NOTES ON THE SOMATOLOGY AND PATHOLOGY OF ANCIENT EGYPT

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R. WOOD LEIGH

UNIVERSITY OF CALIFORNIA PUBLICATIONS IN
AMERICAN ARCHAEOLOGY AND ETHNOLOGY
Volume 34, No. 1, pp. 1-54, 7 plates

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY, CALIFORNIA
1934

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Volume 34, No. 1, pp. 1–54, 7 plates

Issued June 22, 1934

Price, 75 cents

University of California Press
Berkeley, California

Cambridge University Press
London, England

PRINTED IN THE UNITED STATES OF AMERICA

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INTRODUCTION

THIS STUDY is based on an examination of the Egyptian skeletal collection in the Museum of Anthropology, University of California. Opportunity for observing this valued group was afforded by Professor A. L. Kroeber, director of the museum. The collection was made by the Hearst-University of California Expedition (1899–1905) directed by G. A. Reisner. The collection is the largest and probably the most representative, geographically and chronologically, of any in America. Reisner's monograph(6)* is the archaeological background as to provenience and chronology. Excavations were made at Gizeh, El-Ahaiwah, and Naga-ed-Der. The director of the expedition relates that at El-Ahaiwah a Predynastic cemetery, and one of the late New Empire, were excavated. At Naga-ed-Der in the Thebaid the series of cemeteries was found to be nearly complete from the earliest Predynastic period down to the present day. From the necropolis at Gizeh in the Delta were recovered bodies of the official class of the Pyramid-builders. G. Elliot Smith did the anatomical work of the expedition.

The material is fragile because of its extreme age—some of it, roundly, is six thousand years old—and because of the exigencies of collecting, packing, shipping, and an extended exhibit in Cairo before it was sent to Berkeley. Therefore some of the skeletons are fragmentary; but all cranial specimens, including calvarium, facial bones, and teeth, were examined and notes were made on them, though details of descriptive characters and measurements were carded for only two hundred and thirty. The craniometric measurements were made in accordance with the definitions and technique outlined in Hrdlička's Anthropometry. The instruments and aids used were: *compass d'épaisseur, compass glissière,* metric rule, copper wire, and hand lens.

SOMATOLOGY

There is a rich literature on the somatology of ancient Egypt, with some differentiation of various stocks which entered the Nile valley in the course of history. Only certain facial measurements and an attempt at appreciation of some non-measurable features of maxillae and dentition were made on this group.

* Superior figures refer to works cited.

The stature was slight; the height probably averaged about 66 inches; the figure was agile and pleasing. Skulls from Predynastic burials are extremely narrow at the temples, diverging toward the parietal bosses, rather longish, but characteristically pentagonoid or coffin-shaped when viewed from the vertex. When better filled the outline is ovoid. There is a prominent roundish eminence of the occiput between the crest and lambdoid suture. The forehead tends to be vertical and fairly high. There are rather high, distinct temporal crests, which indicate a fairly well developed masticatory musculature. The zygoma are peculiarly flat laterally and thus harmonize with the lateral aspect of the calvarium. The bridge of the nose is high, smooth, and well formed. The face is orthognathous (*vide* gnathic index). The whole cranium is refined in structure. The palate is usually ovoid, or elliptical, and thus simulates the outline of the vertex; it is uniformly symmetrical and pleasing in outline, and malposition of teeth is extremely rare.

MANDIBLE

With respect to racial variation, Smith[8] has this to say of the mandible: "It is a part of the skeleton which lends itself most admirably to the display of those racial contrasts, such as are associated with other differences of skull and skeleton." Greenwell and Rolleston insisted upon the exceptional importance of the mandible as a racial document. Great muscular development will alter the size and the ruggedness of the bone, but cannot affect those essential features in its form which reveal racial traits. Nor, again, is the shape of the bone, they say, determined wholly by the form of the cranium, as some anatomists maintain.

In races in which there are well defined sexual differences, the mandible may serve as an important aid in sex determination. The female mandible is usually smaller, more delicate in outline and surface, smoother; the areas of insertion of the musculature are not so rough as in the male; as a rule, the angle is more obtuse in the female. But the sexual characters of the Egyptian skull are ill defined as a rule, and sex determination from the whole skull is often attended with considerable uncertainty. The Nubians of the upper Nile were similar, according to Jones[4]: "The sexual characters of the skull are often ill-defined, and, therefore, sex determination therefrom is not altogether certain." Male skulls listed as female would of course vitiate data for statistical results. Indices derived from the craniometric measurements would seem to indicate, however, a correct trend in my sex determination by cranial characters, including mandibular.

Two distinct mandible types appear in Egypt. The archaic type is rather small; relative to the body, the ramus is short and broad, the angle is definite, the anterior border of the ramus is an open S with the concavity beyond the third molar and a considerable convexity below the coronoid process; the sigmoid notch is a wide graceful crescent, the impressions of the insertions of the muscles are prominent, the gonions may be slightly everted, the chin is pointed. This type comes from all the sites.

Another type, apparently more recent and possibly of an intrusive stock, of frequent occurrence at Naga-ed-Der, exemplified by 4804*, XII Dynasty, is characterized by a high narrow ramus, surmounted by a high pointed coronoid process, a fairly deep sigmoid notch, a fairly straight anterior border of the ramus, an angle singularly obtuse and indefinite, large mental foramina, smooth rounded menton. This type of mandible is effeminate. There is, of course, a range of variation in both the archaic and more recent types.

Tables 1 and 2 give the complete data of mandibular measurements for males and females respectively. Table 3 gives the range of mandibular measurements—a summary. It is of interest to compare these figures with the measurements of a royal mandible of the XVII Dynasty as given by Smith(9): "The jaw conforms to the Egyptian type: the bigonial breadth is 95 mill., the bicondylar breadth is 135 mill., the height of the symphysis is 37 mill., and the vertical measurement of the sigmoid notch is 46 mill. The length and breadth of the palate are 59 mill. and 38 mill. respectively." Palate breadth is to be distinguished from alveolar breadth in my tables.

There is no appreciable difference between the two sides of the mandible; that is, with but very few exceptions it is symmetrical. The slight but consistent sex difference in table 3 would seem to indicate that my sex determination tended to be correct, as the range for females is smaller than the range for males. This contrast also holds, but to a slighter degree, for the maxillary measurements.

Superior and inferior genial tubercles are two pairs of small, and for many races sharp, spines near the lower part of the inner side of the symphysis for the genio-glossi and genio-hyoid muscles respectively. These tubercles on more than half of the Egyptian mandibles are low, rounded, or ill defined. Even on males, which ordinarily have larger and sharper tubercles than females, they are poorly developed. The character of the genial tubercles is in keeping with the small, refined mandible of the Egyptian.

The mental foramen for the terminal branches of the inferior dental nerve and artery is located somewhat below the middle of the mandible and anteroposteriorly anywhere from the apex of the first premolar to below the mesial root of the first molar, the mode being the position below the second premolar. Table 4 gives the data for location of this foramen. There were occurrences of accessory foramina.

* These are not the Reisner original field numbers; they are the Museum permanent numbers as entered in its catalogue 12. The original field numbers are on record in the catalogue. To avoid needless repetition the 12- has been omitted in front of the specimen numbers in this paper.

TABLE 1

MANDIBULAR MEASUREMENTS

(59 males)

Mus. no.	Age	Bicon.	Big.	Sym.	Body		Ramus		H. S. Notch		Men. For.		Miscellaneous
					R	L	R	L	R	L	R	L	
5088	....	....	92	....	28	29	30	31	48	47	Pm2	Pm2	Large m. foramina
5237	35	....	....	38	....	28	....	29	....	44	....	Pm2	
5230	30	....	96	38	29	30	34	....	51	....	Pm2	Pm2	
5190	50	....	....	36	30	31	....	35	....	....	Pm1-2	Pm2	Angular, everted g.
5143	45	....	....	38	27	....	28	....	57	....	Pm2	Pm2	Accessory m. foramina
5142	55	124	100	37	33	33	35	34	53	54	M1	....	
5125	60	109	96	38	33	33	29	28	52	48	Pm2	Pm2	
5231	40	....	100	30	28	26	33	34	46	....	Pm1-2	Pm1-2	
5164	75	......	80	....	30	30	32	32	56	55	....	Pm2	
4840	40	118	103	31	26	27	33	33	44	41	Pm2	Pm2	Large m. foramina
5200	50	122	93	32	32	30	33	33	56	55	Pm2-M	Pm2-M	
5195	55	114	87	35	31	28	34	36	52	51	Pm2-M	Pm2-M	
5177	70	111	98	29	28	28	31	31	57	59	Pm2	Pm2	Senile
4873	55	....	87	37	31	32	29	35	....	48	Pm2	Pm2	High coronoid
4803	65	117	92	36	27	27	33	32	55	53	Pm2	Pm1-2	Osteo-arth. left
4895	60	121	102	40	32	....	31	32	52	51	Pm2	Pm2-M	Heavy accretions
5219	75	......	96	31	....	....	31	33	52	53	Pm2	Pm2	Attrition: sequelae
5187	50	109	96	29	....	27	33	35	53	51	Pm2	Pm2	Gonions everted
4887	55	117	100	32	29	31	35	34	52	50	Pm1-2	Pm1-2	
5080	60	118	95	37	29	30	30	31	55	52	Pm1-2	Pm1-2	Heavy accretions
4819	35	109	93	33	26	28	33	33	49	48	Pm2	Pm2	
5174	65	114	100	31	31	32	30	35	....	52	Pm2	Pm2	
4834	70	115	94	36	37	37	36	37	....	50	Pm2-M	Pm2	
4865	45	119	106	35	32	31	31	34	56	53	Pm2	Pm2	
5061	40	116	92	27	30	26	32	32	42	38	Pm2	Pm2-M	Roundish angle
5070	65	116	100	36	30	31	31	31	57	57	Pm2	Pm2-M	
4798	65	116	89	39	35	....	36	36	52	50	....	....	
5092	60	110	90	30	31	29	33	32	49	50	Pm2	Pm2	High coronoid

TABLE 1—(*Concluded*)

Mus. no.	Age	Bicon.	Big.	Sym.	Body		Ramus		H. S. Notch		Men. For.		Miscellaneous
					R	L	R	L	R	L	R	L	
4784	50	113	99	36	28	27	36	32	41	39	....	....	
4801	65	......	....	35	35	....	37	....	58	....	Pm2–M	....	Large
4832	30	108	93	35	30	28	32	31	53	52	Pm1–2	Pm1–2	Angle obtuse, ramus h.
5078	50	120	98	44	36	33	33	37	54	52	Pm2	Pm2	
4804	40	115	101	37	33	33	36	36	57	57	Pm2	Pm2	
4907	35	......	96	29	27	28	30	30	....	47	Pm2	Pm2	
4891	30	......	....	33	29	28	33	....	49	....	Pm2	Pm2	
5033	35	114	92	38	31	31	32	31	53	52	Pm2–M	Pm2–M	
5043	35	......	100	32	29	30	....	....	....	....	Pm2	Pm2–M	Accessory m. foramina
5066	45	......	....	31	30	29	....	35	....	48	Pm1	Pm1	
5175	45	......	87	30	28	30	30	31	52	51	Pm2	Pm2	
5152	45	105	88	35	31	30	37	37	47	45	....	Pm2	
5202	45	113	90	....	27	26	37	37	42	42	Pm2–M	Pm2–M	
5150	45	......	....	....	....	28	32	32	53	53	....	Pm1–2	
5180	60	114	98	33	35	30	39	29	67	54	Pm2	Pm2	Asym., arthritis right
5148	50	......	99	39	36	37	37	....	63	....	....	....	Frac. neck left condyle
5199	50	109	92	33	32	33	35	35	....	56	Pm2	M1	
5222	55	114	103	30	28	29	31	30	51	52	Pm2	Pm2	High ramus-type
5169	40	......	....	34	31	34	31	31	52	56	....	Pm2	
5211	50	......	....	....	32	31	....	36	....	54	....	Pm2	
5243	55	......	93	32	28	27	....	29	48	45	Pm1–2	Pm1–2	
5215	40	......	95	37	34	34	38	....	54	....	M1	Pm2	
5168	45	......	91	32	28	28	31	33	55	54	Pm1–2	Pm1–2	No lesions
5191	55	121	93	33	28	29	33	34	54	50	Pm2–M	Pm2–M	Periodontoclasia
5160	50	123	101	33	33	....	31	34	55	58	Pm2–M	Pm2–M	Accretions large
5250	40	......	....	34	32	32	31	33	47	46	Pm2–M	Pm2–M	Pm roots bifurc.
5178	55	......	....	32	....	30	31	34	48	48	Pm2	Pm2	Lesion right
5179	50	......	....	32	32	32	35	37	56	58	Pm2	....	
5184	50	114	87	36	30	31	33	35	48	46	Pm2–M	Pm2–M	High coronoid
5247	40	......	....	36	31	....	33	....	....	....	Pm2	Pm2	High ramus
5240	50	......	....	31	....	31	....	33	....	....	....	Pm2	Men. foramen bifid

TABLE 2

MANDIBULAR MEASUREMENTS

(50 females)

