Human Skeletons of Tehuacán

Abstract. *The oldest series of human skeletons in the New World shows a high incidence of traumatic lesions during the early nomadic hunting and gathering phase, dental patterns which reflect the transition to an agricultural economy, some evidences of microevolution occurring in a local population, and one probable example of pre-Columbian syphilis.*

MacNeish has described a long archeological sequence which has been uncovered in the Tehuacán Valley of Mexico (*1*). Excavations carried out in the past 3 years have produced new evidence on the origins of agriculture and the evolution of civilization in the New World (*2*).

Human skeletons recovered include 32 burials and the fragmentary remains of almost an equal additional number of individuals. The importance of this material lies in its antiquity—the burials form a sequence spanning the last 9000 years—and in its careful excavation in a cultural context, with carbon-14 dates. The six earliest burials are from the El Riego phase which lasted from 6800 to 5000 B.C. Findings of considerable interest include the elaborate burial ritual (probably with human child sacrifice) found from almost the beginning to the end of the sequence, the changing dental patterns related to alterations in economy and diet, the many pathological specimens, and the comparative morphological data which may be used to trace distant affinities of the people.

The skeletons are generally robust with an average stature of 166 cm for the males and 160 cm for the females. Cranial indices fall mainly within the mesocranic range: a few more recent skulls are brachycranic with slight asymmetrical occipital flattening. Supraorbital ridges are continuous across the glabella and extend at least halfway across the superior orbital margin with which they blend. Infraorbital foramina appear very large and in one-quarter of the cases an accessory foramen is present. In all skulls, the inferior nasal margin is indistinctly demarcated. The facial region of both infant and adult is distinguished by a very pronounced zygomaxillary tubercle. This, and the flaring of the zygoma contributes to the vertical facial profile of most of the skulls, particularly those from the earlier levels. Gonial eversion, notching of the inferior border, and a torus on the external oblique line are common mandibular characteristics.

Platycnemia—flattening of the tribal shaft—is minimal. The so-called squatting facets on the talus are neither as common nor as pronounced as in most series of North American Indian bones.

There is a high incidence of certain genetically determined skeletal anomalies such as dehiscence in 23 percent of tympanic plates, thickening of the lateral margin of this plate in 27 percent, presence of a mylohyoid arch in 26 percent, and a septal aperture in 50 percent of female humeri but never in those of males. Another group of anomalies is completely absent: torus palatinus and mandibularis, metopic suture, pterygo-basal bridging, third trochanter of the femur, and vastus notch on the patella.

The degree and pattern of tooth wear in this material fall into three quite distinct categories related to time periods and reflecting dietary habits.

The early pattern is seen in jaws from El Riego and Coxcatlan phases, a time when the people were mainly plant collectors and hunters of small game. An abrasive fibrous diet resulted in severe attrition peculiar because of the obliquely worn surface of the teeth, the confused appearance of a dental arch in which each tooth slopes acutely in a different direction, and the presence of sharp crescents of enamel which remain on the occlusal surface after the rest of the crown has been sheared away. The oblique occlusal surfaces set in different planes were the result initially of pulling sand-covered fibrous plant material obliquely through the teeth to strip off the fleshy, more edible parts. With advanced attrition of these anterior teeth, the opening of their pulp chambers, and subsequent tooth loss, the changing occlusal relationships became the secondary cause of the unusual wear pattern.

Teeth from the Ajalpan phase (1500 B.C. to 900 B.C.) show an intermediate pattern. The degree of attrition of these full-time agriculturalists continues to be high, perhaps due in part to the contribution of abrasive made to maize by the stone mortars in which it was ground. However, signs of oblique wear and enamel crescents are absent; crowns are worn flat, and anterior teeth suffered considerably less attrition than did the grinding molars and premolars.

The pattern of attrition shared by the individuals from the more recent Santa Maria, Palo Blanco, and Venta Salada phases (900 B.C. to A.D. 1540) resembles that of most agricultural groups. The amount of wear is slight, usually with cusps blunted by facets of attrition on the posterior teeth and with a thin line of exposed dentin on the biting edge of the incisors.

