, with parts of two other adults. The partial calva includes the upper part of the frontal bone showing a sloping and probably low forehead, imperceptible bosses, and an incipient median crest which rises into the pronounced sagittal elevation which is the only noteworthy feature of scanty parietal fragments. There is a small sharp depression (scar) on the left side of the forehead. Minimum and maximum frontal diameters are estimated at 93 and 108 mm., respectively.

The incomplete postcranial skeleton includes the lower end of a right humerus and lower halves of both radii. These show weak bowing, oval shaft sections, and barely medium interosseous crests. A right ulna indicates a stature of 173.8 cm. by Trotter's 1958 Mongoloid formula. A right femoral shaft with some upper flattening (platymeria) and very deep midshaft or prominent pilaster has prismatic cross section and medium rugosity for insertion of deep fibres of the lower gluteus maximus. Fragmentary innominates (one right, three left) have narrow sciatic notches. One pair of them shows deep and smoothly depressed concavities extending medially from the iliac fossa immediately anterior and superior to the auricular surface in an area normally relatively flat (pl. 2, *lower*). Anterior and posterior heights of centra for lumbar vertebrae 2, 3, and 4 are 26 and 32, 27 and 29, and 29 and 24 mm., respectively, suggesting a vertical lumbar index of 100 or over. These centra are rimmed by medium "arthritic" exostoses, the usual wear-and-tear result of strain by centrifugal pressure of intervertebral disks during hard use. Marked arthritis with exostoses occurs in the whole right elbow joint.

Burial 2 (UCMA 6072) is the skeleton of a robust male about 40 years of age whose heavy calvaria lacks much of the right side and frontal (pl. 1, *upper left*). Estimated measurements in table 1 give general proportions which are useful for descriptive purposes though statistically invalid. The medium-sized vault is long and strikingly high, ellipsoid (almost byrsoid) from above and rounded *hausform* from behind. A constricted, low, and strongly sloping forehead leads back to parietals with marked sagittal elevation (the actual sagittal suture is neatly depressed), bosses perceptible only in rear view, and high though faintly marked temporal lines (41 mm. from midline at their highest point and about 115 mm. above porion). The occiput is projecting and the centrally massive torus, into which inion wrinkles down, is traceable as a thin ridge laterally into large mastoid processes. The occiput in front

PLATE 1

Skeletal remains from the Tranquillity site. *Upper row:* Burial 2 (UCMA 6072), male; Burial 3 (UCMA 6073), female; University Museum B-12, infant. *Middle row:* Burial 4 (UCMA 6464), female. *Lower row:* Burial 5 (University Museum), small-faced female.

PLATE 2

Skeletal remains from the Tranquillity site. *Upper row:* Burial 6 (University Museum), male. *Middle row:* UCMA 6075, male (?). *Lower row:* UCMA 6075 h, preadolescent child's second mandibular milk molar and first permanent molar (note reaction to extremely abrasive food); Burial 2 (UCMA 6072), lower end of humerus to show special arthritis of "atlatl elbow"; Burial 1 (UCMA 6071) showing concavity above sacroiliac joint.

of the sub-torus concavity, although broken, suggests a deep cerebellar region. Sutures are below average in complexity and medium advanced in occlusion. A round auditory meatus and medium glenoid fossa lie beneath a truly massive supramastoid crest swinging out into strong zygoma and laterally flaring cheekbone attached to strong fronto-malar angle. The orbits were probably low and somewhat sloping (rhomboid ?).

Right and left humeri have oblong and prismatic sections with rather flat and robust shafts. Radii show oval shaft sections, medium bowing, just medium interosseous crests. The forearms are relatively long and the clavicles are rather stubby. Femora show strongly flattened shafts, pronounced gluteal crests, slight fossae and third trochanters, slight bowing and oval shaft sections. Tibial shafts are Hrdlička's type III (lateral concavity) and mesocnemic. A broken right ilium shows narrow sciatic notch and slight bony outgrowths; the upper section of a sacrum is hyperbasal. Anterior and posterior centra heights of vertebrae *T 12* to *L 1–4* are 16 and 24, 15 and 26, (22) and 27, 25 and 26, (22) and 25 mm., suggesting a (deformed) vertical lumbar index of over 110. Pathology includes anterior "wedge" compression fracture of the body of *L 1* and probably *T 12* and *L 2;* a deep pit in the cranial surface of the body of *L 4*, apparently from a Schmorl herniation of nucleus pulposus; and arthritis of elbow and wrist joints. As shown in the lower central part of plate 2, the elbow arthritis involves marked exostoses rimming the joint capsule attachment and eburnation in the radio-humeral joint; there is additional lipping also at the radio-carpal joint. The left calcaneus has a vertical tuberosity with medium Achilles tendon area and separate talar facets. The right talus lacks squatting facets and is average in other traits. Stature reconstruction of 166 cm. is the shortest of the males.

Burial 3 (UCMA 6073) includes scanty remnants of an early middle-aged(?) adult female. As seen in plate 1, *upper row*, the left "half" of the calvaria includes the midline only at the ophryon-nasion region, and is small, high, not broad, clearly byrsoid and *hausform*, with well defined muscle markings and brow ridges. The low and pinched forehead slopes little; the temporal region has average bulge from above though almost flat from the rear; an oval depression (scar) lies at just about the highest part of the temporal line; the earhole is oval; and the glenoid fossa is deep. Nasion is barely depressed; nasal root is medium-wide and medium-low; a maxillary fragment shows medium-large nasal spine with incipient subnasal grooves, slight alveolar prognathism, at least five teeth lost in life, four periapical abscesses of medium size, medium paradontal disease, at least one caries, extreme teeth wear (two teeth left), and probable edge bite.

Left ulna fragments show slight arthritic lipping at the elbow. The left femur shows platymeria, marked gluteal crest and no fossa, slight third trochanter, slightly bowed shaft of planoconvex section, and probably more than average torsion. The right tibia, lacking the upper third, and the left tibia, lacking the lower epiphysis, have diamond section (type IV) slightly concave laterally, slight retroversion of the head, and barely perceptible ankle flexion facets. These tibiae are mesocnemic and seem relatively long. The right innominate fragment indicates wide sciatic notch, slight iliac flare, and small sciatic spine.

Burial 4 (UCMA 6464) is the complete and fairly well preserved skeleton of an adult female, not quite middle-aged (ca. 31–34). The cranium is heavy, fairly muscular, large, and indeterminate in sex characters (pl. 1, *middle*). The ovoid (almost byrsoid) vault is just dolichocrane with narrow forehead, relatively very high, and well filled enough to be more arched than gabled in rear view. Divided and sharply defined brow ridges lie below a constricted and narrow but otherwise average forehead whose bosses tend to merge in the midline. Postcoronal and obelion-lambdoid flattenings stress a posteriorly placed and high vertex. The occiput is long and deep (cerebellar portion) rather than prominent. The occipital torus is a massive mound filling in the space between superior and supreme nuchal lines. Temporal planes of average fullness with slightly bulging frontal segments set off deep sphenoid depressions. Sutures average submedium in complexity with beginning occlusion, and with eight small lambdoid Wormian bones, three sagittal, several temporo-occipital, and epipteric bones on each side. Prominence of occipital condyles and basion is scarcely above average (within medium range) in contrast to opisthion: foramen magnum tilt is 11 degrees with Frankfort plane. The foramen magnum measures 29×35 mm. The pharyngeal tubercle is large, the auditory meatus is elliptical, and the glenoid fossa is shallow with gentle articular eminence slope.

The broad face is hexagonal and was probably mesoprosopic with low upper face (before loss of teeth). Square and scarcely tilted orbits are rimmed below by vertically shallow cheekbones which contribute to facial flatness without more than medium lateral prominence and lead down to average suborbital fossae. Beneath the slight nasion depression, concave and corset-shaped nasal bones mark an incipiently low and pinched nasal root and a wide bridge of average height though of less than average salience: nasalia profile angle is 63°. Dull nasal sills and average spine bound the chaemerrhine nose below, and a hint of prognathism is hidden by marked alveolar absorption following loss in life of all upper teeth. The mandible retains all 16 teeth, which show extreme wear, no caries, and only one small abscess. The narrow and deep lower jaw has wide, triangular, and medium prominent chin, compressed and square angles at junction of squat ramus with thick corpus, large sharp genial tubercles, and a large mandibular torus most pronounced in the premolar root area.