Mus. no.	Age	Bicon.	Big.	Sym.	Body		Ramus		H. S. Notch		Men. For.		Miscellaneous
					R	L	R	L	R	L	R	L	
5228	75	112	91	31	....	....	30	27	48	46	....	....	Senile
5065	70	114	87	33	....	....	31	30	45	44	Pm2–M	Pm2	Senile
5060	75	105	87	25	22	24	27	28	42	39	Pm1–2	Pm1–2	Senile
4809	75	112	96	31	29	29	32	32	47	44	Pm2	Pm2	Senile. Parietal mark
4793	25	110	92	35	30	32	29	31	....	....	Pm1–2	Pm1–2	High, narrow ramus
4878	70	113	89	35	....	31	32	33	45	43	Pm2–M	M	Alveolus resorbed
5181	55	110	....	31	29	....	35	36	40	41	....	Pm1–2	Ramus short, broad
5122	45	107	86	27	....	....	31	30	47	43	Pm1–2	Pm2	Anomaly on r. condyle
5201	70	......	88	26	24	26	30	32	47	41	Pm1–2	Pm1–2	Senile
5162	45	......	....	32	27	27	31	33	46	43	Pm1–2	Pm1–2	
4811	30	100	85	33	27	28	30	30	42	41	Pm2	Pm2	Men. foramina large
4794	40	106	85	30	28	29	31	30	49	48	Pm2–M	Pm2–M	Men. foramina 4 mm.
4866	30	109	90	24	26	24	32	30	49	47	Pm2	Pm2	
5234	45	108	82	33	30	....	30	33	41	37	Pm2	Pm2	
5029	45	......	....	36	24	24	30	29	46	46	Pm2–M	Pm2–M	
5050	20	113	95	25	29	29	35	35	46	46	Pm2–M	Pm2	Predynastic type
4870	55	113	97	35	27	28	34	34	47	47	Pm2	Pm2	
5064	18	......	....	24	24	23	34	33	44	42	Pm1–2	Pm1–2	Men. foramina large
5140	45	102	86	27	....	....	28	27	42	41	Pm2	Pm2	
5248	40	......	....	32	29	30	....	32	....	....	Pm2	Pm2	
5171	30	......	....	33	28	28	33	33	54	54	Pm2–M	Pm2–M	
5159	35	......	....	....	26	28	....	31	....	52	Pm2–M	Pm2	
5157	35	95	77	30	27	28	31	31	44	43	Pm2	Pm2	Teeth very small
5238	20	......	....	23	23	25	28	29	44	46	Pm2–M	Pm2–M	

TABLE 2—*(Concluded)*

Mus. no.	Age	Bicon.	Big.	Sym.	Body		Ramus		H. S. Notch		Men. For.		Miscellaneous
					R	L	R	L	R	L	R	L	
5057	25	......	....	31	26	26	31	32	45	42	Pm2	Pm2	No lesions
5192	30	105	87	27	23	23	31	32	41	40	Pm1–2	Pm2	Mandible small, refined
5144	18	104	89	27	....	22	....	30	....	38	....	Pm1–2	Sub-adult
5046	45	112	101	34	28	29	34	36	53	50	....	....	
4800	70	108	81	29	25	29	27	29	44	46	....	....	Senile
5014	35	114	88	33	30	31	33	34	42	46	Pm2–M	Pm2	Ramus angular
5032	18	......	....	30	....	23	....	35	....	40	....	Pm1–2	Sub-adult
5063	55	......	....	32	....	32	30	....	44	....	Pm2–M	Pm2	Men. foramen bifid
5249	60	......	....	....	....	30	....	26	....	....	Pm2–M	Pm2–M	
5151	65	......	....	....	....	....	....	31	....	....	....	....	Ramus narrow
5165	55	......	....	32	28	....	31	34	46	46	Pm2	Pm2	Accretions heavy
5149	40	113	93	29	24	25	32	32	56	50	Pm2	Pm2	High, narrow ramus
5232	35	......	....	27	31	31	33	34	51	46	Pm2–M	Pm2–M	
5244	75	114	96	30	29	....	29	29	42	43	Pm1–2	Pm1–2	Senile
5155	30	111	92	28	24	24	33	33	44	44	....	Pm2	
5207	40	......	95	31	26	26	26	25	44	44	Pm1–2	....	Refined
5189	35	106	90	27	28	29	27	28	55	55	Pm2–M	Pm2–M	Roundish angle
5059	55	110	97	....	....	....	32	34	51	48	Pm2	Pm2	Alveoloclasia
5151	40	......	84	35	27	25	32	31	54	53	Pm1	Pm1–2	
5229	60	114	85	31	30	....	30	31	47	46	Pm2	Pm2	
5224	65	115	87	27	26	....	29	29	45	44	Pm2	Pm2–M	
5158	50	105	91	33	29	....	30	31	43	41	Pm2–M	Pm2–M	
5225	35	......	....	....	26	28	....	29	....	....	Pm2	....	Very small teeth
5163	45	......	....	28	28	25	25	....	50	....	Pm2	....	
5030	40	100	83	33	29	26	32	32	47	46	Pm2	Pm2–M	Lesion in left lingual
5121	35	113	98	28	24	23	29	29	41	43	....	....	

TABLE 3

RANGE OF MANDIBULAR MEASUREMENTS

Measurement	Average		Minimum		Maximum		Mandibles	
	M	F	M	F	M	F	M	F
Bicondylar	115	109.2	105	100	124	115	(32)	(30)
Bigonial	95.3	89.8	87	81	103	101	(44)	(32)
Symphysis	34.6	30.9	30	27	44	36	(50)	(39)
Body	30.3	28.6	26	26	37	32	(52)	(27)
Ramus—minimum	33	30.8	28	26	38	36	(52)	(44)
Sigmoid notch—height	51	45.8	38	40	58	56	(48)	(40)

TABLE 4

LOCATION OF MENTAL FORAMEN

(Per cent)

M_1		M_1-Pm_2		Pm_2		Pm_2-Pm_1		Pm_1		Mandibles	
M	F	M	F	M	F	M	F	M	F	M	F
3.5	1.1	20.5	25.5	59.8	46.8	14.2	25.5	1.8	1.1	(56)	(45)

Asymmetry

Males	Females
16	12.2

PALATE

Palate form is an important racial feature; there is a conformation, architecture, peculiar to distinct races. Length and breadth measurements of the palate, while of some value, do not convey adequately a realistic concept of its particular form; and, of course, leave off any idea of curvature or height. Photographs or projection drawings from the palate itself convey a truer idea of the type form. Fifty per cent of the Egyptian skulls have a roughly-elliptical shaped palate; in 25 per cent the lateral lines diverge—parabolic; and nearly 25 per cent have somewhat parallel sides—U-shaped; while a very few are rotund. A medium height predominates, with gradations either way of shallow and high.

Tables 5 and 6, Maxillary Measurements, give the palate length, from prosthion to alveolon; and alveolar breadth, the maximum spread outside the alveolar process. The ratio of breadth to length is the maxillo-alveolar index, which also is given in the same tables for males and females respectively. This maximum breadth spread is from 100 to 127 per cent of the palate length;

the average for males is 115.3, and for females 118.1. Analysis of data for the maxillo-alveolar and other indices to determine homogeneity or heterogeneity of a group is made by first arranging the measurements in seriation. Each index will show an extended range of variation; and there will appear some aberrations, discontinuous numbers, and other oddments in the range. If the original data card for such an aberrant number be consulted, the cause of the oddity will often be apparent, for example, senility, sub-adult, edentulous, pathologic deformity, or there may be some racial intrusion. Then the range of numbers is subdivided or given a classification; and the percentage of occurrences falling in each class is determined. The degree of similarity of the individuals will now appear.

Table 7, Classification of Indices, subdivides the range of maxillo-alveolar index as follows: dolichouranic 109.9 and under, mesuranic 110 to 114.9, brachyuranic 115 and over. The percentage of palates in each class, and for the sexes separately, is given. It is to be noted that more than 50 per cent are in the broad-palate class.

DENTAL INDEX

The dental length is the distance from the mesial surface of the maxillary first premolar to the distal of the third molar, all post-cuspid teeth in situ. The ratio of this length to the basion-nasion length is the dental index. The range of this index is divided into microdont up to 41.9, mesodont 42 to 44, megadont above 44. Table 7 gives the percentage of skulls of this group in each class. It occurs that about 66 per cent are microdont, possessing small teeth.

GNATHIC INDEX

The gnathic index of Flower is an important cranial criterion for determining racial relationships. This index is the ratio of the basion-prosthion length to the basion-nasion length; the greater the ratio, percentage, or index, the greater is the projection of the jaw, and consequently the more ape-like is the countenance. In short, it is an indication of facial prognathism. The range of this index is divided as follows: orthognathous below 98, mesognathous 98.1 to 103, prognathous above 103. It so happens that the ancient Egyptians have a low gnathic index, my average for sixty-nine males being 95.2, and for seventy-one females, 95.6. Reference to table 7 will show that approximately 75 per cent are in the orthognathous class; and only three skulls have a prognathous index, one of which was so aberrant that I concluded that he was intrusive, doubtless Negroid. The range is from 85.1 to 104.9 in the entire group. With only two or three exceptions the skulls in the mesognathous and the three in the prognathous classes came from the Naga-ed-Der site and from all eras apparently—Predynastic to Coptic.

The table indicates a general correlation between the orthognathous and microdont, mesognathous and mesodont; in short, the straighter the face, the

TABLE 5

Maxillary Measurements

(69 males)

Mus. no.	Age	P-A	AW	M-A I	B-P	B-N	G I	DL	DI	Miscellaneous
5095	60	49	59	120.4	92	108	85.1	39	36.1	
5125	60	48	61	127	92	104	88.4	....	....	Multiple osteitis
5111	60	49	58	118.3	88	99	88.8	38	38.3	
4789	60	53	63	119	89	99	88.8	39	39.3	
4850	55	52	62	119.2	92	103	89.3	40	38.8	
5231	40	49	62	126.5	93	104	89.4	40	38.4	
4782	55	56	64	114.2	98	109	89.9	39	35.7	
4833	75	....	....	....	94	104	90.3	....	....	Senile
5133	50	51	63	123.5	93	103	90.3	40	38.8	
5164	75	....	....	....	90	99	90.9	....	....	Arthritis l. temporo-mandibular
4787	65	53	61	115	91	100	91	38	38	
5106	50	51	63	123.5	92	101	91	41	40.5	
5067	50	55	67	121.8	95	104	91.3	42	40.3	
4840	40	54	64	118.5	96	105	91.4	42	40	
5200	50	52	63	121	96	105	91.4	42	40	
5104	45	53	67	126.4	96	105	91.4	41	39	
4783	35	48	60	125	89	97	91.7	....	....	Metopic suture
4869	55	55	68	123.6	90	98	91.8	40	40.8	
5195	55	51	60	117.6	92	100	92	40	40	
5177	70	....	....	....	94	102	92	....	....	Senile
4873	55	52	62	119.2	96	104	92.3	....	....	
4839	40	57	64	112.2	101	109	92.6	41	37.6	Metopic suture
4861	30	55	68	123.6	100	108	92.6	44	40.7	
4847	65	54	64	118.5	97	104	93.2	....	....	

TABLE 5—(*Continued*)

Mus. no.	Age	P-A	AW	M-A I	B-P	B-N	G I	DL	DI	Miscellaneous
4803	65	56	66	117.8	96	103	93.2	39	37.8	Arthritis l. temporo-mandibular
4895	60	57	63	110.5	100	107	93.4	42	39.2	Periodontoclasia
4790	55	56	63	112.5	100	107	93.4	41	38.3	
5114	75	....	....	....	88	94	93.5	....	....	Senile
5219	75	....	....	....	97	103	94	....	....	Attrition—extreme
5187	50	54	56	103.7	95	101	94	41	40.6	
4864	70	54	61	112.9	98	104	94.2	....	....	
4887	55	56	66	117.8	100	106	94.3	42	39.6	
4849	25	51	63	123.5	93	98	94.9	42	42.8	
5080	60	54	63	116.6	96	101	95	42	41.5	Accretions
5012	55	57	64	112.2	99	104	95	40	38.4	
5115	45	53	63	118.8	91	95	95.7	41	43.1	Wormian bones
4819	35	56	56	100	95	99	95.9	40	40.4	
5174	65	55	65	116.3	97	101	96	....	....	Metopic suture
5127	55	55	62	112.7	98	102	96	....	....	
4786	30	54	62	114.8	90	94	96	40	42.5	
4834	70	57	65	114	100	104	96	43	41.3	Fistulae in palate
5049	70	....	....	....	99	103	96.1	....	....	
4857	50	53	64	120.7	97	100	97	....	....	
4865	45	57	70	122.8	97	100	97	40	40	
5101	60	53	62	117	97	100	97	44	44	
4823	40	58	63	108.6	99	102	97	46	45	
5071	35	57	70	122.8	101	104	97.1	45	43.2	
5004	40	52	61	117.3	91	93	97.8	43	46.2	L. malar traumatized
4856	30	57	61	170	101	103	98	43	40.5	
5130	60	58	64	110.3	99	101	98	40	39.6	Osteomyelitis. Metopic suture
5109	30	53	63	118.8	90	91	98.9	39	42.8	
5061	40	56	61	108.9	97	98	98.9	42	42.8	Fistula in palate

TABLE 5—(*Concluded*)