The incidence of premortem tooth loss declines spectacularly with the transition to agriculture, from 41.6 percent loss in the early hunting and

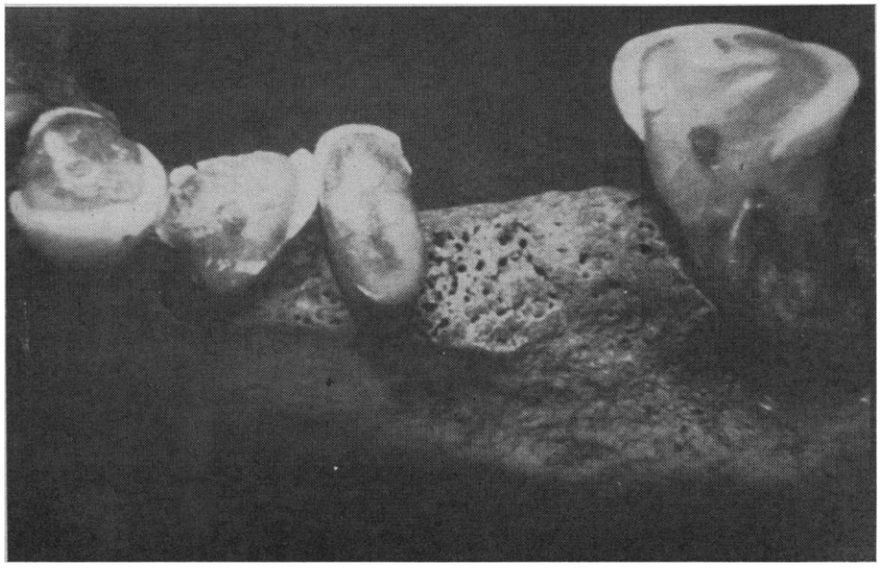

Fig. 1. The obliquely worn dentition of one of the early Tehuacán skeletons showing the crescents of enamel on the occlusal surfaces.

gathering economy to 6.2 percent in the most recent phase. As the incidence of tooth loss changes, so does its etiology. In the early phases the cause is attrition leading to exposure of the pulp chamber. With the adoption of agriculture and its concomitant softer diet high in carbohydrate, caries replaces attrition as the prime cause.

Although in the Tehuacán material the incidence of caries does increase with the change to agriculture, the increase is not as great as anticipated even in the presence of large numbers of congenital enamel pits on the molar crowns, notorious as sites of carious lesions. An explanation for this unexpectedly low increase is that the water of the valley is rich in minerals, and these were deposited (even as now) on the teeth as a heavy calculus which effectively plugs potential caries sites.

Of the five complete adult skeletons from the earliest levels, four show evidence of healed fractures occurring in a total of 17 bones, mainly ribs, vertebrae, and those of the forearm. In contrast, only one fracture occurs (a left fibular shaft) in all of the skeletons from the later phases. The marked decrease in evidence of trauma no doubt reflects the adoption of a sedentary way of life and an easier one. Among the many fractures of the early period, none is of a lower limb bone, an indication that individuals with such fractures were not returned to the cave.

The most spectacular pathological specimen is an adult male skull, dated at 300 B.C., in which the vault has been almost completely destroyed by trepanematosis, probably syphilis. Degenerative disease—osteoarthritis of the limb joints and osteophytosis of the vertebral bodies—is common and appears in all stages of severity. Three serious congenital abnormalities were found: a bilateral hip dislocation, spondylolisthesis of a fifth lumbar vertebra, and spina bifida of the last two lumbar and all five sacral vertebrae.

Much of the recorded data awaits, for comparative purposes, the discovery of new material of known antiquity from other sites in the New World. The Tehuacán material shows interesting similarities to the few available specimens of comparable age such as the skulls from Santa Maria Astahuacan and the Tepexpan skeleton (see *3*).