Right and left humeral shafts are prismatic and irregular in section; the floor of the left olecranon fossa is perforated. Radii are average in bowing and crest, oval in section. The right scapula has an oblique upper border lacking any notch for the suprascapular nerve, possibly a convex vertebral border, an average rugose area for teres origin, and an oval glenoid cavity with slight lipping. The left scapula shows the acromion to be intermediate in shape with unlipped clavicular facet and with a slight age plaque on its lower surface. Pleating is slight. The sternum is broken but suggests that it had facets for seven sternal ribs. Slender

TABLE 1.—MEASUREMENTS AND INDICES OF INDIVIDUAL CRANIA FROM THE TRANQUILLITY SITE [1]

Character	Burial 2 UCMA 6072	Burial 3 UCMA 6073	Burial 4 UCMA 6464	Burial 5 UM	Burial 6 UM	Miscel-laneous UCMA 6075	Summary	Martin [2]	Bio-metric [2]
Horizontal circumference...	(520)	(480)	516	533	531	482	Large	23 a	U
Sagittal arc..............	(370)	—	388	401	402??	350	Large	25	S
Frontal arc...............	(125)	(121)	123	131	135	120	—	26	S_1
Parietal arc..............	124	—	132	123??	139	123	—	27	S_2
Occipital arc.............	(121)	—	133	147??	128??	107	—	28	S_3
Transverse arc............	(318)	(290)	313	303	330	295??	—	24	Q
Maximum length.........	(189)	(170)	185	192	194	175	Large	1	L
Maximum breadth........	(133)	(134)	138	134	140	123	Medium	8	B
Basion-bregma height.....	(142)	—	140	130	(145)	136??	Large	17	H′
Auricular-vertex height....	126	(112)	122	117	132	114	Large	(21)	(OH)
Minimum frontal breadth..	(93)	(90)	89	96	91	94	Medium	9	B′
Maximum frontal breadth..	(118)	—	115	116	119	(105)	—	10	B″
Biasterion breadth........	111	—	121	116?	107	103	—	12	B–a
Biauricular breadth.......	(117)	(118)	122	120	121	117	—	11	—
Left parietal thickness.....	5.2	4.0	5.7	5.0	5.7	6.6	—	—	—
Basion-nasion............	—	—	99	92	(109)	100?	—	5	LB
Basion-prosthion..........	—	—	(93)	90	(102)	97?	—	40	(GL)
Frontal angle (Frank. plane)	(48)	—	52	54	53	53	High	32 (1a)	—
Facial angle.............	—	—	(83)	84	(90)	85??	—	72	P∠
Mandibular angle.........	—	—	118	120	120	114	118.0	79	m∠
Bizygomatic breadth......	(145)	(133)	133	128?	140?	129??	Medium	45	J
Bigonial breadth..........	—	—	88	93	108?	93	—	66	w_2
Face height..............	—	—	(117)	92?	(130)	115?	—	47	GH
Upper face height.........	—	(65)	(65)	57	(75)	69?	Low??	48	G′H
Chin height..............	—	—	37	27	37	34?	Medium?	69	h′
Nose height..............	—	(48)	48	44	56?	52?	Low??	55	NH
Nose breadth.............	—	(25)	27	27	27?	27?	Large	54	NB
Upper nasalia breadth.....	—	12	13	11	13	11?	—	57 (2)	—
Left orbital height........	(33)	—	34	33	34	35?	Medium	52	O_2
Right orbital height.......	—	—	34	31	—	36?	—	52	O_2
Left orbital breadth.......	(42)	(38)	38	38?	40	(38)	Medium	51 a	O_1
Right orbital breadth......	—	—	39	38?	—	40?	—	51 a	O_1
Interorbital breadth.......	—	22?	23	23?	27	22?	—	49 a	DC
Biorbital breadth.........	—	(100)	98	95	104	98?	—	44	(IOW)

See footnotes at end of table.

femora have pronounced cristae, slight fossae and third trochanters, definite platymeria, average torsion and bowing, and oval section. Tibiae have smooth diamond-shape section (type IV), slight head retroversion, and slight "squatting" (flexion) facets. Though external pelvic diameters are small, the broad oval gynecoid inlet equals the average White female in size and proportions; the subpubic angle is wide with unconstricted but markedly lipped rami; the sacro-sciatic notch is wide; the preauricular sulcus is extensive; and the ilium is flaring. The left pubic symphyseal surface shows late Phase VI metamorphosis (Todd), together with slight exostoses, suggesting death just before age 35. The five-segment, homobasal, and sharply curved sacrum is very short, with incipient simian notch and spinal canal closure starting with *S 3*. Lumbar curvature is well marked. Right calcaneus shows slight lateral tilt, extensive Achilles tendon area, strong lateral process, and partly fused talar facets. Tali have average flexion facets and marked obliquity of the external facet (indicating medial torsion relative to the calcaneus). Vertebral bodies are rimmed by arthritic exostoses of slight degree in the upper three-fourths of the thoracic column, medium in lower thoracic, upper lumbar, sacral, and upper cervical regions, and pronounced in lower lumbar and lower cervical regions: these are the regions of most marked anterior convexities and greatest anterior ligament tensions. Stature is reconstructed at 159 cm. and proportions are average by White (rather than Indian) standards.

BURIAL 5 (UM) is the fairly complete skeleton of a young adult female, perhaps almost 30 (pl. 1, *lower*). The coronal is the only suture of the heavy cranium where closure is starting. The large, long, medium high, and

TABLE 1.—MEASUREMENTS AND INDICES OF INDIVIDUAL CRANIA FROM THE TRANQUILLITY SITE[1]—Continued

Character	Burial 2 UCMA 6072	Burial 3 UCMA 6073	Burial 4 UCMA 6464	Burial 5 UM	Burial 6 UM	Miscel-laneous UCMA 6075	Summary	Martin [2]	Bio-metric [2]
External palate length	—	—	(51)	48	(56)	55?	—	60	G_1'
External palate breadth	—	(57)	(59)	60	72?	60??	—	61	EB
Condylo-symph. length jaw.	—	—	105	94	112??	101	—	68 (1)	ml
Bicondylar breadth	—	—	117	(120)	(135)	113	—	65	w_1
Bimental breadth	—	—	42	41	49	45	—	67	zz
Corpus thickness (M_1)	—	—	15	14	16?	16	—	—	—
Left ramus height	—	—	53?	52	62?	60	Low	70	rl
Minimum ramus breadth	—	—	34	29	34	35	—	71 a	rb'
Cranial index	(70.4)	(78.8)	74.6	69.8	72.2	70.3	72.5	8x100/1	—
Length-height index	—	—	75.7	67.7	(74.7)	77.7??	74.0	17x100/1	—
Length-auricular height	(66.7)	(65.9)	65.9	60.9	68.0	65.1	65.0	(21)x100/1	—
Breadth-height index	—	—	101.4	97.0	(103.6)	110.6??	103.5	17x100/8	—
Breadth-auricular height	(94.7)	(83.6)	88.4	87.3	94.3	92.7	90.5	(21)x100/8	—
Fronto-parietal	(69.9)	(67.2)	64.5	71.6	65.0	76.4	69.0	9x100/8	—
Cranio-facial index	—	—	96.4	95.5?	100.0?	104.5?	99.0	45x100/8	—
Zygo-frontal index	—	—	66.9	75.0?	65.0?	72.9?	69.5	9x100/45	—
Fronto-gonial index	—	—	98.9	96.9	118.7?	98.9	103.0?	66x100/9	—
Zygo-gonial index	—	—	66.2	72.7?	77.1?	72.1?	72.0	66x100/45	—
Facial index	—	—	(88.0)	71.2?	(92.9)	89.1?	(85.0)	47x100/45	—
Upper facial index	—	—	(48.9)	44.5?	(53.6)	53.5?	50.0?	48x100/45	—
Nasal index	—	(52.1)	56.2	61.4	48.2??	51.9?	54.0	54x100/55	—
Orbital index	—	—	89.5	86.8	85.0	90.0 rt.	87.0	52x100/51 a	—
External palatal index	—	—	(115.7)	125.0	(128.6)	(109.1)	Wide	61x100/61	—
Sex	Male	Female	Female	Female	Male	Male?		—	—

[1] Measurements in parentheses are estimates made where the cranium is incomplete. They have no statistical value. Measurements with question marks are doubtful because of reconstruction. Although this is as accurate as possible, the queried measurements have restricted statistical worth. The data in the Summary column are judged by American Indian rather than European morphological norms.