Mus. no.	Age	P-A	AW	M-A I	B-P	B-N	G I	DL	DI	Miscellaneous
5105	40	52	64	123	98	99	99	43	43.4	
5137	40	56	63	112.5	98	99	99	41	41.4	
4952	35	56	66	117.8	102	103	99	44	42.7	
5136	55	69	70	101.4	103	104	99	43	41.3	Oblong skull
4897	30	57	64	113.2	101	101	100	39	38.6	
5070	65	59	68	115.2	101	101	100	43	42.5	
4837	35	54	60	111	99	99	100	42	42.4	
4822	25	54	60	111	96	96	100	42	43.7	
4821	30	51	61	119.6	94	94	100	40	42.5	
4841	45	58	67	115.5	104	104	100	43	41.8	
4791	50	59	62	105	103	103	100	42	40.7	
4798	65	56	59	105.3	99	99	100	....	....	
4894	40	56	70	125	98	96	102	43	44.7	Atypical—scaphoid
5092	65	53	60	113.2	98	96	102	40	41.6	
5184	50	56	60	107	100	98	102	....	....	Coronal fracture
4859	65	62	64	103.2	99	97	102.7	47	48.4	Sub-nasal prognathism: 26 mm.
4796	50	61	62	101.6	103	100	103	44	44	Sub-nasal prognathism
4781	45	59	65	110	102	94	108.5*	44	46.8	Prognathism: mapped out
5028	50	55	64	116.3	......	......	....	....	....	
4816	40	52	57	109.6	......	......	....	....	....	
5087	55	51	60	117.6	......	......	....	....	....	
4858	45	57	66	115.8	......	......	....	....	....	
4996	60	52	65	125	......	......	....	....	....	
5237	35	54	61	113	......	......	....	....	....	
5230	30	57	62	108.7	......	......	....	....	....	
5190	50	58	68	117.2	......	......	....	....	....	Large, rugged skull
5143	45	57	61	107	......	......	....	....	....	
5142	55	69	64	92.7	......	......	....	....	....	Large. Metopic suture

TABLE 6

MAXILLARY MEASUREMENTS

(71 females)

Mus. no.	Age	P-A	AW	M-A I	B-P	B-N	G I	DL	DI	Miscellaneous
4845	40	51	63	123.5	91	95	85.2	42	44.2	Osteo-periosteitis
4945	65	50	61	122	88	100	88	....	....	Radicular cyst
5228	75	....	....	....	92	104	88.4	....	....	Nearly edentulous
5072	35	49	59	120.4	88	98	89.8	36	36.7	M^3 diminutive
5117	60	50	62	124	86	95	90.5	....	....	Senile
5065	70	....	....	....	88	97	90.7	....	....	Extreme attrition
5060	75	....	....	....	88	97	90.7	....	....	Senile
4810	45	51	57	111.7	88	96	91.6	....	....	
5085	55	52	58	111.5	88	96	91.6	40	41.6	
4809	75	....	....	....	90	98	91.8	....	....	Osteo-periosteitis-parietal
4779	50	49	60	122.4	91	99	91.9	....	....	
5025	40	45	54	120	85	92	92.3	36	39.1	
4829	35	51	61	119.6	90	97	92.7	39	40.2	
4830	25	48	61	127	89	96	92.7	....	....	
4852	75	....	....	....	95	102	93.1	....	....	
5103	55	49	48	97.9	88	94	93.6	....	....	
5123	60	50	61	122	89	95	93.6	42	44.2	
4886	35	51	58	113.7	89	95	93.6	38	40	Osteitis left maxilla
4843	40	51	56	109.8	88	94	93.6	39	41.4	
4892	25	46	55	119.5	88	94	93.6	39	41.4	Malocclusion
5131	50	48	50	114	90	96	93.7	35	36.3	
5107	20	50	58	116	91	97	93.8	40	41.2	
4878	70	55	67	121.8	91	97	93.8	39	40.2	
4797	75	52	59	113.4	92	98	93.8	....	....	
4851	40	54	66	122.2	92	98	93.8	41	41.8	
4799	75	....	....	....	94	100	94	....	....	Senile
5006	55	....	....	....	90	95	94.7	....	....	
5068	65	52	47	90.4	90	95	94.7	....	....	Senile

TABLE 6—(*Continued*)

Mus. no.	Age	P-A	AW	M-A I	B-P	B-N	G I	DL	DI	Miscellaneous
4780	35	51	56	109.8	93	98	94.9	38	38.7	
4822	55	54	59	109.2	93	98	94.9	40	40.8	
4842	30	51	64	125.5	96	101	95	41	40.6	
5181	55	51	56	109.8	95	100	95	....	....	Archaic type mandible
5084	60	50	57	114	90	94	95.7	....	....	
5122	45	50	57	114	91	95	95.7	....	....	Anomalous process r. condyle
5201	70	....	....	....	90	94	95.7	....	....	Senile
4817	16	51	61	119.6	90	94	95.7	....	....	Sub-adult
4827	55	49	55	112.2	89	93	95.7	....	....	
5112	60	53	55	103.7	94	98	95.9	....	....	
4795	65	52	62	119.2	95	99	95.9	....	....	Maxillary sinusitis—right
4848	35	52	61	117.3	95	99	96	41	41.4	
5083	30	48	58	120.8	89	92	96.7	....	....	Metopic suture
5162	45	48	57	118.7	90	93	96.7	40	43	Inferior cuspid root bifid
4922	70	53	57	107.5	91	94	96.8	....	....	
5108	20	51	61	119.6	93	96	96.8	....	....	
5134	40	53	56	105.6	92	95	96.8	40	42	
4788	40	57	61	107	95	98	96.9	41	41.8	Impacted right cuspid
5093	30	50	58	116	87	89	97.7	39	43.8	
4916	30	48	54	112.5	90	92	97.8	36	39	M^3 diminutive
5115	70	....	....	....	90	92	97.8	....	....	Wormian bones
4802	30	52	57	109.6	92	94	97.8	....	....	
4808	25	52	59	113.4	92	93	97.8	42	45	
4815	35	51	55	107.8	90	92	97.8	38	41.3	
4986	40	52	62	119.2	95	97	97.9	42	43.3	
5100	30	50	60	120	94	96	97.9	38	39.5	
5074	60	51	61	119.6	96	98	97.9	....	....	
5132	35	60	54	108	95	97	98	....	....	

TABLE 6—*(Concluded)*

Mus. no.	Age	P-A	AW	M-A I	B-P	B-N	G I	DL	DI	Miscellaneous
4838	40	53	61	115	97	99	98	41	41.4	
5007	30	52	61	117.3	95	96	99	42	43.7	
5045	30	52	60	115.3	94	95	99	....	....	
4794	40	56	59	105.3	103	104	99	41	39.4	No lesions
4807	30	51	64	125.4	93	94	99	40	42.5	
4866	30	53	62	117	99	100	99	39	39	
4825	30	54	59	109.2	97	97	100	42	43.3	
4983	30	55	62	112.7	91	91	100	43	47.2	
4971	65	54	59	109.2	94	94	100	37	39.3	Senile
4879	35	52	60	115.4	94	93	101	....	....	
4933	40	53	63	118.8	97	96	101	40	41.6	
4915	30	56	63	112.5	100	98	102	40	40.8	
5234	45	50	60	120	90	88	102.2	....	....	
5092	45	56	62	110.7	97	94	103.2	42	44.6	
4959	30	59	61	103.3	106	101	104.9	44	43.5	
4956	65	56	63	112.5	......	......	....	....	....	
5050	20	56	65	116	......	......	....	....	....	Predynastic type mandible
4870	55	54	62	114.8	......	......	....	....	....	Maxillary sinusitis—left
5064	18	54	57	105.5	......	......	....	....	....	Sub-adult
5140	45	53	59	111.3	......	......	....	....	....	
5248	40	50	57	114	......	......	....	....	....	
5171	30	52	61	117.3	......	......	....	....	....	
5159	35	54	64	118.5	......	......	....	....	....	Diminutive teeth
5157	35	46	55	119.5	......	......	....	....	....	Diminutive teeth
5238	20	46	55	119.5	......	......	....	....	....	Diminutive teeth
5057	25	53	61	115	......	......	....	....	....	
5192	30	50	60	120	......	......	....	....	....	
5144	18	47	58	123.4	......	......	....	....	....	Sub-adult
4910	17	48	60	125	......	......	....	....	....	Sub-adult

smaller the teeth are apt to be. Table 8, Résumé of Maxillary Measurements, gives the range of the various craniometric measurements with the indices derived therefrom. The gnathic index and other figures seem to be in harmony with those published by Flower and others for ancient Egypt. Oetteking says the alveolar prognathism (sub-nasal) distinguishes them from other orthognathous races.

TABLE 7

CLASSIFICATION OF INDICES

	Males		Females	
	No.	Per cent	No.	Per cent
Maxillo-alveolar index				
Dolichouranic	14	19.1	16	21.6
Mesuranic	17	23.3	17	23
Brachyuranic	42	57.6	41	55.4
	73	100	74	100
Dental index				
Microdont	35	66	25	65.8
Mesodont	13	24.5	8	21
Megadont	5	9.5	5	13.2
	53	100	38	100
Gnathic Index				
Orthognathous	50	72.5	57	80.3
Mesognathous	19	27.5	12	16.9
Prognathous	(1)	....	2	2.8
	69	100	71	100

TABLE 8

RÉSUMÉ OF MAXILLARY MEASUREMENTS

Measurement	Average		Minimum		Maximum		Skulls	
	M	F	M	F	M	F	M	F
Prosthion-alveolon	54.6	51.4	48	45	62	59	(72)	(76)
Alveolar breadth	63	59	56	50	70	67	(73)	(76)
Maxillo-alveolar index	115.5	118.1	100	103.3	127	127	(73)	(74)
Basion-prosthion	93.4	92	88	85	104	106	(69)	(71)
Basion-nasion	101	96	91	91	109	104	(69)	(71)
Gnathic index	95.2	95.6	85.1	85.2	103	104.9	(59)	(71)
Dental length	41.4	39.8	38	35	47	44	(53)	(38)
Dental index	40.9	41.4	35.7	36.3	48.4	47.2	(53)	(38)

Note: Discontinuous numbers were eliminated seriatim.

OCCLUSION

Even though the Egyptian is orthognathous, the shortened maxillae provide fully for a symmetrical dental arch with its units in beautiful alignment. The compensatory changes accompanying shortened maxillae have been reduction in tooth size, and, to some extent, degradation of morphology, of the two posterior molars particularly (*vide* dental index, cusps). There is seldom an incongruity of jaw size and tooth size that has crowded some of the teeth outside of the line of occlusion. Only one exception is present: in a female, age 25, with a U-shaped, undersized palate, the two cuspids are in facio-occlusion and the right third molar is in disto-bucco occlusion.

The mesio-distal relationship of mandible to maxillae is invariably correct. Resulting from function and attrition in older individuals, the incisors may assume an edge-to-edge relationship. In the group only five other simple Class 1 (Angle) cases of malocclusion occur. A female has an impacted right mandibular molar. In a female, 40, the superior right cuspid is unerupted-impacted, lying horizontally in the palate; in a female, 35, there is a retained left deciduous cuspid, and its permanent successor can be seen in the alveolus above; in a male, the inferior central incisor is in facio-occlusion; and in a child a superior lateral incisor is rotated and in lingual relation to the cuspid.

DIASTEMA

Skull no. 5066, male, Predynastic, has diastema measuring 5 mm. at cervix between the inferior cuspid and first pre-molar bilaterally. The superior teeth are large. This is a simian character which accommodates the interdigitation of the larger superior cuspid. In this skull only was this anomaly of phylogenetic significance noted.

TUBER MAXILLARE

The maxillary tuberosity has interest from morphologic as well as surgical and prosthetic considerations. I measured the post-dental length of the alveolar process in some 140 skulls. This length varied from 1 to 10 mm.; 128 of these were equally distributed in the range of lengths from 2 to 5 mm. More females than males had the shorter measurement. On the evolutionary hypothesis that the progressive shortening of the maxillae and mandible accompanying the frontal enlargement of the brain-case has resulted in a mutability in size and form of the teeth, a correlative form of *tuber maxillare* and third molar might be expected, that is, a tooth may be small because of lack of space in the shortened jaw. But there seems to be no true correlation in this regard in this group. No. 4782 has small third molars with two and three cusps but with a post-dental alveolar space of 6 mm. No. 5132 has very diminutive third molars—abortive vestiges; yet posterior to these teeth is an alveolar extension of 10 mm. Similarly, no. 5072 has a one-cusp third molar, but a postdental extension of 6 mm. But no. 4794 with third molars of five cusps, large, also has tubers 7 mm. long; and no. 4823 with third molars of five cusps has an excess alveolar length of but 3 mm. It appears that the size and form of the third molar is not always dependent upon the length of the tuberosity; nor the tuberosity on the size of the tooth. Jaw form and size, and tooth form and size, would appear to be distinctly separate units of inheritance.

In the mandible of living orthognathous races, such as the Caucasian and Japanese, incongruity of jaw length and tooth size is often unfortunate for the individual, resulting in oversized, impacted, or malposed teeth. In the Egyptian group there were not more than two malposed mandibular third molars. Impacted maxillary cuspids occur with different causative factors operating.

POSTERIOR NASAL SPINE

At the medial point of the posterior border of the osseous palate is a pointed terminal of the palate bone, which with that of its opposite forms the posterior nasal spine. There is a wide racial variation in form of this spine. The prevailing Egyptian type is a long sharp triangle, a variant of which is a bud-shaped terminal; the next most frequent type is a short triangle, often ill defined, sometimes broad and truncated. The larger triangular spines end with a bevel lip. A few broad spines are bifid.

HAMULUS PTERYGOIDEUS

Extending from the lower margin of the inner ptergoid plate is a conspicuous but fragile, more or less hook-like, process, directed outward and bounding a deep little notch through which the tendon of the tensor palati plays. Marked racial differences in the form of the hamulus occur. The Egyptian type is a fine roundish process about 1 by 8 mm. There are a few short flat ones, about 3 by 6 mm.

