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Aztec Cannibalism: An Ecological Necessity?

The Aztec diet was adequate in protein and cannibalism would not have contributed greatly.

Bernard R. Ortiz de Montellano

In a recent article Harner proposed that the Aztecs conducted sacrifices in order to supplement their diet through cannibalism (1). The parts of his argument with which I am concerned are:

1) The Aztecs lacked domesticable herbivores and therefore lacked a good source of protein.

2) Corn and beans could satisfy protein needs but must be eaten together to be useful.

becoming a part of the privileged nobility and thereby partaking of the extra food.

5) Unpublished figures (Woodrow Borah, cited in Harner) place the population of Central Mexico at 25 million, with 250,000 sacrificed yearly, and that of Tenochtitlan at 300,000, with 15,000 sacrificed annually.

6) The evidence of widespread cannibalism is clearly shown in Spanish

Summary. It has been proposed that Aztec human sacrifice and cannibalism can best be explained as a response to population pressure and famine. The greatest amount of cannibalism, however, coincided with times of harvest, not with periods of scarcity, and is better explained as a thanksgiving. Tenochtitlan received large quantities of food tribute and engaged in intensive (*chinampa*) agriculture. These two sources alone would have provided enough to feed practically the entire population of the city. The Aztecs also consumed various animals and insects that were good protein sources. The amount of protein available from human sacrifice would not have made a significant contribution to the diet. Cannibalism was not motivated by starvation but by a belief that this was a way to commune with the gods.

3) Droughts often led to shortages and famines, increasing population pressure. Population pressure led to increased human sacrifice accompanied by cannibalism to satisfy this protein shortage. [In Tenochtitlan (the Aztec capital), at least, only the limbs of the victim were consumed and only the upper class (approximately 25 percent of the population) was allowed to partake.]

4) The other 75 percent of the population supported the use of warfare and sacrifice because bravery in combat offered the possibility of an individual's

chronicles of the conquest, but these have been ignored by modern Mexicans and anthropologists.

I show that Harner's thesis is flawed in its major aspects and that much evidence which opposes his thesis can be brought forward.

Harner's argument is that the pressure of population on resources led to hunger and thus to cannibalism. This argument is invalid if, in fact, there was an adequate diet for the population. There is evidence to support this.

If cannibalism is a good response to

protein deficiency, then human meat should make a significant dietary contribution. In this article I show that it did not suffice as a protein source, even for the privileged 25 percent. If the meat was really needed for dietary reasons, the other 75 percent of the population was in even greater need since its diet was sparser than that of the nobility. It is not satisfactory to say that the commoners strived for future rewards, since protein consumption cannot be delayed for the time span (several years until reaching adulthood) proposed by Harner.

The principle of parsimony seems to dictate that, rather than beginning with an abnormal response, such as cannibalism, to dietary deficiency, responses which have occurred frequently in the past with other cultures should be investigated. Such responses to population pressures are improvement in agriculture and expansionist conquests.

With respect to motivations, it is relevant to examine those of the Spanish chroniclers of the conquest as well as those of present-day Mexicans and anthropologists.

Most of the data I present deals with Tenochtitlan, both because there is more information available for this city and because it represents the most extreme use of sacrifice mentioned by Harner (5 percent of the population compared to 1 percent of the population yearly for the entire region).

Pre-Columbian Diets

Before claims to nutritional inadequacy can be established, standards need to be validated. This is not as simple as Harner's article would lead us to believe. Poleman states in a recent article (2),

[N]utrition is still a young science; and these requirements more properly "recommended allowances," are not nearly as precise as we would like them to be. In fact, the history of FAO, the World Health Organization (WHO), and the Food and Nutrition Board of the U.S. National Research Council in estimating nutrient needs has been one of constant (downward) change. The blunt truth is that we still

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Table 1. Sample diets derived solely from grains received in tribute by the Aztecs and which meet dietary requirements of the Food and Agriculture Organization-World Health Organization (FAO-WHO). The data from (52).