[2] Definitions of measurements according to Martin (1928) and the Biometric School are listed by number or by key letters. Auricular height uses the highest point (vertex) and not the sagittal suture point above porion (apex) as its terminus.

narrow vault has relatively wide frontal and base, and is pentagonoid and rounded *hausform*. Small divided brow ridges bound a broad, low, and bulging forehead whose clear-cut bosses blend with a perceptible median crest along the open metopic suture. Large postcoronal depression, long obelion-lambda plane, large parietal bosses, and prominent upper occiput show vault angularity. The medium-to-small mound-shaped occipital torus is set in relief by a slight concavity between it and the long and deep cerebellar region. Temporal planes have slight fullness and are partly concave in rear view. About 19 Wormian bones complicate the lambdoid suture, and pteria are of K form. In contrast with opisthion the basal region does not protrude, giving a 16° tilt to the foramen magnum (dimensions 26 $\times$ 38). The earhole is round, and the glenoid fossa shallow with gentle eminence slope. Even adding 4 mm. to the face height of 88 to allow for teeth wear does not mitigate the excessive facial lowness. The outline is almost square, with slight taper inferiorly. Small shallow cheekbones with marked anterior but average lateral thrust bound level oblong orbits and blend into deep suborbital fossae. Nasalia, now broken, were not salient (nasalia angle estimated 70°–75°) and led from a very broad and almost flat nose root to a wide bridge of medium height. The wide pyriform aperture contributes to a hyperchaemerrhine index and is characterized by slight subnasal grooves and medium spine which points downward. Medium facial and alveolar prognathism and medium projection of the shallow pointed chin give a concave facial profile. The parabolic palate is wide and low-arched. Marked paradontal disease and nine periapical abscesses (six upper, three lower) of medium size or larger help to explain loss of six teeth in life: all six carious teeth observed have perforated crowns which would allow infection to spread through the root canal. This and the extreme teeth wear wherever occlusion was maintained explain loss of the lateral roots of both upper first molars whose crowns are completely eroded. As in

TABLE 2.—MEASUREMENTS AND INDICES

Character	Burial 1 UCMA 6071 male		Burial 2 UCMA 6072 male		Burial 3 UCMA 6073 female		Burial 4 UCMA 6464 female		Burial 5 UM female	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Humerus: Maximum length	—	—	(305)		—	—	297	293	262	(265)
Maximum head diameter	—	—	(43+)		—	—	42	41	(39)	—
Maximum middle diameter	—	—	25	23	—	—	20	19	18	17
Minimum middle diameter	—	—	18	16	—	—	15	14	13	14
Radius: Maximum length	—	—	241	—	—	—	222	222	194	198
Ulna: Maximum length	277	—	256?	—	—	—	242	240?	219	218
Clavicle: Maximum length	—	—	130	137	—	—	141	141	—	—
Femur: Maximum length	—	—	(410)	—	—	(400)	420	426	384	384
Bicondylar length	—	—	(405)	—	—	—	416	419	383	382
Maximum head diameter	—	—	—	46	—	41	42	42	42	41
Subtroch.: ant.-posterior	26	—	22	—	—	23	21	21	23	22
transverse	32	—	37	—	—	32	28	29	28	27
Midshaft: ant.-posterior	32	—	24	—	—	26	25	25	24	23
transverse	24	—	25	—	—	24	23	24	24	24
Tibia: Diagonal length	—	—	—	—	(343)		344	342	309	308
Nutrient ant.-posterior	—	—	—	37	—	33	30	29	30	31
Foramen transverse	—	—	—	25	—	22	20	19	18	21
Calcaneus: Length	—	—	—	77	—	—	74	—	—	68
Breadth	—	—	—	41	—	—	40	—	—	43
Talus: Length	—	—	52	—	—	—	48	48	50?	49
Breadth	—	—	40	—	—	—	38	37	41	41
Projective height	—	—	29	—	—	—	27	28	27?	28
Pelvis: Innominate height	—	—	—	—	—	—	(194)	(194)	—	179?
Innominate breadth	—	—	—	—	—	—	(150)	(150)	(145)	—
Biiliac breadth	—	—	—	—	—	—	260		(260)	
Inlet breadth	—	—	—	—	—	—	133		(122)	
Inlet antero-posterior	—	—	—	—	—	—	111		(96)	
Interspinous	—	—	—	—	—	—	(104)		—	—
Biischiatic	—	—	—	—	—	—	152		—	—
Sacrum: Height	—	—	—	—	—	—	89?		(90)	
Breadth	—	—	—	—	—	—	112		(100)	
Lumbar: Centra anterior	—	—	—	—	—	—	124		125	
Heights posterior	—	—	—	—	—	—	118		123	
Body build: Reconstructed stature	173.8		166.0		(156.5)		159.2		148.2	
Indices: Brachial index	—	—	(79.0)		—	—	74.7	75.8	74.1	—
Claviculo-humeral	—	—	(43.8)		—	—	47.5	48.1	—	—
Humero-femoral	—	—	—	—	—	—	71.4	69.1	68.4	—
Crural	—	—	—	—	—	—	82.7	81.6	80.7	80.6
Femur robusticity	—	—	—	—	—	—	11.4	11.5	12.5	12.3
Calcaneus length-breadth	—	—	—	53.25	—	—	54.1	—	—	63.2
Talus length-height	—	—	55.77	—	—	—	56.2	58.3	54.0?	57.1
Vertical lumbar	(100+)		(100+)		—		95.2		98.4	
Humeral flatness	—	—	72.0	69.6	—	—	75.0	73.7	72.2	82.3
Platymeric	81.25	—	59.46	—	—	71.88	75.0	72.4	82.1	81.5
Pilastric	133.33	—	96.00	—	—	108.33	108.7	104.2	100.0	95.8
Cnemic	—	—	—	67.54	—	66.67	66.7	65.5	60.0	67.7

OF POSTCRANIAL SKELETAL PARTS

Burial 6 UM B181–184 male		UCMA 6075a female		UCMA 6334 mixed		UCMA 6465 mixed		UCMA 6531–2 mixed		UM B83–177 male		Summary
Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	
—	—	—	290	—	—	Male		—	—	—	—	Average
—	—	—	40	—	—	44	—	*UM*	*UM*	*B–83–177*		—
								B–86	*B–82*			
—	—	21	21	Female	20	—	21	21	19	—	22	Large
—	—	16	16	—	14	—	17	16	15	—	17	Average
											B–106	
261	—	232	231	—	—	—	—	—	—	—	243	Average
278	—	—	(247)	—	—	—	—	—	—	—	—	—
—	—	—	(136)	Male	141	—	—	—	—	—	—	—
										B–142	*B–81*	
445	—	(389)	394	—	—	—	—	*UCMA*	—	(483)		Average
440	—	(387)	383	—	—	—	—	*6532*	—	—	—	—
48	—	41	41	—	—	—	—	46	—	—	—	—
28	—	20	22	—	—	—	—	*UCMA*	—	29	30	Small
33	—	30	31	*UCMA 6075*		Male	—	*6531*	—	37	38	Large
32	—	25	26	—	32	34	—	24	—	34	35	Large
27	—	24	24	—	25	27	—	21	—	29	29	Average
—	—	340?	336?	*UCMA 6075j*		—	—	—	—	—	*B–113*	Average
—	—	33	32	Adolesc.	33	—	—	—	—	—	42	Average
—	—	23	22	—	23	—	—	—	—	—	36	Small
				UCMA 6334								
—	—	(67)	—	Female?	72	—	—	—	—	—	—	—
—	—	36	—	—	39	—	—	—	—	—	—	—
								UCMA		*UCMA*		—
						Male	Female	*6532*		*6532*		
—	—	47	—	—	46	51	46	49	—	56	—	Average
—	—	39	—	—	39	45	35	40	—	40	—	Average
—	—	27	—	—	27	(29)	26	28	—	—	—	Low
—	—	—	(203)	—	—	—	—	—	—	—	—	—
—	—	—	(148)	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—
171.3		157.5		—		—		—		168.0 radius		169.8 male
										(176.4) femur		155.3 female
—	—	—	79.7	—	—	—	—	—	—	—	—	77.0
—	—	—	(46.9)	—	—	—	—	—	—	—	—	(46.6)
—	—	—	75.7	—	—	—	—	—	—	—	—	71.6
—	—	—	87.7	—	—	—	—	—	—	—	—	83.5
13.41	—	—	13.1	—	—	—	—	—	—	—	—	12.3 female (robust)
—	—	—	—	—	54.2	—	—	—	—	—	—	56.2 (short)
—	—	57.5	—	—	58.9	—	56.5	57.1	—	—	—	57.2 (low)
												(<100) (average)
—	—	76.2	76.2	—	700	—	81.0	76.2	78.9	—	77.3	75.8 (sl. flattening)
84.85	—	75.0	71.0	—	—	—	—	—	—	78.4	79.0	75.6 (flat)
118.52	—	104.2	108.3	—	128.0	125.93	—	114.29	—	117.2	120.7	114.0 (very salient)
—	—	69.7	68.8	—	69.7	—	—	—	—	—	61.9	66.4 (sl. flattening)

Burial 4, the lower teeth appear to outlast the uppers. A medium overbite has worn the remaining upper incisor too far to see how deeply it was grooved labially (i.e., shovel shape). As a whole the jaw is delicate, with compressed angles and average muscular attachments but medium mandibular torus.