ANOMALIES OF CRANIAL SUTURES

The metopic suture between the original halves of the frontal bone occurs in several males, some of the largest individuals, but is not observed in females. Nos. 5174, 4839, 4783, 5142 are typical of this persistent suture.

The sphenoparietal suture in these rather small, frontally narrow, skulls is usually no more than an angle or point suture. In an appreciable number of crania it is absent; the superior-posterior angle of the great wing of the sphenoid is 2 cm. anterior to the angle of the parietal: the frontal articulates with the squamous portion of the temporal bone, as, for example, in nos. 5007, 4952, 5133. In this suture in many of the skulls is an intercalated small bone, the *pterion ossicle,* between the sphenoidal angle of the parietal and the great wing of the sphenoid.

Wormian bones in the lambdoid suture occur very infrequently.

TOOTH MORPHOLOGY

The enamel is well formed and usually has a white to light brown hue. In an appreciable number of individuals it is singularly smooth with a beautiful pearly or waxy luster and light cream to whitish hue. These teeth probably received hygienic attention. Crenated or convoluted enamel is observed occasionally only on third molars. No. 5155 has maxillary molars in which there is a deep circular groove demarcating the occlusal third; this doubtless is the stigma of a developmental disturbance—hypoplastic defect. The cusp elements are demarcated, more frequently than not, by deep grooves; but this does not imply a break in continuity of enamel. In the absence of requisite oral environmental factors these deep grooves are not the locus of caries.

The cervical enamel margin of premolars and molars is roughly horizontal. There is no tendency of the enamel to extend rootwise into the bifurcations terminating in a sharp point as is quite characteristic of the American Indian. Occasionally, however, a detached enamel pearl is present on a root some distance from the cervix.

Physical anthropologists have set up as a criterion of racial affiliations the presence or absence of lingual marginal ridges on superior incisors. The American Indian and various Mongoloid groups have incisors with very prominent marginal ridges as the norm—the shovel-shaped teeth of Hrdlička. Hellman has classified with type photographs the varying height of these ridges. Some of the Egyptian incisors have low marginal ridges, but usually there are no ridges.

Not many of the superior anterior teeth are in situ. Because of their conical-shaped roots the incisors have been lost post mortem. A detailed description of an occasional one is pertinent: no. 4880, Old Empire, female, 17; the central incisor is 9 mm. wide, antero-posterior thickness at crown-cervix 7.5 mm., crown height 12 mm. The lingual marginal ridges are very low, but discernible; there is a narrow, shallow, rough fossa just above the linguo-cervical bulge. The difference in size of central and lateral is marked. The type lateral incisor has on its lingual aspect a triangular fossa formed by rather low broad marginal ridges which converge to a well developed cingulum. This fossa seldom occurs on the central incisor.

CUSPS

The cusp formula of the molar teeth varies with race. The dentition of archaic races, such as the Australian and Negroid stocks, is comparatively constant in cusp pattern; while most other races show considerable mutability of cusp formula. In lower races the superior molars are quadricuspid, the inferior quinquecuspid: $\frac{4\text{–}4\text{–}5}{5\text{–}5\text{–}5}$.

The cusp form of the inferior second molar has been a subject of special somatological study by Sullivan. In modern Caucasians this molar usually has but four cusps. Owing to advanced attrition and ante mortem loss, observation of this tooth was limited to eighty-one mandibles. These jaws came from all sites and eras: the cusp form of the mandibular second molar appears to have been stable for four thousand years in Egypt, and it is strictly comparable to that of other white races, including the typical crucial arrangement of the grooves. Table 9 gives the data concerning this tooth.

TABLE 9

CUSPS ON SECOND MANDIBULAR MOLAR

Cusps	Mandibles	Per cent
3.5	1	1.2
4	78	96.3
5	2	2.5
Mode 4	81	100

The norm of the mandibular first molar in this group is five cusps; the fifth cusp is a small triangular tubercle intercalated at the mid-distal margin. That of the second is four cusps, with the typically modern crucial arrangement of the grooves. There is distinct contrast in size and form between these two teeth—typical of modern Caucasians. Mandible no. 4891, Naga-ed-Der, Old Empire, is exemplary. The inferior third molar tends to be quadricuspid; but it is frequently degenerate, small, or diminutive. However, it maintains its size and form better than does the maxillary third molar. The jaws studied show not more than two occurrences of impacted mandibular third molars.

The Egyptian maxillary first molar is distinctive. In addition to the normal four cusps it has an accessory cusp which is known as the *tuberculus anomalus* of Carabelli. This accessory element is coalesced on the lingual aspect of the mesiolingual (antero-internal) cusp. Duckworth[(2)] shows (fig. 192, p. 257) these accessory cusps or tubercles on the molar teeth of an Egyptian skull. Skull no. 4900 has molars possessing the typical tubercle of Carabelli. On unworn teeth, where a sizable cusp is not present, there is a vestige—an incipient bulge demarcated by a slight groove or pit. No. 4882, child, 7, is a good illustration of sizable cusps. A smaller accessory cusp is similarly positioned on the second molars of this skull. No. 4910 has a vestigial groove on one second molar, and a well defined pit on the other second molar; thus there is a tendency to form these cusps on the second molar, concrete evidence of evolutionary changes. No. 4822, male, 25, has Carabelli's cusps on all three molars bilaterally. No. 4880, Naga-ed-Der, female, 17, has second superior molars, trapezoidal in form, bearing vestigial cusps of Carabelli.

It can be stated definitely that the dentition of the remains of the Gizeh Pyramid-builders, like those of Proto-Egyptians from Naga-ed-Der, is characterized by constancy of Carabelli's cusp on the maxillary first molar—a racial character. It is a sizable cusp, plainly observable on unworn teeth; on worn teeth its former presence is determined by the remains of the upper end of the groove which demarcates this cusp, on the mesial surface, well toward the lingual angle. A standard of comparison is established by observing the terminal of this groove on unworn teeth possessing the accessory cusp; also by the nonexistence of the groove-ending on teeth of other races patently not possessing this cusp. This criterion for determining the occurrence of the *tuberculus anomalus* on all Egyptian teeth is, then, valid; and the uniform occurrence justifies the foregoing characterization. It is asserted (Duckworth, 2:259 ff.) that this accessory cusp is distinctive of the higher rather than the lower human races.

The maxillary second molar in this Egyptian group is undergoing degradation second only to that of the third, both in form and in size. Both the second and third maxillary molars appear to be compressed in the arch mesio-distally, and assume a characteristic trapezoidal form. The decrease in size and distortion in form is mostly at the expense of the hypocone, disto-lingual cusp.

The maxillary third molar shows many gradations of involution from a quadricuspid to a tricuspid, bicuspid, and conical form. The predominating tendency is to the tricuspid form, trapezoidal or triangular in outline. No. 5159 has a left tricuspid third molar on which are two most indistinct lines showing the degradation of the hypocone, disto-lingual cusp; and on the right is a tiny crescentic tubercle. This is concrete, graduated, evidence of involution. No. 4959 has a third molar with the disto-lingual cusp placed *lingually* to the mesio-lingual cusp—involution resultant from antero-posterior compression. Some maxillary third molars have a small extra buccal element fused to them, for example, no. 5071. This buccal cusp is the homologue of an infrequent supernumerary element in this region in some races—an atavism of a larger dental series. No separate supernumerary dental elements were observed in the Egyptian collection. Diminutive size of maxillary third molars is not necessarily imposed by lack of space in the alveolar arch. No. 5132, female, 35, has diminutive, cylindrical-shaped third molars which measure only 5 mm. in diameter; but there is posteriorly an excess space of 10 mm. in the *tuber maxillare.*

The molar norm for the California Egyptian series tends to be: in the maxilla, a rapid diminution in size from first to third; the first molar possesses Carabelli's accessory cusp; the second is markedly compressed mesio-distally, and this produces a trapezium in occlusal outline, mostly at the expense of the hypocone, disto-lingual cusp, both in size and in form, but the other cusps are reduced and distorted also; the third maxillary molar is tricuspid, with some vestigial markings of the hypocone. No skulls, however, were devoid of evidence of the third molar; nor is its reduction so great as obtains in an appreciable number of skulls of another race I recently examined—pre-Spanish Peruvians, in which it is a vestigial remnant. In the mandible, the first molar is quinquecuspid; the second is quadricuspid; and the third tends to be quadricuspid, there being some variants. If the *tuberculus anomalus* be assigned the value of one-half cusp, then the dental cusp formula for Egypt is: $\frac{4.5\text{–}4\text{–}3}{5\ \text{–}4\text{–}4}$. Table 10, Cusps on Molars, gives the complete data from which this formula is derived.

TABLE 10

CUSPS ON MOLARS

Molar	M^1	M^2	M^3	M_1	M_2	M_3
Teeth observed	153	150	131	87	84	72
Cusps	Per cent					
5	....	....	....	100	5	27
4.5	100	1.3	5.3	....	....	10
4	....	84	29	....	95	54.4
3.5	....	9.4	8.2	....	....	3.1
3	....	5.3	49	....	....	5.5
2	....	....	4.5	....	....	....
1	....	....	4	....	....	....

ROOTS

Crown form and cusp evolution have been subjected to much more detailed study by anatomists than have dental root forms. Observation and recording of what appear to be anomalies of roots, with respect to both form and number, may aid toward conclusions with respect to racial phylogeny. The following anomalies were observed in the Egyptians.

The superior central incisor root tapers rapidly and uniformly to a fine point. This is in keeping with the rather small and refined osseous system.

The mandibular premolars are characterized by a bifurcation line throughout their length; and the first is bifid, more often than not, in its apical third, with distinct divergence of the two branches. A form similar to this was found to be the norm in the dentition of several tribes of American Indians. In general, it may be said here, descriptions of roots in most texts of anatomy are generalized and conventionalized statements based on remote observation of a limited number of Caucasian teeth. There were occurrences of bifid inferior cuspid root; for example, in nos. 5162 and 5149.

Nos. 5222 and 5250, males, have superior premolars with three completely divergent roots, and the inferior second premolar root of the former is marked with a deep bifurcation line. Table 11 gives the occurrence of bifurcation and trifurcation of maxillary premolars and bifurcation of mandibular premolar roots. Radiography would doubtless reveal many similar occurrences in the series.

With respect to premolar roots, Duckworth (2:265) observes: "In the Simiidae the upper premolar teeth have three roots, thus resembling the upper molar teeth in those animals and in the Hominidae. The occurrence of three-rooted upper premolar teeth in the Hominidae is by no means unknown." I have observed the occurrence of three-rooted superior premolar teeth in the Eskimo, Sioux, California Indians, Peruvians, prehistoric people of Guam, and old Hawaiians. In modern white races this form of premolar is of infrequent occurrence.

In this Egyptian collection a number of post-cuspid teeth have broad septa connecting the ordinarily separate roots, for example, the mesial and lingual roots of the superior first molars. Such teeth suggest similarity to the so-called taurodont teeth of Neanderthal and other primordial races. No. 5056, Middle Empire, is an example; but the Egyptian teeth are not nearly so large and blocky.

TABLE 11

BIFURCATION OF PREMOLAR ROOTS

(Males)

Mus. no.	Teeth	Anomaly
4897	Pm^2	Bifid
4822	Pm^1Pm^2	Two roots
5092	Pm^2	Two roots
4899	Pm^1Pm^2	Two large divergent roots; bifurcated
5222	Pm^1	Three completely divergent roots
5250	Pm^1; Pm^2	Two roots; three roots
5190	Pm^1Pm^2; Pm_2	Three roots each; two roots
4869	Pm^1	Three roots
4849	Pm^1	Bifurcated
4819	Pm^1Pm^2	Two roots each

Note: The following females have similarly divided premolar roots: 4830, 4842, 4817, 4808, 4825, 5140, 5238, 5244, 5155, 5225, 5163, 5119.

PATHOLOGY

ATTRITION

Attrition is the gradual wearing away of the hard parts of the teeth through the physical and physiological agencies of mastication of food. Dental pathology of the archaic Egyptians is characterized by attrition, to the degree of pulp exposure, particularly of the superior molar teeth; and resultant periapical osseous lesions. It is possible that these lesions were causally related—as primary infection foci—to the serious and widespread osteo-arthritic deformities of the Nile people. Attrition frequently shortened the teeth to the cervices without pulp exposure, as shown, for example, by no. 5046. This is particularly true of the maxillary premolars. The gradual centripetal lesion stimulates the pulp to form adventitious dentine, which is laid down in apposition to the shortening process. In these teeth the pulp retreats and successfully blocks, literally and figuratively, the onslaught of attrition which threatens its exposure. Microscopically, the secondary dentine is dense with few, if any, fine fibrils; macroscopically, it is well defined. The circumferential primary dentine has become sclerosced by reduction and obliteration of the dentinal tubuli, effected by calcium deposition. The destructive and irritating action of attrition stimulates the pulp and protoplasmic fibrils of its peripheral cells to react in a protective manner by retreating, diminishing in size, and increasing the density of its protective covering.

But the protective reaction of the vital dental tissue frequently fails to cope with the rapid centripetal destruction, caused by functioning on an abrasive diet, of the superior first molar in particular. The eruption of this tooth in the sixth year, together with its key position in the dental arch which tends to impose the brunt of the masticatory function upon it, tend to bring about its destruction before others. In Predynastic times especially, the trituration of bread containing the coarse husks of barley and millet, of resistent stringy fibers of marsh tubers, admixed with a liberal contamination of rock particles from the grinding-stones and the desert winds, abraded the functioning surfaces of the teeth too fast for vital protective reaction to save the formative organ—the pulp.