Item	Energy (kcal)	Protein (g)	Fat (g)	Calcium (mg)	Phosphorus (mg)	Vitamin A (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Ascorbic acid (mg)
<i>Diet 1</i>										
Corn (400 g)	1432	33.6	18	44	484	0.6	1.52	0.4	7.6	—
Beans (100 g)	343	22.7	1.6	1.3	415	0.008	0.47	0.40	2.1	1
Chia (100 g)	463	15.6	22.7	518	518	0.01	0.38	0.13	3.74	—
Huauhtli (100 g)	53*	6.2*	0.6	468*	91	2.74	0.09	0.29	1.5*	75
Total	2291	78.1	42.9	976	1508	3.36	2.86	0.97	15.0	76
<i>Diet 2</i>										
Corn (300 g)	1074	25.2	13.5	33	363	0.45	1.44	0.3	5.7	—
Beans (200 g)	686	45.4	3.2	2.6	830	0.016	0.94	0.3	4.2	2
Chia (200 g)	926	31.2	45.4	1036	1036	0.02	0.76	0.26	7.48	—
Huauhtli (100 g)	53*	6.2*	0.6	468*	91	2.74	0.09	0.29	1.5*	75
Total	2739	108	62.7	1540	2320	3.23	3.23	1.15	18.9	77
FAO-WHO	2200	45		800	800	1	1.2	1.8	20	45

*Data taken from Oliveira and Carvalho (9) corrected to net rather than dry weight. These values are probably low since they are for amaranth leaves, and the Aztecs also ate the seeds of the amaranth.

do not know the nutritional requirements for various populations under various environmental conditions. The organizations charged with preparing estimates, therefore, have consciously erred on the side of caution.

Even international requirements tend to overestimate the needs.

To assume that a diet requires protein from domesticable herbivores just because that is the usual American and European diet is quite ethnocentric. A study of the composition of Mexican foods suggested that "it could be possible to nourish the Mexican people without the use of dairy and meat products," that "the food pattern in Mexico is quite different from that of the United States," and that "it would be unadvisable to base the Mexican nutrition program upon that of the United States" (3). In fact, some of the malnutrition of present-day Indians in Mexico and Guatemala can be attributed to the substitution of European foods, which are less nutritious, for traditional items, that is, liquor instead of *pulque* (fermented agave juice which is rich in minerals and vitamins, particularly ascorbic acid), wheat bread for tortillas (3), coffee instead of the more nutritious corn and chocolate beverages, and bottled rather than breast milk (4, 5). The traditional alkali processing of corn involved in making tortillas enhances the nutritional value of corn by making niacin and amino acids much more available and by increasing the calcium content 100-fold (6). This, as well as the consumption of beans (which have complementary amino acids such as lysine), may account for the absence of pellagra (caused by niacin deficiency) in corn-bean consumption areas of Central America and Mexico (7). Amaranth, one of the staple grains of the Aztecs, was banned by the Spanish because of its

close association with religion. It has been found to be a rich source of protein and exceptionally rich in lysine, an amino acid usually deficient in plant protein (8-10). Behar (5), Katz *et al.* (6), and Adams (11) conclude that pre-Columbian diets were superior to the present diets of Indians.

The Aztecs had available and consumed a much larger variety of foods than we do (12). In addition to a wide list of tropical fruits and vegetables, Sahagun enumerates more than 40 varieties of waterfowl (13). The diet did not stop there. Aztecs ate armadillo, pocket gopher (*tozan*), weasels (*cuzatl*), rattlesnakes, mice, and iguanas as well as deer, turkeys, and dogs (14). Their diet included a large variety of fish, frogs, aquatic salamanders (*axolotl*), fish eggs, water flies, corixid water beetles (*axaxayacatl*) and their eggs (*ahuauhtli*), and dragonfly larvae. Several varieties of grasshoppers, ants, and worms were also consumed (13, book 11, pp. 58-98; 14, vol. 2, pp. 390-396). All of these species are animal sources of protein that could be used to supplement diets. Insects are extremely efficient food converters and produce proteins comparable to those of herbivores (15). The food potential represented by insects is enormous. For example, if all of the offspring produced by one cabbage aphid during one season lived, the maximum collective weight would be greater than that of the earth's entire human population (15, p. 62). Some of these insect and amphibian species have been shown to be quite nutritious (16).

Harner neglects to mention the huge amounts of food brought to Tenochtitlan each year as tribute. These are listed in the Codex Mendoza (17). Although there is no dispute about the number of Span-

ish units of measure involved, there are differences of opinion on the conversion factors to modern units. A diet (Table 1) which meets the recommended daily allowance for an adult male can be designed using only the four staple foods which were brought as tribute to Tenochtitlan: corn, beans, chia (*Salvia hispanica*), and huauhtli (*Amaranthus* sp.) (17). Table 2 gives the amounts of tribute of the four major grains in metric tons per year and the number of people who could be fed for 1 year at the diet levels given in Table 1. Thus, solely on the basis of the four primary grains brought as tribute each year, between 60,000 and 150,000 people could be fed a balanced diet exceeding the daily protein requirements.