There are nine small flat exostoses (osteomata) on the vertex region of the right parietal bone. There are slight indications of healed osteoporosis cranii (porotic hyperostosis) in the fine pitting observed in the upper occipital and lateral parietal regions.

Though small, the postcranial bones in no other way confirm the hint of achondroplasia perceptible in short cranio-facial base, tilted foramen magnum, concave face, and bulging forehead. Right and left humeral shafts are irregular and prismatic in section, and the left olecranon fossa is perforated. Right and left radii have prismatic and oval sections with slight bowing and medium crests. Elliptical scapular glenoid surfaces are slightly lipped like the clavicular facet on an acromion of possibly triangular shape. Teres origins are average. Femora show pronounced crista, medium fossa, medium torsion (pronounced on left), slight Poirier's facet, definite facet for medial gastrocnemius origin near the adductor tubercle, slight bowing, oval shaft section, and slight platymeria. Tibiae show marked head retroversion, no "squatting" facets, and oblique (type II) shaft section with only incipient platycnemia. The much broken pelvis seems to have had a broad oval brim of gynecoid-platypelloid form, rather small innominates with deep concavities anterosuperior to the auricular surfaces, wide subpubic angle with marked lipping of rami, wide sciatic notch with extremely marked preauricular sulcus, average iliac flare, and left pubic symphysis probably phase V. The short five-segment sacrum is sharply curved, starting at *S 2*, is hyperbasal with extensive articulation between left ala and expanded transverse process of *L 5* (right broken away). The sacrum shows spinal closure at *S 4*. Though there are 5 lumbar vertebrae and 7 cervicals, there are 13 thoracic vertebrae. Stewart (1941) notes the same variation in Buena Vista No. 372292; a recessive gene may determine this (Kühne, 1932). Since the last lumbar is partly sacralized the sacral region is not moved caudad as far as the lumbar region. The lumbar curve is intermediate. The right calcaneus has vertical tuberosity, average Achilles tendon area, marked lateral process, and fused talar facets. Tali have slight flexion or "squatting" facets and only slight inward torsion of the head ("advanced"). Stature reconstruction of 148 cm. is short; arms are short relative to legs, and distal limb segments short relative to proximal as expected with stature reduction. Though very slight lipping serrates the upper centra rims of *L 3* and *4*, cervical centra show marked exostoses. Slight pathology of the right radius appears to be a very well-healed Colles' fracture 15 mm. above the styloid process.

Burial 6 (UM B-181-184) is the broken calvaria (pl. 2, *upper*) and stream moved but attributable face, jaw, femur, rib, vertebra, and forearm fragments of a powerful middle-aged male, probably over 40. Medium closure of sagittal and coronal sutures and beginning closure of lambdoid do not hide their simple, medium, and pronounced degrees of serration, respectively. The large, notably high, and broad-based vault is byrsoid and gothic-arched *hausform*. Very massive continuous brow ridges set off a low, markedly sloping, pinched forehead with median keel leading smoothly back into the parietal sagittal ridge. Vertex is smooth and far back with slight and relatively vertical lambdoid flattening above deep but not prominent occiput. The torus is an average mound capped by a thin rugous line. *Lineae supremae* form a small separate mound at a higher level. Inion is imperceptible. A single small lambdoid Wormian bone occurs. Pterion is in K. Temporal planes are virtually average in fullness next to deep sphenoid depressions. Mastoids and supramastoid crests are large; glenoid fossae are average with thick postglenoid processes, and elliptical auditory meati. The massive face was probably leptoprosopic. Robust, rather than salient, cheekbones enclose square orbits above nonflat suborbital fossae. Despite lack of definite contact points for the whole palate, the large nasal height seems fairly certain. Nasion depression is slight with broad and low nose root. Sills and spine are average with bare suggestion of subnasal grooves. The palate shows a small ridge torus. A deep and bilateral chin with small projection suits the heavy jaw notable for breadth at condyles and angles in spite of only slight jowl eversion. A strong mylo-hyoid ridge delimits a small irregular lump torus in the premolar root area. Twenty-two teeth were lost in life; paradontal disease is present, and four out of five medium abscesses are periapical at teeth with carious crowns following extreme wear. Five of the seven teeth left are carious.

A small round perforation 80 mm. above and 45 mm. behind the left porion is surrounded by radiating cracks in the outer table and shows a flatly conical expansion to a large gape in the inner table. The broken fragments were found inside the vault. The damage is equivalent to fracture of glass after a sharp blow. This injury apparently occurred when the head was intact and might have caused death. One of the radiating cracks crosses the sagittal suture.

The right radius has prismatic section, average bowing, and marked crest. The robust right femur with very massive gluteal crest lacks both fossa and third trochanter, shows medium torsion, above average bowing, plano-convex section, and large head diameter. The shaft is not platymeric but has a high pilastric index. Reconstructed stature is 171 cm.

UCMA 6074 comprises the incomplete mandible and long bone shafts of a child 5 or 6 years of age. With chin height 22 and bimental 38, the jaw has a bilateral chin with neutral projection. The first permanent molar is starting to erupt, and its cusps show the Dryopithecine pattern. Milk tooth wear is below medium. A noteworthy skeletal feature is excavation of the iliac fossa immediately anterosuperior to the auricular surface together with a sharp flange which overlapped the articular cartilage.

UCMA 6075 is a cranium (pl. 2, *middle*) elicited from among fragments of 10 skulls. This is the only skull of this group at all complete. Beginning occlusion of coronal and sagittal sutures suggest young adult age (25–35) and the skull looks male (?) rather than female, in spite of small size, because of muscularity and size of face and of foramen magnum. The ill-filled vault is strikingly narrow and high, ellipsoid, and *hausform*. Above medium brow-ridges and low forehead, the frontal shows definite constriction and median crest. Parietals show average post-coronal depression, gabled roof with parietal bosses reinforced by the temporal lines, and slight obelion-lambda flattening above medium occiput and average mound torus. A large temporal muscle area relative to cranial capacity is clear in high temporal lines (39 mm. from the sagittal suture at their highest point), and on the frontal bone where the least breadth between temporal lines diminishes from 96 to 92 mm. at 20 and 60 mm. above nasion. Temporal planes show slight fullness with rear view concavity above large supramastoid crests. The skull base projects more than usual, the auditory meati are elliptical, and glenoid fossae shallow with gentle eminence slope. The face is intermediate in proportions and medium in absolute but not relative size, with an oval front view. Orbits are high and square. Cheekbones are large and prominent laterally and especially anteriorly, though with average suborbital fossae. The nose is unexpectedly wide, but in slight nasion depression, probable root characters, and unimpressive sills and spine, the nose resembles Burial 6. Alveolar prognathism is medium but total facial projection only slight. The palate is low, and triangular chin neutral in projection. More striking is the square-angled stubby ascending ramus, though the gonia are actually inverted. Six teeth were lost in life, paradontal disease is present, the two abscesses are large, and one of five remaining teeth is carious. An edge bite accompanies down-to-gum teeth wear for which 5 mm. have been added to the measurable face height of 110 ?? mm. Scarcely perceptible pitting on occipital squama and upper posterior parietals may be osteoporosis.

There are three narrow-notched male innominates, much broken, assignable to two or three individuals, and showing depressions anterosuperior to the auricular surface as in plate 2, *lower right*. The midshaft region of a robust left femur is prismatic and very deep from front to back, with medium bowing. A left calcaneus has vertical tuberosity, average tendon area, small lateral process, separate talar facets. These and the upper segment of a hypobasal sacrum are the only apparently male skeletal parts, hence assigned to skull 6075 or to one of the male skull fragments.

UCMA 6075 *a* is the back and base of a female skull, probably middle aged (40–50). Breadth is 127 mm., biasterion 102 ? mm., biauricular (107 mm.), and occipital arc and chord about (120 mm.) and (103 mm.), respectively. Temporo-occipital and squamous sutures are both obliterated though lambdoid closure is only medium. The occiput is deep, with medium curve, weak torus, and small "thumbprint" depression at inion. Temporal fullness is average, temporal lines reach the lambdoid suture joining big supramastoid crests, mastoids and glenoid fossa are average, and auditory meatus oval. The total impression is a high, narrow, and probably *hausform* vault. The anterior segment of an almost edentulous mandible may belong. The median chin shows average projection and depth of 30 mm. (without teeth), bimental 48 mm., and thickness 13 ? mm. With marked pyorrhea and 3 small abscesses, 10 teeth were lost in life. The central alveolar border of a left maxilla also shows a small abscess, marked wear on two teeth, and medium alveolar prognathism.