Even royalty of the XVII Dynasty exhibits the effects of an abrasive diet. Smith, in The Royal Mummies,(9) depicts on plates 2 and 3 the mummy of the king Saqnounri III, and remarks: "Although the teeth are so well-worn as to be almost all molariform, the fact that all the cranial sutures are still patent suggests that the king was not much more than thirty years of age at time of death." In describing the type jaw he says further: "There is a complete set of healthy teeth almost entirely free from tartar deposits. The third molars on both sides of both jaws are practically unworn, but all the other teeth are well worn."

Jones(4) describes dental attrition of the early people of Nubia:

> The essential feature in the worn-down teeth of the Predynastic man is the levelling of their crowns—the tooth wears down uniformly all over its surface. In contrast to this archaic form of attrition, in the teeth of later and alien people in the Nile Valley, there is a marked hollowing out of the centre of the crowns. Wearing of the teeth is common in Nubia to the present day.

Attrition of teeth is common in the remains from all the sites, ranging from exposure of dentine of the cusps, first degree; through second, obliteration of cusps leaving islands of enamel at bottom of grooves; shortening of the crown to near its neck, third degree; to exposure of the pulp, fourth degree, and beyond. Remains from the earlier epochs show wear younger in life, and more teeth with fourth degree attrition than those of the Middle Empire; while Coptic specimens have slight wear, in fact show afunctional conditions of the teeth. Not only was attrition the primary cause of pernicious periapical osseous lesions and possibly metastatic consequences (*vide* periapical osteitis, osteo-arthritis); it was also a proximate factor in the causation of dental caries by means of inducing inter-proximal food impaction following obliteration of contact between the units of the arch. Generally speaking, cusps were obliterated by the age of 35 years and the pulps of one to four of the first molars were exposed by 50. In many old persons the pulp of every tooth was exposed through wear; for example, no. 5244.

DENTAL CARIES

In this collection only 12 per cent had one or more carious teeth. In age, one was a child of 7 years, seven were young adults, and twenty were from 40 years of age to senility. Thus caries in this group has its highest incidence past middle life. Occurrence was practically the same in each sex. Of an aggregate of fifty-four cavities, 60 per cent had begun at the proximo-cervix. The lesions developed at these proximo-cervical sites after the teeth had been worn beyond the contact points, or after slight migration of teeth in the arch following the loss of some; and both of these conditions induced food impaction and eventuated in caries. There are few pit cavities. Only post-cuspid teeth were attacked by caries. About 65 per cent of individuals having carious teeth had periapical osseous lesions consequent thereupon—on an average of two per person.

The provenience and chronology of skulls with carious teeth are: Naga-ed-Der, Predynastic, 2; Gizeh, Old and Middle Empires, 17; Naga-ed-Der, VI to XII Dynasties and to Coptic, 9. Because of the small number of crania and the disproportion of numbers from the various epochs, this list would probably not be a true indication of incidence of caries in eras. Widespread attrition and negative evidence of caries in Predynastic times seem to indicate, however, that coarse subsistence was not contributive to prevalence of caries. Also it seems that in later epochs, caries was more prevalent in the upper social strata, among persons living on a more refined diet, as suggested by the greater number from Gizeh—remains from the mastabas of the Pyramid-builders.

Smith[10] sums up the replacement of attrition by caries as the chief destructive process as the history and civilization of Egypt unfolded.

But dental caries, although extremely rare before the Pyramid Age, became common as soon as people learned luxury. In the cemetery of the time of the Ancient Empire, excavated by the Hearst Expedition at the Gizeh Pyramids, more than five hundred skeletons of aristocrats of the time of the Pyramid-builders were brought to light, and in these bodies it was found that tartar-formation, dental caries and alveolar abscesses were at least as common as they are in modern Europe today. And at every subsequent period of Egyptian history one finds the same thing—the wide prevalence of every form of dental disease among the wealthy people of luxurious diet, and the relative immunity from it among the poorer people who live mainly on a coarse uncooked vegetable diet.

The same observer[9] presents photographic evidence and gives a word picture of the ravages of caries in a royal personage of an undetermined era.

The skull exhibits large symmetrical thinning of both parietal bones, such as is common in the remains of the Egyptian aristocracy from the time of the Ancient Empire onward. The cranium is a short, relatively broad ovoid: the face is a small oval with pointed chin. All the teeth on the left side of the upper jaw are carious excepting only the canine and the third molar; and the first and second left lower molars are reduced to mere carious stumps.

PERIAPICAL OSTEITIS

Exposure of the dental pulp by any destructive process entails its infection, and ultimately necrosis, since this bit of embryonic tissue encased within unyielding walls is utterly devoid of powers of regeneration. Infection atria are simultaneously opened by way of the apical foramina into the periapical tissue. The infected alveolo-dental periosteum proliferates and the surrounding bone is involved in a limited osteitis with or without a fistulous drainage into the oral cavity. The initial acute stage is followed by a usually painless continuous lesion so long as the tooth remains in situ and until the proliferating membrane is destroyed. In skeletal material this chronic process is evidenced by varying-sized apertures in the alveolar processes into which project denuded root apices, as is richly illustrated in the Egyptian collection.

I have found pulp exposure widely effected by attrition caused by abrasives admixed with food in its preparation by primitive peoples, exemplified by the California Indians[5] and other American tribes. Caries, prevalent with people of sedentary habits and carbohydrate diet—for which association there is overwhelming evidence, destroys the hard parts of the teeth and thus infects and exposes the pulp. Traumatic fracture of teeth, which occurs fairly frequently in primitive people such as the Eskimo, causes pulp exposure. Rarely, by extension, the inflammatory process, which begins at the alveolar border, encroaches upon and infects and kills the pulp by way of the root apex. Periapical osseous lesions ensue from pulp exposure by any and all of these agents. In archaic Egypt attrition was the primary cause of lesions of the facial bones. Parelleling the development of civilization, and directly concomitant with a more refined cuisine among persons of the upper strata of Egyptian society, caries replaced attrition as the primary cause of alveolar abscess—periapical osteitis.

These observations on the University of California Egyptian collection with respect to the pernicious effects of attrition are in agreement with the extensive and discerning observations of both Smith and Jones. On page 158, Egyptian Mummies,[10] Smith says:

Both in Nubia and Egypt the ordinary form of dental caries is exceedingly rare in predynastic and proto-dynastic people, and among the poorer classes it never became at all common until modern times. But as these people ate coarse food mixed with a considerable amount of sand, the teeth rapidly wore down, and as the result the pulp-cavities became opened up; in the fertile soil of the exposed dental pulp, septic infection found a much readier place of attack than the hard resisting enamel and dentine of the tooth itself afforded; hence it is common to find alveolar abscesses without dental caries, but some of the royal mummies suffered from both. Most of the dental disease of the archaic Egyptians and the poorer classes of the ancient Nubians in all periods is to be explained in this way.

Jones[4] remarks:

Neglected dental disease accounts for practically the whole of the septic conditions of the bones of the face.

The pulps of the maxillary first molars are more frequently exposed than other teeth. This is because this tooth erupts and begins to be used at the early age of 6 years; also because, owing to its key position in the arch, it receives the brunt of mastication. The maxillary second molars are the next most frequently involved. In senile persons the pulps of nearly all the maxillary teeth are exposed with resultant lesions surrounding the roots; and the loss of teeth in the edentulous and nearly edentulous is traceable to this pernicious sequential process. No. 5125, male, 60, shows the pulps of all the maxillary teeth except the third molars exposed through wear, with periapical osteitis resultant; and there are four more osseous lesions from the same cause in the mandible.

Periapical osseous lesions are well represented in the material from all the sites and eras. Table 12 summarizes the occurrence and causes of periapical osteitis.

TABLE 12

PERIAPICAL OSTEITIS

Skulls	Number of lesions	Primary cause	Per cent
18	31	Caries	7.5
92	378	Attrition	92.5

The lesions vary in size from a few millimeters to 10 and even 15 mm. in diameter. A variant of the ordinary lesion is the radicular cyst (*vide infra* Radicular Cyst); and by direct extension the pathological process comes to involve the maxillary sinus with suppurative sinusitis ensuing (*vide infra* Maxillary Sinusitis). The periapical lesion frequently fuses with resorption of bone, starting at the alveolar border—periodontoclasia. And, in the light of present medical knowledge, it is a legitimate inference to assume that by means of metastasis the periapical osseous lesions have a causal relation with the prevalent osteo-arthritis in Egypt.

The process of dental attrition exposing the pulp with its pernicious sequelae is well known to dental pathologists, and is clearly defined in Egyptian crania. The primary cause of periapical osseous disease is patent to the practiced observer in at least 98 per cent of the lesions. In the light of these facts it is unfortunate that statements credited to Sir Marc A. Ruffer[7] have entered scientific literature. They may have originated in posthumous editing of his notes. In section 5, Other Lesions, of his paper the following statement with regard to the etiology of alveolar abscess in Egyptian crania is made; it is crude and inaccurate in description and nomenclature, naïve in rationalization:

> If the infection had spread from the exposed pulp to the apex of the root through the apical canal, signs of softening of the pulp chamber [*sic*] should have been evident, whereas in many cases no trace of such previous softening existed. On the contrary the pulp, though freely exposed, appeared hard and healthy [*sic*], this state of things giving no support to the theory that microörganisms had penetrated through the apical canal.

The writer obviously knew neither dental anatomy nor pathology. Evidently secondary dentine formed by the living pulp has been called the "pulp." A bit of soft, delicate, embryonic tissue, such as the pulp is, freely exposed ante mortem with rapidly ensuing necrosis certain, and after a post mortem lapse of several millennia, could not appear "hard and healthy."

More than a few fragments of roots of deciduous molars are encased in the alveolus formed around the permanent premolars. Physiological resorption by giant-cell activity ceased before the destruction of these spicula; they are caught rigidly in the new alveolus formed around their successors; but they appear to be physiologically innoxious. They are mistaken by some observers for supernumerary or anomalous dental elements.

RADICULAR CYST

This lesion is a variant of the chronic periapical abscess, and it is always associated with a pulpless tooth. Its development is contingent upon the existence of two factors: (*a*) embryonic—occurrence of epithelial rests in the dento-alveolo periosteum, classically described by Malassez as *débris épithéliaux paradentaires;* and (*b*) infectious—the entry of bacteria which may stimulate the rests to proliferate. The epithelial cells proliferate into small spherical masses; these aggregations are doomed to central liquefaction, and the gradual accumulation of fluid within the central cavity produces pressure on the overlying bone with atrophy ensuing. The cortical covering may become attenuated to a parchment-like thinness.

This type of cyst is well represented in this group of crania, occurring in about twelve persons. The cavities vary in average diameter from 5 to 15 mm. Teeth involved are maxillary incisors, cuspid, and premolars. The cyst occurs more frequently about the lateral incisor than in connection with any other tooth. In an old female, no. 4945, a cavity 10 mm. in diameter existed beyond the apex of the left cuspid. The wall is smooth and hard. In no. 4799, also a senile female, a cyst had developed which involved the teeth from the right central incisor to the second premolar; it measures about 15 mm. in length, the facial wall is greatly bulged out, and the floor of the right naris is domed upward. Jones describes a similar cyst involving the floor of the naris of a Nubian skull, but does not apply the name "radicular cyst."

No radicular cysts were observed in the mandible. No coronal—dentigerous—cysts occur in this collection.

MAXILLARY SINUSITIS CHRONIC

Of 206 skulls, 21, or more than 10 per cent, showed old fistulae draining the maxillary sinus through the alveolus of a molar tooth, or, in two edentulous skulls, the former site of molar teeth. Skull no. 5222 has a fistula leading from each sinus through the alveolus of the second molar; the left fistula measures 10 by 5 mm. and is depicted in plate 6*b*. No. 5136 has two distinct fistulae by way of two roots of the second molar. The apertures of such fistulous tracts are well defined: the margins are sclerosced and rounded, the diameter varies from 1 to 3 cm., chronicity is obvious. There are doubtless many other fistulae that were not observed because of their close proximity to tooth roots. The first and second molars were involved, eleven times each; occurrence was almost equally divided between right and left sides. Thus in this small group, which includes children and young adults, there is an incidence of 10 per cent with chronic maxillary sinusitis. If the figures were given of those persons only who were more than 45 years old at death, the percentage would be appreciably higher. The obvious cause of the diseased sinuses is infection by extension from periapical dental lesions in close proximity to the sinus floor. Reversing the order of genesis, the periapical lesion resulted from an infected necrotic pulp, which in turn was exposed to the oral environment through the ravages of attrition, rarely caries. This skeletal material affords plentiful evidence of the far-reaching sequelae of infection atria through the teeth.

No. 5072, female, 35, had chronic ethmoiditis. From the ethmoid cells two fistulae, 5 and 8 mm. in diameter, pass through the left orbit wall; the floor of the orbit is depressed. The left maxillary sinus has been involved through a crescent-shaped opening at the margin of the ethmoid bone. This, of course, was not of dental origin. It probably proved fatal.

No. 5130, male, about 60, has an extensive osteomyelitis extending from the second premolar to the second molar in the right maxilla. The facial cortex and cancellous bone are destroyed, but the lingual plate is intact. Two teeth were lost. The margin of the lesion below the zygomatic ridge is smoothly beveled, probably indicating trauma.