The data gained from the human skeleton through morphological description, the incidence of hereditary anomalies, evidences of pathology, and changes in the dentition may contribute to the reconstruction of a prehistoric culture and its people. The rare occasions when a series of human skeletons may be studied in conjunction with the analysis of a rich cultural sequence provide us with a tantalizing taste of how much can be learned by this method.

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References and Notes

1. R. S. MacNeish, *Science* **143**, 531 (1964).
2. By the Tehuacán Archeological-Botanical Project which is under the auspices of the Robert S. Peabody Foundation for Archeology, Andover, Mass., and which is supported by NSF and the Rockefeller Foundation.
3. Details of the analysis of the skeletal material will appear in an early volume of the final report of the Tehuacán project. This report was read at the annual meeting of the American Association of Physical Anthropologists in Mexico City in July 1964.
4. I thank Dr. R. S. MacNeish, director of the Tehuacán project, for the opportunity to study this material and for guidance in the interpretation of the data as part of the total archeological picture.

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Chloroplast Mutagenesis: Effect of N-Methyl-N′-Nitro-N-Nitrosoguanidine and Some Other Agents on Euglena

Abstract. *Treatment of normal green* Euglena gracilis *with* N-*methyl*-N′-*nitro*-N-*nitrosoguanidine results in permanent loss of the ability to form chloroplasts in close to 100 percent of the organisms. The resulting "bleached" strains can be maintained for over 100 generations; no reversion to chloroplast-containing organisms occurs within this time. Alkylating agents, azaserine, mitomycin C, acridines, nitrous acid, hydroxylamine, and* γ*-irradiation do not bleach significant proportions of cells even at concentrations sufficient to kill most of the cells. These results may be due partly to differences in the base compositions of nuclear and chloroplast DNA.*

The chloroplasts of many green organisms are known to possess some degree of genetic autonomy (*1*). While no definitive work on the molecular basis of the genetic determinants of the chloroplasts has been reported, the recent discovery of DNA associated with the chloroplast fraction (*2*) suggests that the information required for the synthesis of some or all of the chloroplast proteins may be encoded in chloroplast DNA.

Exposure of the phytoflagellate *Euglena gracilis* to any one of a variety of chemical or physical agents induces "mass mutation" to apoplastidic ("bleached") cells (*3*). Loss of chloroplasts is permanent but not lethal so long as the organism is provided with an organic carbon source. Many bleaching agents are highly specific in that they do not lower the ability of the organisms to survive and they may not even affect the growth rate. Detailed studies of the bleaching effects of ultraviolet light indicate that the "target" is cytoplasmic nucleic acid (*4, 5*). The cells damaged in this way by ultraviolet light can be completely reactivated by exposure to visible light (*4*), which suggests that thymine dimers in DNA may be responsible for inactivation (*6*). Some of the chemical bleaching agents are known to be radiomimetic, mutagenic, and to inhibit DNA synthesis in bacteria (*7*).

Euglena gracilis strain Z was cultivated in defined medium, *p*H 3.5 (*8*) or *p*H 7 (*9*), in the light at 26°C unless otherwise indicated. Plating experiments were carried out with tryptic soy agar. Media containing drugs were sterilized by filtration through HA Millipore filters; other media were autoclaved. The effects of the various agents were tested in cultures (5 ml each) contained in tubes. Immediately after preparation, each tube was inoculated with about 4×10^4 organisms. A sample of each culture was removed after 24 hours, diluted appropriately, and plated to determine survival and the extent of bleaching. In general, agents were tested in media at both *p*H 3.5 and *p*H 7.0. The effect of nitrous acid was determined by exposing cells for different lengths of time to a solution of 0.05*M* acetate buffer containing 0.001*M* sodium nitrite. The *p*H of this solution was adjusted to 4.5 immediately before use. The effect of Co^{60} γ-radiation was tested by irradiating cells in the defined medium, *p*H 3.5, in glass tubes at a dose rate of about 2500 r per minute. The dose was determined by means of a Philips Universal Dosimeter. Cells were plated about 1 hour after irradiation.