Humeral shafts are irregular in section and both olecranon fossae are perforated. Gracile radii have prismatic shafts. Scapulae have oval glenoid surface with slight lipping, medium teres origin, triangular acromion with unlipped clavicular facet and slight age plaque. Femora show traces of third trochanter, massive gluteal crest, slight fossa, slight Poirier's facet, medium torsion and bowing, and prismatic and planoconvex right and left shaft sections. They are robust with clear platymeria. Tibiae show medium head retroversion, laterally concave (type III) shafts, and imperceptible flexion facets. A left innominate with medium sciatic notch, small preauricular sulcus, but probably diverging ischium shows the previously noted concavity next the auricular surface. A broken right calcaneus has separate talar facets. A left talus with slight flexion facets shows strong head divergence and torsion from the vertical axis. Some arthritic lipping occurs on tarsals and elbow joints. Reconstructed stature of 157.5 cm. goes with relatively long distal limb segments, and relatively long humerus compared to femur. All bones show a peculiar slender ruggedness conceivably connected with an "economy" of bone during the growth period. Humeri show marked deltoid flange, and ulnae are sinuous. Femora show a lateral flange in the upper quarter of the shaft and perceptible lateral concavity in the lower third, and are so divergent in "natural" position as to suggest knock-knees. Tibiae are incipiently sabre form with anteromedial convexity and lateral shaft concavity combined with marked outward torsion of the distal ends.

UCMA 6075 *b*, *c*, and *d* are parietal fragments of three apparently male crania with marked sagittal crests showing tendency for a central small groove along the suture line (as in Burial 2), especially posteriorly.

UCMA 6075 *e* and *f* are an occipital fragment with mound torus, and a male left temporal bone with notably long mastoid, thick and flaring zygoma, shallow glenoid fossa, oval meatus.

UCMA 6075 *g* is a female glabella region (bone less mineralized).

UCMA 6075 *h* is the left half of a mandible of a 10-year-old child with length (90 mm.), bicondylar (106 mm.), chin height 26 mm., thickness 15 mm., ramus height and least breadth 42 mm. and 29 mm. and angle 124°. The median chin shows slight projection. Since the second milk molar is still in place next to the first permanent molar the jaw gives instructive data on teeth wear as seen in plate 2, *lower:* the milk molar's wear is extreme after about 8 years in the mouth and the permanent molar shows medium wear after 4 years. Even allowing for greater enamel toughness of permanent teeth, it is clear that on the Tranquillity food-gathering diet these would have been extremely worn by the late twenties or early thirties. The wear is of the usual prefarming bevel type.

UCMA 6075 *i* is the right ramus of a small jaw with 29 mm. minimum breadth.

UCMA 6075 *j* includes upper ends of heavy adolescent tibiae showing active epiphyseal union. Left nutrient foramen level diameters 33 × 23 mm. give a mesocnemic index of 69.70.

UCMA 6333 comprises the broken skeleton of a child 3–4 years old, with femur length of 180 mm., platymeric index of 100.0.

UCMA 6334 includes the right elbow region of a robust male(?) with olecranon perforation and slight lipping. A large left clavicle is markedly rugose. The right chin region of a jaw fits fragment B–31 from Dr. Satterthwaite's excavation. Chin height of 36 ? mm., bimental of 44 mm., and bilateral chin with slight projection mark this specimen. A gracile left humerus, perhaps female, has planoconvex shaft section. A left talus lacks flexion facets and has pronounced diversion angle and external facet obliquity.

UCMA 6465 includes part of a thick right parietal comparable to Burial 6, a jaw fragment, a right humeral head, lower left humerus with prismatic section, left scapula fragment, central shaft of right femur with deep oval section, and left talus with almost vertical axis of the head. These all appear to be male (?). A smaller right talus also shows only slight tilt of head axis. Adult 5th metacarpal and phalanges, adolescent upper right humerus and ischium, and infant right humerus and left femur also occur in this numbered lot.

UCMA 6466 includes a rather flat child frontal with very marked median crest, and infant skull fragments.

UCMA 6531 includes thick left frontal fragments with medium bosses and imperceptible median crest, right femur shaft with oval section, and other fragments.

UCMA 6532 includes right femoral head of 46 mm., lower right tibia, and broken right talus with medium flexion facets and slight head diversion, all male (?). The right ankle of a female (?) shows a modal talus. Parietal fragments indicate a thick small vault gabled but not flat sided.

UM B–12 is the slightly warped broken calva of an infant 6–12 months old (pl. 1, *upper right*). Length (143 mm.), breadth 109 mm., frontal arc (95 mm.), parietal arc 91 mm., maximum frontal 92 mm., indicate mesocrany, and the morphology does not clearly anticipate the adults described.

UM B–106, a left radius 243 mm. long, is less mineralized than others and fits a stature of 168 cm.

UM B–82 and 86 are left and right lower humerus shafts planoconvex and prismatic in section, respectively.

UM B–83 plus B–177 is a lower left humerus shaft, planoconvex, 22 × 17 mm. (index 77.27), articulating with UM B–124, the upper ends of radius and ulna showing slight lipping at the elbow joint.

UM B–142 and 81 are paired rugged femoral shafts with massive cristae, slight fossae, no third trochanters, average bowing, prismatic sections, probable large maximum length, and considerable shaft flattening.

UM B–113 is a diamond (type IV) tibial shaft section 42 × 26 mm., platycnemic with index 61.90.

UM B–107 is a broken male right temporal with large rounded mastoid, elliptical meatus, and thick tympanic plate. Possibly B–83, –177, –81, –142, –113, and –107 all belong to a single tall male (176 cm. based on a femur length estimate of 483 mm. with head lacking).

Thus, beside 6 definite burials of adults (8 if UCMA 6075 is added), there are fragments of about 22 adults, 5 adolescents and children, and 3 infants. These are minimal figures and suggest that a fairly extensive cemetery and dwelling site may await excavation in an uneroded part of the area.

SYNTHESIS

The Tranquillity skulls are large, long, and extremely high, thick-walled, mildly byrsoid and phaenozygous in top view, and rounded *hausform* in back view. The forehead is not metrically narrow but is constricted behind and above lateral angles of heavy brow ridges, is low, sloping, and shows a perceptible median ridge running into the slightly grooved blunt parietal gable after interruption just before bregma. High temporal lines help define average parietal bosses, with temporal planes flat in rear view but fairly full from above. The occiput is deep with mound torus and clear-cut muscle insertion marks, but is not projecting despite a break in the profile curve near lambda. Muscularity is stressed in mastoid and zygomatic zones, and there are tendencies for elliptical auditory meatus and shallow glenoid fossae with gentle eminence slopes. The face is big and broad relative to braincase and especially relative to forehead. It is impossible to be sure of striking depth of the lower face because of teeth loss. Though cheekbones are strong anteriorly and orbits square, the orbits are not high and the suborbital region not flat. Nasion is only slightly depressed beneath a relatively flat downward extension of the strong glabella, and the nose root is low and smooth in a wide interorbital region. The nose itself is broad and probably not salient and has sills without gutters. Probable alveolar protrusion and broad palate are indefinite because of teeth loss which is clearly the end of a sequence of extreme down-to-gum teeth wear, crown caries leading to periapical abscesses, and paradontal disease. The sequence must have begun with food full of abrasive material, from mano and metate probably as well as meat, since teeth wear exceeds our expectation even for California. The jaw is solid, with strong chin by Indian standards (slight projection), incipient mandibular torus, square and compressed angles, and squat ramus.