EXTRANEOUS ACCRETIONS AND PERIODONTOCLASIA

Excretion of calcium and other salts dissolved in the saliva is a physiological process which varies with metabolism. On contact with air the dissolved salts tend to precipitate on the surfaces of teeth in proximity to the orifices of the salivary ducts, that is, upon the lingual surfaces of the inferior incisors and the facial surface of the superior first molars. Some organic material from the mouth is entrapped with the salivary precipitate. Friction of tongue and food, particularly if the latter is fibrous and requires vigorous mastication, reduces the adhesion to the teeth. The tenaciousness with which lime deposits adhered to the gingival margin of the teeth of some of the Egyptians is shown by their presence in situ after the lapse of several millennia. Accretions of a whitish hue are very hard; more friable material has a brownish coloration and clay-like texture. Pendulous aprons of the foreign material overlap the labial gingival tissue of the mandibular incisors and the lingual tissues of the molars.

Periodontoclasia is chronic destructive degeneration of the investing tissues of teeth, eventuating in exfoliation. Alveoloclasia is the breaking down of the osseous support, and is observable in skeletal material. It is to be said there is a physiological recession of the alveolar crest from childhood to senility. This recession is to be distinguished from pathological resorption. The distance from the enamel margin to the alveolar crest gradually increases. This increase is, in effect, a continued physiological eruption of the teeth—partly compensatory for the shortening of the teeth by wear. In a child of 7 years the distance at the mesio-facial angle of the maxillary first molar is 0; at 16 years of age it is about .5 mm., as, for example, in no. 4817; in no. 5230, male, 30, the distance is 1.5 mm., with healthy conditions; in no. 4850, male, 55, the distance on the maxillary molar is 4 mm., conditions of tissue healthy. The pathological degeneration may be discerned not only in greater exposure of the tooth root, but also in resorption of the cancellous as well as the cortical alveolus; and it extends to the bifurcation, and eventually to the apices.

Evidence in the Egyptian crania indicates that accretions, periodontoclasia, and caries are not incompatible, as is often stated. Both accretions of considerable size and caries are strongly indicative of reduced function. Where the teeth have been used vigorously, as generally in archaic Egypt, and death came before attrition exposed the pulp or destroyed contact, the teeth are free from both caries and alveolar degeneration. But following fourth degree attrition, periapical osteitis abets resorption both near the apex and at the alveolar border. In these crania, loss of some teeth has induced alveolar resorption of neighboring teeth: afunction, malfunction, migration, further accretions, and extended alveoloclasia are induced. But it is patent that accretions are the alpha of proximate causes of periodontoclasia.

A skull from Coptic times, *circa* 300 A.D., male, 40, shows very large brownish friable accretions, on the molars particularly, and the teeth show very slight wear—both afunctional manifestations; and concomitantly the alveolar process is resorbed to the bifurcations of the roots. This more recent skull is in contrast to the Protodynastic type; it is thin and scaphoid, and the palate is broad. It furnishes an example of advanced periodontal degeneration. With the advent of Greek influence in Egypt the cuisine became luxurious and refined.

With reference to accretions, Jones[4] in his somatological and pathological descriptions of ancient Nubia notes:

> It is not until the era of the alien settlers of the Byzantine times that dental disease becomes really common and assumes anything like its modern frequency of incidence. It is in this period that accretions upon the teeth are sizable.

There are no Predynastic skulls with typical alveolar resorption, that is, resorption having its origin at the margin. Those with periodontoclasia come from all sites, and in time from the Old Empire to Coptic times, and from the latter era come the most pronounced examples of degeneration of the investing tissues accompanied with enormous extraneous accretions and evidences of afunction. All the persons affected were 45 years of age or older. In the order of frequency of involvement were the third, second, and first molars, mandibular and maxillary; in only about six skulls were the premolars involved, as for example in no. 4895, male, 60 (pl. 6*c*); and in only one were the superior incisors involved with typical periodontoclasia.

EXFOLIATION AND SENILITY

Teeth, or parts thereof, surviving middle life are subjected to the cumulative effect of pernicious influences as old age approaches. A trio of forces—disease, function, and senility—converges to the ultimate exfoliation of the dentition. First, periapical lesions, consequent upon pulp exposure and degeneration of the alveolar margin caused by accretions and other factors, continue and frequently fuse in the general process of bone resorption. Secondly, as attrition destroys the teeth to their cervices, the former obtuse plane on the superior teeth, slanting from the linguo-cervical to the facio-occlusal angle, gradually shifts toward the facial, and eventually the gradient is toward the facio-cervical region. The occlusal force is now upward and inward, inducing outward pressure on the apices, and this induces pressure atrophy, resorption, of the facial cortex. The economy with which tooth remnants function exemplifies the continuing adaptation of an organ to requirements. Thirdly, accelerating these processes is the physiological state of calcium resorption now taking place in the life-cycle of the individual, a salient phase of the involution of senescence. Verily, the dentition is a transitory organ not designed to be taken to the grave by the extremely senile. But the individual has time to adapt himself to the inevitable; and these resorptive processes, more evident in the maxillae of ancient Egypt, were neither unduly painful nor the causal factors unknown and mysterious as redundantly set forth by Ruffer.[7]

Most persons who had lost teeth were past the half-century mark in age; and no person under 35 years or so had lost any. About 50 per cent had lost one or more teeth; but of this proportion one-half had lost only one or two, such as the maxillary or mandibular third molar or the first molar. Five were edentulous or nearly so. Exfoliation of teeth in by far the greater number was consequent upon pulp exposure; but a few molars were lost directly by periodontoclasia. Half as many mandibular as maxillary teeth were lost, and nearly 80 per cent of those were mandibular molars; first, third, and second, in order of frequency. Table 13 gives the relative percentage of maxillary teeth lost.

TABLE 13

MAXILLARY TEETH LOST ANTE MORTEM

(Relative percentage)

Tooth	Per cent	Tooth	Per cent
Central incisor	5.6	Second premolar	11
Lateral incisor	6.2	First molar	22
Cuspid	3.1	Second molar	15
First premolar	9.6	Third molar	27.5

OSTEO-ARTHRITIS

Osteo-arthritic lesions, including osteo-arthritis deformans and spondylitis deformans, are evident throughout the Nile valley and from Predynastic epochs to the present time. The commonest form of this pathological process is spondylitis deformans, occurring in the spinal column. Varying numbers of vertebrae of the lumbar, dorsal, or cervical regions may be immovably coalesced. The Hearst Expedition recovered at the Gizeh Pyramids one body in which there was a complete union of all the vertebrae. In other joints the changes usually consist of (*a*) eburnation of bone on the articular surfaces or (*b*) roughening outgrowths—bone hyperplasia. There are many skeletons in the California collection with severe arthritic changes.

Smith[(10)] says: "Rheumatoid arthritis is *par excellence* the bone disease of the ancient Egyptian and Nubian. It is of great antiquity and prevalence." He further states that the vertebrae, the shoulder joints, and the temporomandibular joint were the seats of its ravages.

Jones,[(4)] in his preliminary report on Nubia, says of arthritis deformans, it "is fairly abundant at all periods and affects most commonly the shoulder and the hip: but scarcely any joint—not even excepting the temporo-mandibular joint—has failed to present several examples of the disease."

There are several examples of osteo-arthritis of the temporo-mandibular joint in this collection. No. 4803 (pls. 3*b* and 4) is typical. There is erosion and porosis of the superior and posterior surfaces of the left condyle; and a dense, macroscopically amorphous exostosis, 2 mm. in thickness, covers the glenoid fossa and eminentia articularis. There has been considerable compensatory adaptation in the mandibular movement, resulting in fourth degree attrition of several teeth on the left side. The left joint is more frequently involved than the right.

With respect to the etiology of these osteo-arthritic lesions, it may be significant that in the very example just mentioned, the individual harbored an old periapical abscess; and several others developed from teeth the pulps of which were exposed by malfunction resulting from the arthritis—a vicious cycle. Paradental bone lesions occurring in the same skeletons as arthritic changes suggested to Ruffer[(7)] that the former may have a primary causal relation to the latter. Elective localization of infectious processes may have been the inciting cause; and the infection may have found atria into the body by way of dental lesions, the genito-urinary tract, or otherwise.

Jones[(4)] says, of cause: "The causal factor of the disease is essentially one of environment, and not race." It was the mode of life of the indigenous people, as well as the immigrants, in the Nile valley. Their constant dabbling in the waters of the Nile was not without deleterious effects on the osteo-arthritic system, according to this keen observer. Hard labor and dietary factors may be named also.

SYPHILIS, RACHITIS, LESIONS ON PARIETAL BOSSES

There are no dental stigmata of congenital syphilis in the collection of crania examined; nor is there any lesion of the calvarium or facial bones which remotely resembles specific lesions. Hypoplastic enamel and atypical teeth are extremely rare in this group.

My observations are not at variance with those of Smith and Jones. The former[(10)] says: "No true case of rickets or of syphilitic disease has been found in any ancient Egyptian remains . . . nor anything even remotely resembling syphilitic injuries to the teeth." With reference to Nubia, Jones notes[(4)]: "The complete absence of any affection of the teeth in any way resembling the effects of syphilis is a very strong argument against its existence." He also says that some curved and distorted bones suggest the existence of rickets, but that many of these curvatures were brought about in the grave from pressure and other post mortem causes.

On the parietal bosses of many skulls there is a flattened or sometimes indented area apparently caused by intentional pressure acting over a considerable period of time, such as the carrying of some burden habitually on that part of the head. The lesions are usually bilateral, but are not always of equal size. No. 5125, VI–XII Dynasties, about 60, has a triangular area just above the temporalis crest measuring 4 cm. on each of its sides. The external plate is indented and somewhat eroded and of dark color; and, evidently because of pressure, excessive vascularization and ulceration had occurred. No. 5244, Gizeh, Old Empire, female, senile, has triangular depressions on the parietal bosses. The triangle is roughly equilateral and the sides measure about 4 cm. Between these two depressed areas and along the sagittal suture is a roundish groove, measuring about 1 cm. across. The left triangular area is translucent in this senile skull. Endoscopic examination shows the internal table unaffected on the triangular areas, but there is evidence of an inflammatory process under the sagittal groove.

Jones invokes the ethnic habit of carrying water jars on the head as the cause of these triangular areas on the parietal eminences. They show long-continued vascularities, periosteitis, and ulceration, with sinking in of the outer table, the inner table usually being unaffected. Lesions occur on females, and the females are known to have been the bearers of the water jars.

FRACTURES

Fractures of the radius, ulna, and clavicle are of frequent occurrence in this skeletal material—more frequently from Gizeh. Many of these fractures may have been caused by clubbings by masters: the unfortunate victim, fending his head, received the blow on forearm and collar. Archaeological evidence apparently supports the somatological findings in this respect.

No. 5148, male, 50, shows a healed fracture at the neck of the left condyle, and this has caused the head of the condyle to incline inward and forward from the normal.

DENTAL OPERATIVE INTERFERENCE

In the Hearst Egyptian collection there is absolutely no evidence of dental operative interference. In many individuals, diseased remnants of teeth could have been eliminated with the simplest gesture, but nothing was done to rid the person of unsound teeth. The utmost biological economy is shown in the retention and functional utilization of diseased and frail teeth. Attrition often shortened the superior first molars beyond the pulp chamber; large osseous lesions frequently encompassed their apices; the position of the roots shifted as the plane of attrition approached the cervix, with resultant atrophy of the bone overlying the apices through untoward pressure, yet active function continued. No. 5065 is typical. This condition is common to many primitive people.

My observations concerning the absence of dental surgery is in agreement with the findings of Smith and Jones. In Egyptian Mummies,[10] page 158, the former states: "There is in no case the slightest suggestion that any operative measures were adopted in order to cope with dental trouble and in spite of frequent statements to the contrary, tooth-stopping was never practiced in ancient Egypt." In the Survey of Nubia,[4] page 283, Jones says of the people of the upper Nile valley: "At no period do the teeth of any body show signs of the dentist's handiwork."

The literary evidence from ancient Egypt is of similar import. It is evident from the prescriptions in the Ebers and other papyri that dental therapeutic measures were doubtless practiced; but with reference to definitive operative procedures, such as extraction of teeth, filling operations, or prosthesis, no literary allusions have been discovered. The Ebers papyrus mentions no dental operations, though operations on other parts of the body are detailed.

Professors Ebers and Schmidt, Egyptologists, say they found nothing that could be attributed to the work of dentists. Similarly, Virchow, the craniologist and pathologist, found no evidence of dental surgery or art. Guerini[(3)] says that J. R. Mummery made a careful research on purported dental art in ancient Egypt and reported negative findings.

CORN IN EGYPT

Man, like the bear, is naturally omnivorous. The ability to subsist on a wide range of edibles has been of decided advantage to both species in their rise, their spread over wide latitudes, their dominion, and their survival. Primitive man without trade subsisted exclusively upon the fauna and flora of his limited habitat; and the extent and variety of his sustenance were determined by his ability to retrieve and to some extent by his ingenuity in preparing food. Adaptation of a tribe or race to a geographical area invariably entailed specialization in one or two main articles of diet—staples, which were supplemented by occasional or seasonal foods.

The predominant subsistence in the Nile valley from archaic times has been graminivorous; cereals have been the staples. Analysis of the intestinal content of Predynastic man has identified husks of indigenous barley uniformly, and to a lesser extent millet. Small root-tubers have been found both in very ancient burial pots and in the alimentary tract; also copious remains of fish were found as well as mammalian bones. Fish was abundant in the waters of the Nile, and game on its banks.

But primitive man inhabiting the Nile valley was ingenious; this race in this soil and climate evolved possibly the first distinctive civilization. This native power of invention, fortunately situated on rich arable lands in a salubrious climate, possessed an area singularly isolated by natural barriers which prevented its culture from being molested until after it was well established. The inventiveness and industriousness of the Egyptians so nurtured the natural resources for food production that with the flowering of civilization the diet became varied, luxuriant, and refined. The early Egyptians were probably the first to make metal fishhooks. Very early they domesticated sheep, goats, and cattle—truly a great stride of primitive man toward dominion. The archaeological evidence seems to indicate that this people introduced the cultivation of barley; certainly they devised the technique of irrigation; and probably they were the first people to use cow's milk as food for human beings.[8] Here, then, are the fundamental inventions for a rich and varied diet.

Following the annual inundation of the flood lands bordering the Nile, the ground remains moist enough for the complete growth of millet, barley, and wheat. With the development of irrigated agriculture the cereals became firmly entrenched as the staples. From barley, not only was bread made, but from it also was the divine beverage, beer, fermented. Barley attained a symbolic significance as the life-giving element. Egyptian civilization developed directly with the cultivation of cereals. And the diffusion of civilization over other lands has been coextensive with the cultivation of the cereals. Egypt did not possess the superior cereal wheat in its wild state, but she wisely appropriated and naturalized many plants from adjoining countries—the vine and the olive, probably before recorded history, and later the peach and cherry. The wheat first cultivated in Egypt was emmer. Barley was superseded by emmer, and then emmer by the superior and later Syrian wheat-bread grain.

Following the cultivation of wheat came horticulture. The vine was cultivated at an early time, as was the fig. Other fruits were dates, melons, pomegranates, and apricots. Not only did all Egypt enjoy the fermented beverage from barley; the upper classes, as humanity became stratified, fortified their meals with wine of both the grape and the date. The date palm was as important in ancient times as it is now. Beekeeping was a very ancient industry. Honey was much eaten, cane-sugar being unknown. Honey was held in high regard from most ancient times: the legendary ruler of the Delta bore the title of Bya, the "Bee-man," and his emblem was the figure of a bee. A legend has the Nile flowing with honey for eleven days. Egypt not only became the granary of the world, but was also regarded as the land of milk and honey. Flocks were herded; milk products manufactured; pigs and goats raised for their flesh and milk.

Breasted[1] summarizes the diet for the Old Kingdom, *circa* 3000 B.C., as follows:

> The food was rich and varied; we find that even the dead desired in the hereafter "ten different kinds of meat, five kinds of poultry, sixteen kinds of bread and cakes, six kinds of wine, four kinds of beer, eleven kinds of fruit, besides all sorts of sweets and many other things."

This, of course, refers to the rich, the noble, and official classes.

The same author continues:

> It was the enormous harvests of wheat and barley gathered by the Egyptians from the inexhaustible soil of the valley, which made possible the social and political structure so well organized. Besides grain, the extensive vineyards and wide fields of succulent vegetables, which formed a part of every estate, greatly augmented the agricultural resources of the land. Large herds of cattle, sheep, goats, droves of donkeys, and vast quantities of poultry, wild fowl, the large game of the desert and innumerable Nile fish, added not inconsiderably to the produce of the field, in contributing to the wealth and prosperity which the land was now enjoying.

The food of Egypt became more refined and luxuriant as time went on. A few centuries before the Christian era, *circa* 300 B.C., a Greek dynasty, the Ptolemies, were ruling and applying Greek science to Egyptian horticulture. A fine quality of olive oil was produced, and various nuts and citrus fruits were cultivated. At this time a sample menu for an overseer might be: luncheon—wheaten-bread and honey, to which is added a cup of milk (warmed as was always the custom); for a man of the menial class—lotus-bread or barley-bread, relished with an onion or some cloves of garlic, and washed down with copious draughts of barley brew; evening meal for a master—lentil soup flavored with onion, garlic, or leek, eaten with bread made of barley or wheat; grape or date wine; a meat list including beef, mutton, veal, goose, goat's flesh; vegetables, asparagus and chickpeas or cabbage; cheese with celery, lettuce, or cress; for second wine the juice of the grape spiced with coriander; honey.

It is to be noted that in Byzantine and Coptic eras the teeth functioned less than in Predynastic times. Large accretions formed on the teeth, and periodontoclasia and caries contributed to tooth destruction. It may be noted in passing that many of the therapeutic recipes (several of which are dental) recorded on the medical papyri included for their vehicles dough, honey, and milk, all certainly conducive to dental caries. It is to be said, finally, that so far as the health and preservation of the teeth are concerned, the mode of preparation of food is primary. In Egypt in Predynastic times abrasives were admixed with the food being prepared, with resultant destructive attrition; when the Ptolemies ruled, the cuisine was refined, afunction was abetted, caries and alveolar degeneration were rampant.

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EXPLANATION OF PLATES

[Numbers preceded by 12– are University of California Museum of Anthropology catalogue numbers; numbers in parentheses are Leigh's original numbers.]

PLATE 1

a. 12–4834 (L64). Norma basilaris of skull, male, age about 70, Naga-ed-Der, VI–XII Dynasties. A high elliptic palate accommodates a normal arch. No teeth were lost ante mortem. There is no evidence of caries. The incisors have been fractured post mortem. The teeth show advanced attrition; the plane of wear slants upward from the facio-occlusal angle toward the linguo-cervical margin of the crown. Attrition, resultant from an abrasive diet, pulp exposure therefrom, and pernicious pathologic sequelae, are typically represented in this skull. Centrifugal apposition of secondary dentine in the premolars has prevented pulp exposure by centripetal wear. The first molars are worn to the floor of the pulp chamber. Following exposure and necrosis of the pulp, chronic periapical abscesses developed with draining fistulae through the alveolar process; note aperture on distal aspect of M^1.

b. 12–4809 (L91). Norma verticalis of a typical Egyptian skull, female, age about 75, Naga-ed-Der, VI–XII Dynasties. This characteristic vertex is pentagonoid or coffin-shaped: the frontal region is narrow between the temples but with defined frontal eminences; the lateral boundaries are straight lines diverging posteriorly; the posterior margin is roughly triangular. On each parietal boss of this skull is a triangular lesion. In life this surface was unduly vascularized; periosteitis and sinking in of the outer table ensued. The condition was doubtless brought on gradually through pressure from a head burden. It is an ethnic mark found throughout the Nile valley, occurring on females, who were known to be the carriers of water jars.

a. Male: Fourth degree attrition. *b*. Female: Pentagonoid vertex; ethnic parietal lesions.

PLATE 2

a. 12–4894 (L103). Lateral aspect of skull, male, age about 40, Naga-ed-Der, Coptic, early Christian epochs. The skull is frail, of fine texture, scaphoid, but with typical narrow forehead and occipital eminence. The palate is broad. There is no dental attrition; but note heavy brownish accretions on molars with concomitant resorption of the alveolus—periodontoclasia. The crowns of the left cuspid and first premolar have been destroyed by caries. The dietary habits have evidently been quite different from those of earlier epochs; reduced function of teeth is obvious.

b. 12–4886 (L145). Lateral aspect of skull, female, age about 35, Naga-ed-Der, Old Empire. On the lateral aspect of the left maxilla involving the alveoli of the second and third molars is a hemispherical depression 2 cm. in diameter. The margins are sharp; the walls form a fine reticulum; an aperture opens into the maxillary sinus. Evidence of osteoperiosteitis extends from the depression over the posterior surface of the maxilla—under the zygoma. The character of this lesion precludes chronic periapical abscess or its cystic variant. The destruction probably resulted from the growth of a neoplasm, possibly fatal.

a. Male, Copt: Dental accretions, afunction.
b. Female: Osteo-periosteitis of maxilla involving sinus.

PLATE 3

a. 12–5122 (L233). Norma lateralis of skull, female, age about 45, Mesheikh, Middle Empire. Typical Egyptian profile: prominent occipital eminence, orthognathous face, arched nasal bridge, symmetrical mandible. Attrition of teeth and resorption of alveolar border are evident. A peg-shaped process, 4 × 7 mm., projects forward from the internal angle of the articular surface of the right condyle, and a complementary area is marked on the eminentia articularis.

b. 12–4803 (L94). Lateral aspect of skull and mandible with integument and textile wrappings in situ on face; male, age about 65, Naga-ed-Der, VI–XII Dynasties. Severe dental attrition has exposed the pulp of the superior first molar with resultant chronic periapical osteitis. Resorption of border of alveolus investing molar teeth has occurred. Note carefully the erosion of superior and lateral surfaces of condyle; chronic osteo-arthritis has involved the left temporo-mandibular articulation.

a. Female: Occipital eminence, orthognathous face, arched nasal bridge.

b. Male: Periapical osteitis; osteo-arthritis of temporo-mandibular articulation.

PLATE 4

12–4803 (L94). Basilar aspect of skull shown in plate 3*b*. First molars have been worn beyond the floor of the pulp chambers. Attrition has also exposed pulps of the left first premolar and cuspid with resultant combined fistulae opening on the palate; and the left lateral incisor exhibits periapical osteitis on the facial aspect. No teeth were lost ante mortem. In the left glenoid fossa is an apposition of hyperplastic bone from 1 to 3 mm. thick. This new bone is extremely dense. Differentiation of eburnated new bone from the fossa may be noted on its posterior margin. Apposition of bone in the fossa is complementary to resorption of the head of the condyle (shown in previous view), both resultant from long-continued inflammatory process. Limitation of function has produced the asymmetry of attrition noted. A causal relation may have existed between the chronic periapical osteitis about the first molars and the severe osteo-arthritis of the mandibular joint.

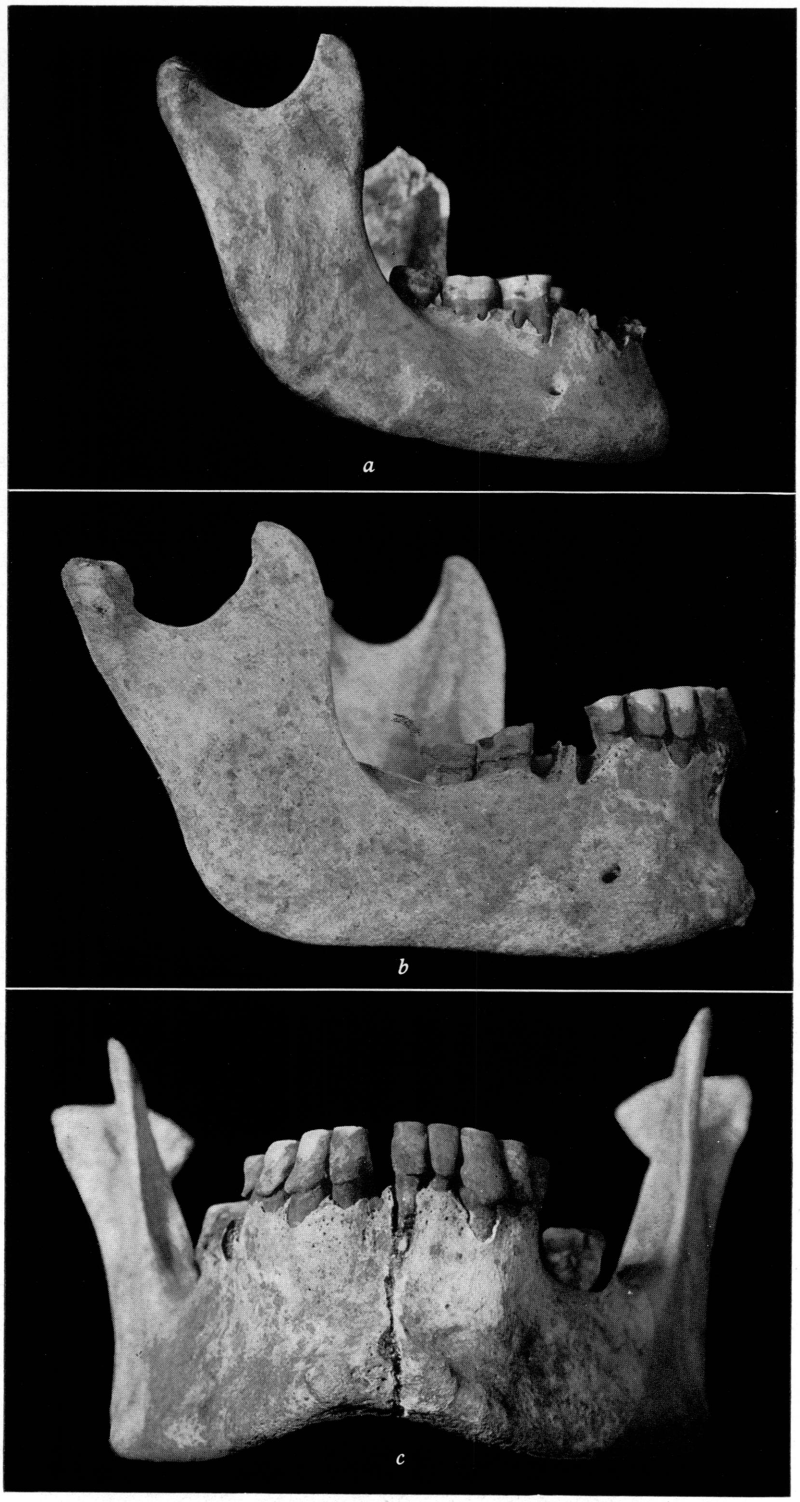
Same individual as pl. 3*b*: Hyperplastic bone in left glenoid fossa—osteo-arthritis.