Postcranial bones suggest statures of 169–172 cm. and 150–153 cm. for males and females (Trotter's Mongoloid formulae) exceeding recent San Joaquin

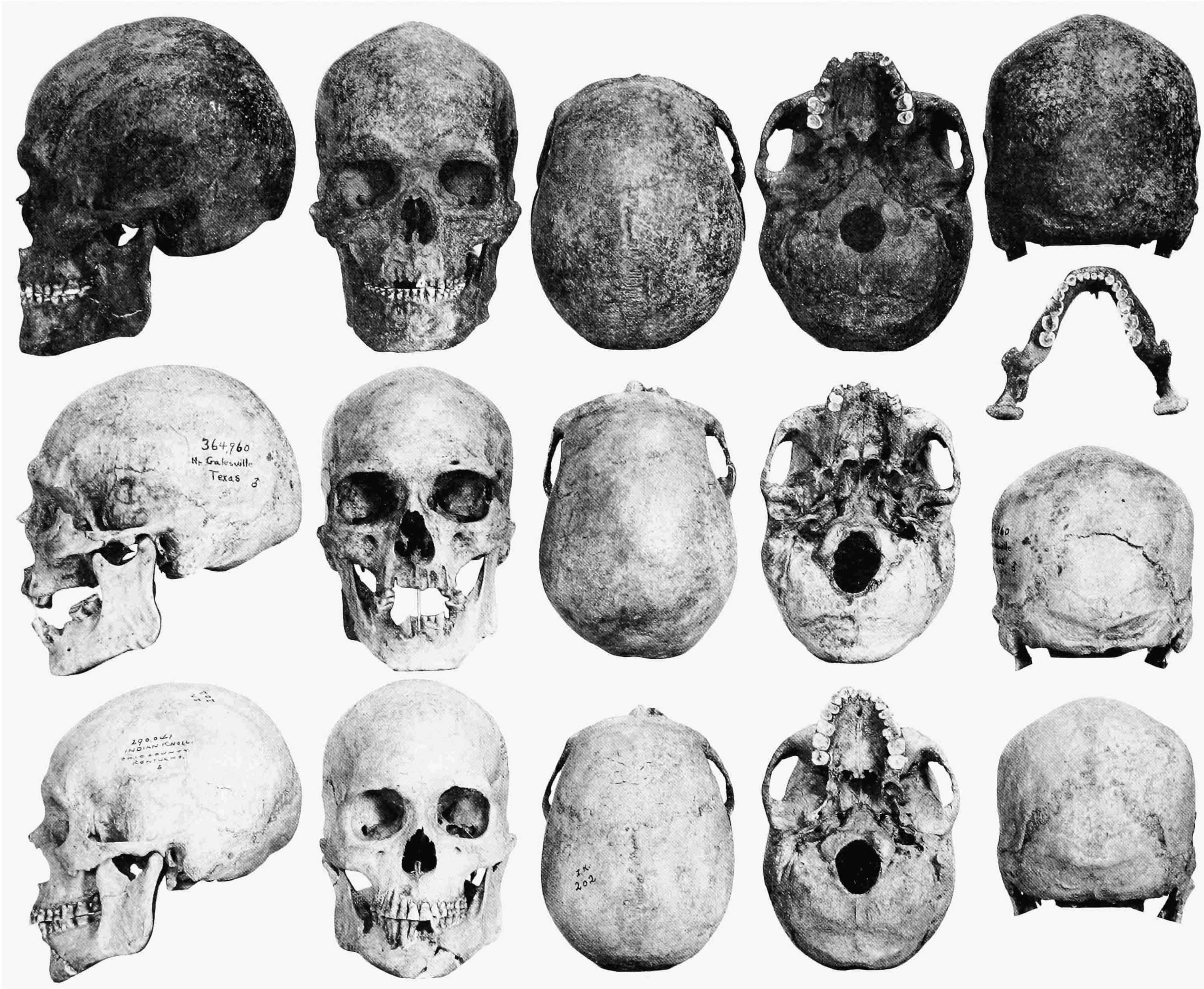

PLATE 3

Palaeamerican skulls from California, Texas, and Kentucky. *Upper row:* USNM 368964, male from Sandhill Mound, Sacramento Valley, Late Period Phase 1, 1st millenium B.C. (excavated by R. W. Heizer, 1933). *Middle row:* USNM 364960, male from rock shelter near Gatesville, Brazos river drainage, east central Texas, recent period (excavated by C. R. Bailey, 1933). *Lower row:* USNM 290041, male from Indian Knoll, Green River, Ohio Co., western Kentucky, 3d millenium B.C. (excavated by C. B. Moore, 1916). These illustrate the local diversity of Palaeamerican populations.

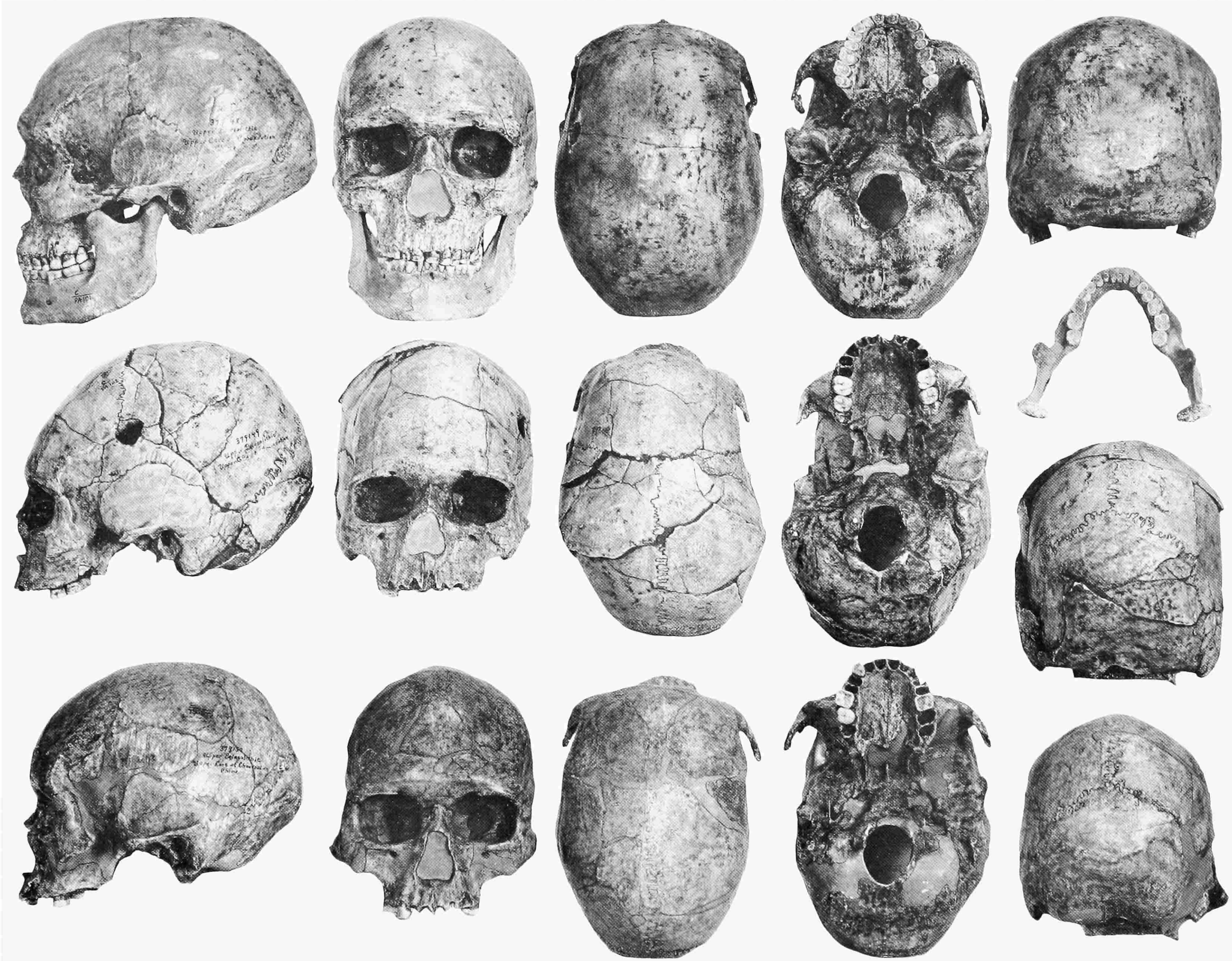

PLATE 4

Paleolithic skulls from Choukoutien, North China. *Upper row:* PA 101, the male skull from the Upper Cave at Choukoutien, North China, of latest Paleolithic date. *Middle row:* PA 102, female skull from this site. *Lower row:* PA 105, female skull from this site. Note striking contrasts with Tranquillity Burial 6. Chronologically and geographically these are closest to the first New World immigrants. (Excavated by W. C. Pei, 1933; casts made by Franz Weidenreich.)