PLATE 5

a. 12–5189 (L222). Lateral aspect of type mandible, female, age about 35, Gizeh, Old Empire. This jaw is dissimilar to the Predynastic type. The body is not high; the ramus is high but narrow. The angle is obtuse and rounded; the anterior border of the ramus is nearly straight. In the mental region the incisive fossa is not defined and the anterior surface forms with the occlusal plane an obtuse rather than a right angle. This is a distinctive type mandible; it indicates a later stock in the Nile valley.

b. 12–5160 (L209). Lateral aspect of mandible shown in *c*. The accretions are seen as pendulous aprons over the labial gingival tissues. The first molar on each side and the right central incisor had been lost ante mortem because of the accretions. The alveolar process is extensively resorbed from the remaining molar teeth.

c. 12–5160 (L209). Frontal aspect of mandible, male, age about 50, Gizeh, Old Empire. Calcareous accretions overlap the alveolar border. This extraneous material irritated the gingivae and alveolar border, resulting in resorption. Post mortem fracture at symphysis.



a. Female, type mandible: High, narrow ramus; obtuse angle.
b. Male: Pendulous calcareous accretions.
c. Same individual: Alveolar resorption below accretions.

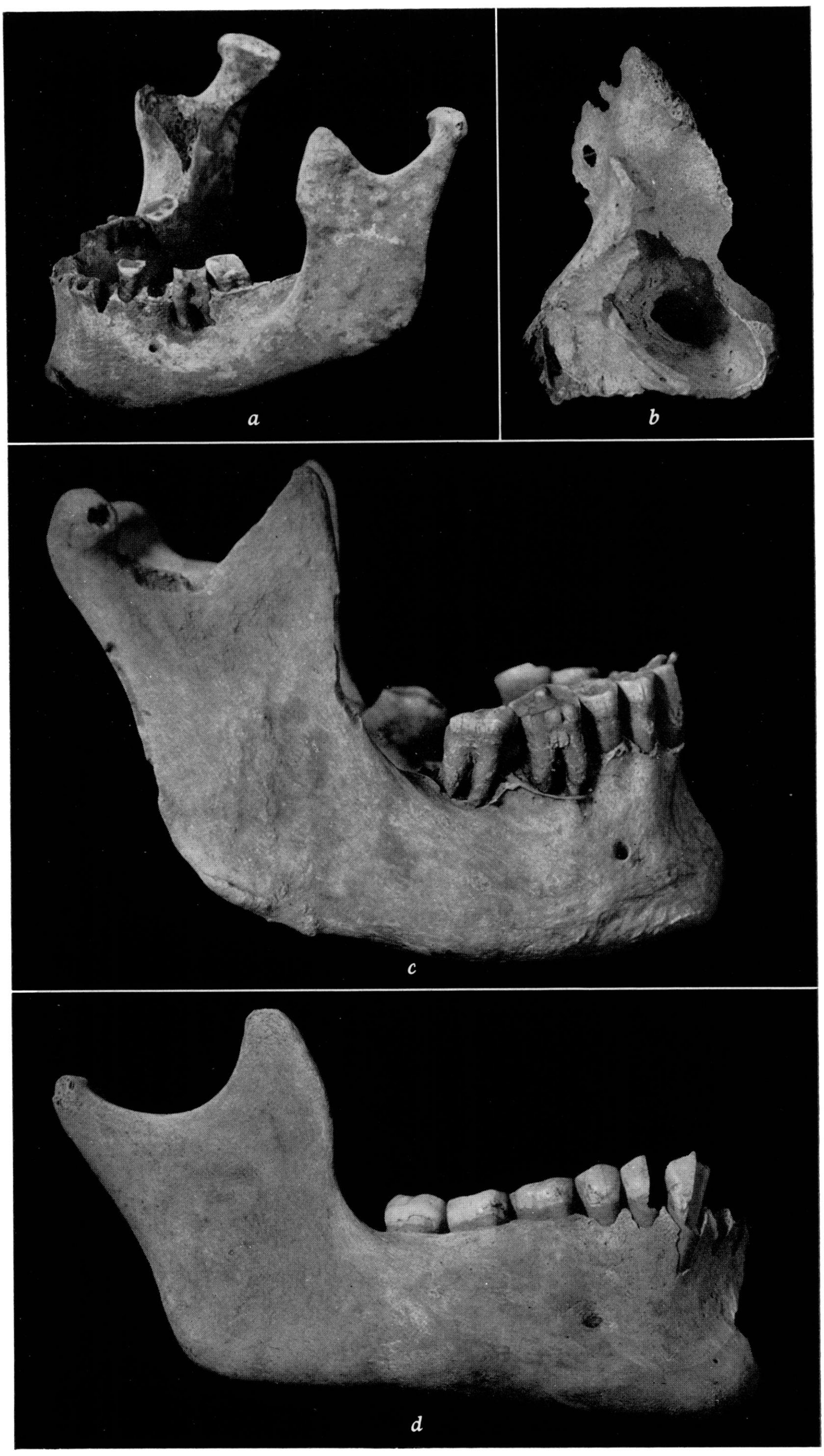
PLATE 6

a. 12–4809 (L91). One type of Egyptian mandible: the body is short, the rami low and broad with anterior borders of sigmoid outline; the coronoid process is blunt, the notch a shallow crescent. No teeth were lost ante mortem. Attrition exposed the pulp of the left first molar, chronic periapical osteitis consequently occurring.

b. 12–5222 (L191). Interior of maxillary sinus, male, age about 55, Gizeh, Old Empire. Fragment of left maxilla, as exposed to view downward to the floor of the sinus in the region of the molar teeth. Through the floor is a large oval fistula, 10 × 5 mm.; the margins of the aperture are well rounded and sclerosced, indicating chronicity. The infection atrium by way of the apices of the first and second molars was consequent upon pulp exposure through attrition. The external surface of the maxillary sinus shows an osteoperiosteitis. The right maxillary sinus is similarly involved through the lingual root of the second molar, producing a fistulous opening, 6 × 4 mm. in diameter.

c. 12–4895 (L123). Lateral aspect of mandible, male, age about 60, Naga-ed-Der, VI–XII Dynasties. Later type of mandible: the ramus is high and narrow with high sharp coronoid process and deep sigmoid notch; the anterior border is straight. The angle is roundish and obtuse, the gonions everted. The mental eminence is well developed. The dentition tends to be a transitory organ. The posterior teeth are extensively involved in periodontoclasia to the point of exfoliation. Heavy brownish accretions are on the lingual surfaces. A thin, everted, collar of new bone is evident at the margin of the resorbing alveolus; this sharp lamina is characteristic of this destructive inflammatory process. The lower teeth are not worn nearly as much as the upper teeth.

d. 12–5050 (L139). Lateral aspect of Predynastic type mandible, female, age about 20, Naga-ed-Der, Predynastic. This mandible is an excellent example of the Predynastic type —female. The jaw is characterized by beauty of symmetry, definition of outline, refinement of structure and surface detail, and harmony and efficiency of the implanted dentition. The body is amply deep, the mental protuberance triangular. The ramus is broad, the angle well defined, the gonions mildly inverted. The anterior border of the ramus is smoothly notched beyond the third molar; above, a convexity terminates in the coronoid process. The sigmoid notch is a broad perfect crescent. The articular surface of the condyle is refined. The musculature was not too heavy. The dental arch is a broad ellipse with ideal arrangement of its units. The enamel is without fissures, and is of a pearly hue. This specimen being from a young female adult, there is maturity without the advanced effects of function, ravages of pathologic processes, or atrophy of senility. The enamel is clean and shows slight wear. From this mandible the norm of the distance from the enamel border to the alveolar crest may be taken—1.5 mm.



a. Type mandible: Low, broad rami; periapical osteitis resultant from attrition.
b. Interior of left maxillary sinus: Large fistula through floor.
c. Male, type mandible: High, narrow ramus: advanced periodontoclasia.
d. Female, beautiful example of Predynastic type mandible.

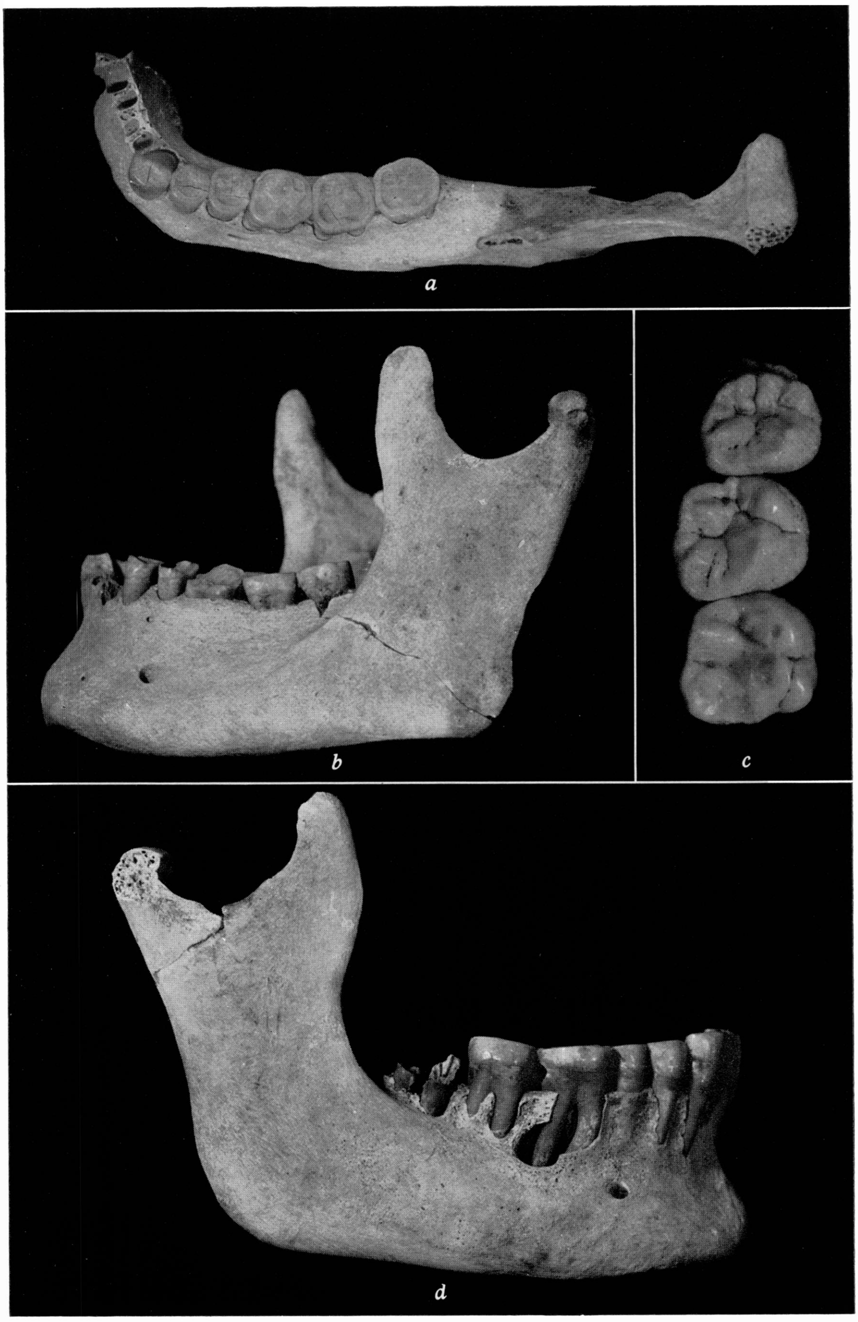
PLATE 7

a. 12–5250 (L210). Occlusal view of left mandibular teeth, male, age about 40, Gizeh, Old Empire. Second degree attrition is exemplified: dentine is exposed at positions of former cusps; islands of enamel, formerly at the bottom of grooves, form a mosaic with the contrasting dentine.

b. 12–5222 (L191). Left lateral aspect of mandible of male, age about 55. This is essentially the archaic type mandible with some variation: the ramus is higher and the coronoid process is exceptionally high. Other morphologic features are typical: definite, almost right, angle; gonions not everted; sigmoid notch a symmetrical crescent; the anterior border of the ramus presents a large concavity at its base, surmounted by a convexity.

c. 12–5056 (L231). Occlusal view of three superior left molar teeth, female, age 18, Gizeh, Middle Empire. These teeth are large; the enamel is remarkably light colored. There is a rapid diminution in size from first to third. The Egyptian dentition is characterized by a constant occurrence of Carabelli's cusp on the superior first molar. This anomalous tubercle is sizable on this first molar, and outlined on the second. While the cusps and grooves are well marked, there is a characteristic softness in their lines.

d. 12–5163 (L164). Lateral aspect of mandible of female, age about 45, Mesheikh, Middle Empire. This type mandible is archaic; it is characterized by a definite angle, and a ramus the anterior border of which has a marked sigmoid curvature. Several teeth with supporting bone have been extensively destroyed by caries and its periapical sequelae. In the first molar, caries at the disto-cervical border of the enamel has extended to the pulp, with chronic periapical osteitis consequent. Note the old fistula with sclerosed border opening from the distal root. Four osseous lesions of identical cause are in this jaw.



a. Occlusal mosaic: Second degree attrition.
b. Male, archaic type mandible: Exceptionally high coronoid.
c. Occlusal aspect of maxillary molar teeth; Carabelli's cusp.
d. Female, archaic type mandible: Dental caries and periapical sequelae.