(Stewart, 1941) and modern Yokuts (Gifford, 1926) standards without exaggeratedly Indian limb proportions. The brachial index is 77 (4) and the crural index 83.5 (3). With index of 75.8 (9), the humerus is less flattened than expected (Hrdlička, 1916; Rivet, 1909). A platymeric index of 75.6 (8) falls between much flattened East Algonquian femora (Hrdlička, 1916) and the Lower Californian Pericues (Rivet, 1909). Pilastric saliency is extremely marked with 114.0 (11) index, as in most American Indian and hunting groups. Low mesocnemic index of 66.4 (7) shows more tibial flattening than Pericues but less than Algonquians. With height index 57.2 (7) the talus is low, and calcaneal index of 56.2 (4) short. The femur robusticity index averages 12.3 for three females and is 13.4 in one male, indicating heavy bones. Body build is robust and similar to other California groups, Kentucky shell-midden gatherers (Snow, 1948), and other archaic groups. The similarity to Newman's (1957) Sacramento Valley samples, especially the Early horizon group, is closest except for the complete and very surprising lack of platymeria among these groups.

COMPARISONS

Small sample size makes comparison subjective. The Tranquillity group might be expected to resemble the early Palaeamerican groups or their survivors, except that these are themselves quite diverse, agreeing in little more than linearity of skull vault and lack of extreme Mongoloid features (cf. Stewart *in* Wendorf, 1955; R. W. Newman 1957; Neumann 1952). Nearby, a resemblance to Rivet's (1909) Pericues of Lower California is not surprising, even to the teeth wear, the long bone flattening and muscle ridges and the olecranon fossa perforation. The Pericues, however, are cranially too low and too narrow and facially too prognathous and too strong-jowled to be unchanged descendants of the Tranquillity people. Inhabitants of Santa Catalina and San Clemente Islands (Gifford, 1926, *after* Hooton) differ similarly as seen in table 3.

Locally, in the Central Valley of California and on the Santa Barbara coast (Kroeber, 1938; Heizer, 1939; Rogers, 1929; Newman, 1957), there is a clearcut microevolutionary change from Early to Late culture levels over the past 5,000 years or more of about the same order as recorded for Greece (Angel, 1951) or Egypt (Morant, 1925), and less sharp than noted by Hrdlička and by Laughlin (1963) for the Aleutian area. In the Sacramento Valley specifically, Newman (1957) shows the Early population to be bigger in size (though still not tall) with bigger, more robust and muscular, more linear and flatter-sided skull vault and much stronger-jawed face with less prognathism than the later populations. One might expect a similar sequence in the San Joaquin Valley, with the corollary that an extrapolation backwards in time of the trend established by Newman and observed by Heizer, by Kroeber, and by Stewart (1941), should approximate the Tranquillity sample. Although this is in general true in comparison with the late period Buena Vista sample (Stewart, 1941) from the hills near Tranquillity and with Gifford's (1926) San Joaquin sample, it does not work in detail. The Tranquillity vault is more linear than the Early Period group and equally robust and non-Mongoloid; but the face is less high, much wider-nosed, and has a jaw less strong in jowls and chin than expected by the suggested extrapolation. This face resembles Newman's (1957) small broad-faced type. If one considers this smaller, wider-nosed, and less rugged Tranquillity face as a small group variation, then local continuity seems a little stronger than the resemblance to Pericues or to Coastal Californians. On the basis of morphological similarities, the Tranquillity population closely approaches Gifford's (1926) samples and photographs of living Northern Hill Yokuts, Southern Miwok (less closely), and Western Mono. These are located around the Southern San Joaquin area and belong to Penutian and Shoshonean linguistic groups, which may well have been much more ancient in California and the Great Basin culture areas than other language stocks except Hokan (Kroeber, 1923; Klimek, 1935).

Actually the primary point is the long continuity in refuge areas of many Palaeamerican physical features (long high head, rugged brow ridges, deep jaw with square but not everted angles, relatively low face, and rather short broad nose) and not the possible associated antiquity of particular languages or culture patterns. I must stress, too, that this is continuity of physical traits and not of a type. The Western Mono, for example, are a low-headed version of this relatively non-Mongoloid trend, comparable to the Santa Catalina islanders.

In a broader geographic frame of reference one might expect similarity with other groups fitting what Neumann (1952) calls Otamid, and an approach to his Iswanid and Ashiwid groups although it is at once obvious that these latter variants in the southeast and southwest areas of the United States (cf. table 3) are much smaller in size. The early Texas coast series (Woodbury, 1937; Stewart, 1935; Hooton, 1933) is as close to the Tranquillity people as are the Pericues, differing only in having a longer and lower skull vault. On the other hand, the early Indian Knoll Kentucky

TABLE 3.—MEAN MEASUREMENTS OF SKULLS FROM TRANQUILLITY COMPARED WITH MALE SAMPLES FROM OTHER AREAS IN CALIFORNIA, PALAEAMERICANS IN TEXAS AND KENTUCKY, AND A COMPOSITE EAST ASIA GROUP (BORNEO TO NORTH CHINA)

Character	TRANQUILLITY [1]		BUENA VISTA		SACRAMENTO VALLEY		SANTA CATALINA AND SAN CLEMENTE ISLANDS		PERICUES		INDIAN KNOLL		TEXAS OTAMID		EAST ASIA [1]		Reference number in Martin (1928)
Region	San Joaquin Valley, South-central California		San Joaquin Valley, California		North-central California		South coast California		Lower California		Green River, Ky.		Oso and Big Bend, Tex.		Niah, Pho-BinGhia, Tzuyang, Liukiang, Upper Cave Choukoutien		
Period	Palaeamerican		Late		Early		Pre-Colonial		Pre-Colonial		Archaic		Archaic		Paleolithic-Mesolithic		
Date	10000–5000 B.C.		A.D. 1–1700		2500–1500 B.C.		A.D. 1–1700		A.D. 1–1700		3500–2500 B.C.		3500–2000 B.C.		40000–7000 B.C.		
Investigator	Angel		Stewart		R. W. Newman		Gifford, Hooton		Rivet		Snow		G. Woodbury		Brothwell, Verneau, Woo, Weidenreich		
	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	
Length	192. 0	4	183. 0	8	190. 4	43	190. 0	39	191. 6	12	178. 8	253	189. 6	22	192. 8	8	1
Breadth	137. 2	5	143. 0	9	144. 7	43	137. 0	32	126. 6	11	135. 4	258	130. 1	18	142. 4	8	8
Auricular height	125. 0	5	High	—	124. 1	31	Very low	—	Low	—	119. 0	239	[2] 117. 0	1	122. 6	7	21 vertex
Basion-bregma height	141. 6?	5	139. 0	8	145. 9	30	128. 0	30	131. 3	11	139. 9	227	134. 4	10	146. 4	5	17
Minimum frontal breadth	95. 2	4	—	—	97. 0	41	—	—	92. 2	10	91. 6	264	[2] 91. 3	8	100. 4	8	9
Bizygomatic breadth	136. 5	4	142. 0	8	143. 4	20	139. 0	28	138. 7	10	136. 0	246	136. 0	11	140. 0	5	45
Bigonial breadth	98. 2	4	—	—	110. 6	36	—	—	108. 8	3	104. 2	252	—	—	108. 0	3	66
Upper face height	68. 4?	5	73. 9	9	76. 4	26	74. 0	32	72. 8	12	70. 0	233	70. 2	9	68. 8	6	48
Chin height	35. 0	6	—	—	40. 0	40	—	—	38. 1	3	34. 4	223	[2] 36. 0	7	33. 6	5	69
Nose height	51. 5	4	51. 0	9	53. 0	31	54. 0	36	52. 6	12	51. 0	246	51. 8	12	49. 7	6	55
Nose breadth	28. 0	4	25. 0	9	26. 5	30	25. 0	37	26. 7	12	24. 4	248	26. 7	15	27. 7	6	54
Orbit height	34. 6	5	33. 9	9	35. 3	29	—	—	33. 0	12	33. 3	238	32. 7	12	33. 2	5	52
Cranial index	71. 7	4	78. 3	8	75. 8	41	[3] 72. 0	66	66. 2	11	75. 8	252	69. 2	18	74. 0	8	8/1
Fronto-Parietal index	69. 4	4	—	—	67. 5	41	—	—	72. 9	10	67. 8	253	[2] 68. 5	5	70. 4	8	9/8
Facial index	85. 3?	4	85. 4	6	88. 6	14	—	—	85. 3	3	86. 9	213	—	—	83. 0	4	47/45
Nasal index	54. 4	4	48. 9	9	50. 0	29	48. 0	67	50. 9	12	48. 0	239	51. 7	12	55. 9	6	54/55
Orbital index	87. 8	4	88. 3	9	89. 9	28	—	—	83. 3	12	78. 4	232	81. 8	12	78. 4	5	52/51a
Face profile angle	85. 5	4	—	—	88. 1	28	Mesognathous		Prognathous		84. 8	170	—	—	83. 2	5	72

[1] Includes female measurements increased by 6 percent.
[2] Oso only.
[3] Both sexes.

(Snow, 1948), Alabama (Newman and Snow, 1942) and Illinois shell-mound (Neumann, 1952) groups do differ in having relatively a shorter and higher and smoother vault, more flaring jowls, narrower noses, and flatter canine fossae. Southwest basketmakers differ even more (Seltzer, 1944), although Coahuila cave skulls, Tarahumare, and living Pima and Papago (Hrdlička, 1908) are apparently somewhat closer to the Tranquillity, Early California and "Otamid" norms (cf. pl. 3).

Stewart (1960) has pointed out that the Tzuyang skull from Southwest China and the Liukiang skull from South China both could be lost in samples of American Indian skulls, though these Upper Pleistocene crania are not closely similar and the Liukiang skull in low vault, brow ridges, nose, and palate shows features which are "Australoid" or perhaps represent Birdsell's (1951) hypothetical Amurian (or Ainoid) population. Neumann (Stewart, 1960) says essentially the same thing about the somewhat later Upper Cave skulls (pl. 4) from Choukoutien (Weidenreich, 1939). In the other direction, Hooton, Count, Hrdlička and many others (*quoted in* Stewart, 1960; Birdsell, 1951) have identified Paleo-Amerind individuals or even "types" which approximate Australoid or archaic White, and Negritoid or Melanesoid modes in East and Southeast Asia. These latter comparisons never apply closely to more than single morphologic complexes, for example, the low face, broad nose, and prognathism in some Tranquillity and California skulls. Hence the population labels are misleading, as Birdsell and Stewart both point out, since a single functional or genetic trait complex may appear characteristically in several different breeding populations or subraces. For example, the Liukiang South Chinese Paleolithic male skull, some Shang dynasty Chinese skulls (H-m. Yang, personal communication) and the female from Burial 5 at Tranquillity have low and broad noses, shallow malars, short faces and alveolar protrusion: a Negritoid (or Australoid ?) trait complex if one uses the usual type labels. The complex needs validation functionally (big incisor-canine crowns and growth restriction of anterior skull base ?) and genetically (analysis of data in family orthodontic research projects) and a reasonable code number (40001) or label (Squat IC). One could then plot the existence and frequency of such trait complexes as well as of single traits in time and space by populations and could avoid the absurdities found when a limited and purely metric comparison shows Palaeamericans from Alabama closer to a Northwest European isolate than to a Kentucky shell-mound group.

I run a different risk of absurdity in table 3 in comparing with Tranquillity and others an early Eastern Asia series, since this is an artificial average based on Niah (Brothwell, 1960), Pho-Binh-Gia (Verneau, 1909), Tzuyang (Chang, 1962; Woo, 1958), Liukiang (Chang, 1962; Woo, 1959), and the Upper Cave at Choukoutien (Weidenreich, 1939), with female measurements increased by 6 percent in order to approximate male averages. According to this sample the pool of peoples from which Palaeamericans may have come had big, long, and strikingly high skull vaults, rugged, scaphoid or *hausform*, without much Mongoloid constriction of forehead. They had short faces, broad throughout, with the expected wide noses and low orbits, perceptible prognathism and at the same time more facial flatness than in a White or Negroid population sample. This eastern Asiatic proto-Mongoloid norm does indeed show long-range resemblances to eastern Upper Paleolithics (Angel, 1952) and to Australoids (or Amurians and Negritoids), as well as to Palaeamericans. The Tranquillity sample differs in being more linear, with more pinched forehead and jaws and slightly higher lower face and orbits: changes in a Mongoloid direction. Other Palaeamerican samples, as shown in table 3, have bigger and slightly flatter faces and more pinched foreheads, as the fronto-malar angle shifts forward over the massvie dentition. There is also a trend toward shorter heads and much variation in head height and in Mongoloid morphology

Conclusions

From these speculations one can draw three conclusions, differing in certainty.

The most certain one is that the first invaders from Asia, the Palaeamericans, migrating southward over a timespan of 5–10,000 years after the height of the last glaciation (Willey, 1961), split up into many slightly differing breeding isolates, whose divergences occurred more through sampling accidents (drift) than through selection. The kind of variability of the Tranquillity sample, especially the extreme in Burial 5, supports this picture.

The least certain conclusion concerns evolutionary selective pressures resulting from a tough meat diet and hard living conditions leading to a short lifespan. These pressures would put a high premium on the fertility of a few women, especially those having massive teeth to resist wear (cf. Brace, 1962). Possibly Mongoloid features are a result of such pressures. The source for this extra tooth and face size not yet fully developed in late Pleistocene East Asia might be a recombination of genes from a tropical Negritoid population (contributing canine plus incisor breadth and prognathism) with genes from Sinanthropus descendants like Mapa (Woo, 1959 b; Coon, 1962) contributing shovel incisors and face massiveness, and perhaps also with Upper Paleolithic "White" genes. Evolution from such a proto-Mongoloid blend in a Mongoloid direction would have occurred in both Asia and America after 20,000 B.C. Apparently this evolution went much further in Asia.

The third conclusion concerns this difference in speeds of microevolution. The Tranquillity group in particular is still proto-Mongoloid and modern Hill Yokuts, Southern Miwok, and Western Mono appear to have changed little from it. Until very recently the tule-swamp character of the region had changed very little, except for the gradual (and late ?) extinction of most larger game mammals other than deer, and the ensuing wet phase. Regions of climatic and ecologic stability during the retreat of the last glaciation would probably be influenced by maritime climate and separated from the North or Plains areas.

In contrast to this, Northeast Asia, the Bering Strait region, and northern North America underwent a series of climatic and sea level changes comparable to those of Europe and the Mediterranean. Here there took place an evolutionary change to a big-faced, large-headed fully Mongoloid norm, equivalent to the Upper Paleolithic to Alpine and Mediterranean change in Europe and the Near East. A little of this Mongoloid change was plausibly injected into America in early Mesolithic times, and again to form the Aleut-Eskimo people (Laughlin, 1963) before 6,000 B.C. Until we have more data on frequencies of key traits and complexes, it is hard to guess whether the American Indian in general has absorbed Asiatic genes to any extent in post-Pleistocene times: the probable relation of Diego blood type to a Palaeamerican distribution and the lack of type B in the New World suggest that there was little addition from Asia after the end of the Pleistocene. In that case we are faced with an interesting parallelism in evolution in a Mongoloid direction, with the slower rate of change in America partly explained by relative climatic stability of southern coastal, island, mountain, jungle, and woodland ecologic zones as opposed to northern coastal, plateau, and plains areas, even though the variety of American ecologic zones is wide

Summary

1. Skeletons or bony fragments from at least 25 adults, 8 children, and 2 infants show a degree of chemical change ("mineralization") like that of bones of extinct *Camelops*, *Equus*, and *Bison* at the Tranquillity site near Tranquillity, Calif., as determined by Heizer and Cook. The human bones appear to be "paleontologically" Pleistocene in date.

2. Adult lifespan averaged 32 years in this band of hunters and gatherers of vegetable food. Although stature was tall (170+ cm. male estimate and 155 cm. female estimate), as estimated from nine skeletons, and the build muscular, the long bone shafts were flattened and show the "economy" of bone typical in hunting groups (Upper Paleolithic, Pericues, Algonquians) with just adequate diets.

3. Peculiar arthritis of the elbow, mostly in males, may reflect vigorous use of the atlatl. Vertebral arthritis developed early, with wedge fracture in one case. Olecranon septum perforation occurs in half the females and one male. The elbow peculiarities,

suprasacral iliac depressions, and occurence of an extra vertebra in Burial 5 may have genetic importance in a relatively isolated group.

4. Teeth wear was extreme, especially on incisors and upper teeth, exceeding the rate of wear in some Upper Paleolithic groups and producing periapical abscesses and early tooth loss which may have limited lifespan and thereby favored fertility of women with tough teeth.

5. The robust skulls are long and extremely high, with somewhat pinched foreheads and broad and strong-jawed faces having low-rooted broad noses. They differ little from the East Asiatic Pleistocene proto-Mongoloid norm so far established or from modern groups in the southern San Joaquin Valley. The Tranquillity skulls differ more from other California groups and from other Palaeamerican series as would be expected if microevolution in America over the past 20,000 years has involved sampling accident (drift) as well as isolation and selection.

6. American populations, except in the north, evolved much more slowly in a Mongoloid direction than Asiatic ones perhaps because of more stable, more varied, and less stringent dietary and climatic selective pressures.

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