Another stable source of foodstuffs not mentioned by Harner were the *chinampas*. Crops were grown on artificial structures in the lake surrounding the city, "chinampas," built of mud scooped from the lake bottom. The lake supplied the moisture required, and highly intensive cultivation techniques were used. Chinampas were not affected by droughts, and produced seven crops a year, including two corn crops (18). On the basis of current *chinampa* yields, it has been estimated that 1 hectare of *chinampa* would feed 20 individuals (19). Armillas has estimated that there were over 9000 hectares of *chinampa* land in the early 1500's (20). These "gardens on a swamp" would provide a drought-free source of food for approximately 180,000 people.

Since somewhere between 240,000 and 330,000 people could be fed adequately on tribute and *chinampa* agriculture alone, and the population of Tenochtitlan was approximately 300,000, it does not seem reasonable to postulate

protein starvation as an impelling force to cannibalism. To provide a margin of error, these calculations do not take account of the variety of available foods mentioned above, which include additional protein sources.

Two possible objections to the above come to mind: (i) foodstuffs from tribute might not have been distributed to the general population, and (ii) a protein deficiency in a period previous to 1500 might have impelled the Aztecs to cannibalism. The weight of evidence supports the idea that foodstuffs obtained in tribute were distributed to the population, particularly in times of need (21–25). The royal palace, as in other royal establishments, fed a large number of members of the nobility and artisans who fabricated luxury goods. Two accounts of the yearly consumption of the palace of Texcoco are available (21, vol. 2, p. 308; 22, vol. 1, p. 167; 24, vol. 2, p. 266). It would be logically inconsistent to argue that the nobility kept tributary foodstuffs sufficient for the entire population entirely for themselves and in addition was compelled to supplement its diet with human flesh.

Meat was apparently not in short supply in earlier periods. Coprolite evidence shows that meat was the second most abundant component of the diet both in Ocampo, Tamaulipas in 1450 and in Tehuacan, Puebla in 1120 (7, pp. 29–49). Both of these dates are within the time span of the Toltec-Aztec presence in Mexico.

There may have been less famine than Harner supposes or than would be required to drive people to cannibalism. The chronicles and codices record two major famines in the period of the independent existence of the Aztecs, when the growth of the practice of human sacrifice took place (23, p. 158; 24, p. 241; 26–28). The worse famine took place in the years 1450 to 1454, when four successive crop failures took place. There are some interesting things to note about the famine.

1) The severity of the crop failures was mitigated for the first 2 years because the people were fed from the surplus grain stored by the king in the past. Mass starvation occurred only after several successive years of crop failure. This fact certainly opposes the view that Aztec society was on the brink of starvation as a normal condition, and supports the view espoused above that the Valley of Mexico ordinarily had an extremely rich and varied source of food.

2) In these famines the chroniclers bitterly decry the fact that people were starving to death and lying unburied—

Table 2. Amount of tribute received by Tenochtitlan and number of people that could be fed at the dietary levels in Table 1 for 1 year. Four different conversion factors from 16th-century measures are shown.

Commodity	Conversion factors (kg/fanega)			
	42 (53)	55.5 (12, 54)	75 (55)	119 (56)
Corn				
Amount (10 ³ tons)	6.36	7.77	10.50	16.73
Diet 1 (10 ³ persons)	43.60	53.20	72.00	115.00
Diet 2 (10 ³ persons)	58.10	71.00	96.00	152.80
Beans				
Amount (10 ³ tons)	4.41	5.83	7.88	12.50
Diet 1 (10 ³ persons)	121.00	160.00	216.00	342.00
Diet 2 (10 ³ persons)	60.50	80.00	108.00	171.00
Chia				
Amount (10 ³ tons)	4.41	5.83	7.88	12.50
Diet 1 (10 ³ persons)	121.00	160.00	216.00	342.00
Diet 2 (10 ³ persons)	60.50	80.00	108.00	171.00
Huauhtli				
Amount (10 ³ tons)	3.78	5.00	6.75	10.71
Diet 1 (10 ³ persons)	104.00	137.00	185.00	293.40
Diet 2 (10 ³ persons)	104.00	137.00	185.00	293.40

prey to wild beasts (28, p. 45; 29). If people were resorting to cannibalism as a response to hunger, the complaint about bodies being eaten by wild beasts strikes a discordant note.

Along this line are also descriptions of the fall of Tenochtitlan to the Spanish and their allies (29, p. 138; 30, p. 109).

People were starving and eating bark for sustenance when all around them was a slaughterhouse of dead enemies and allies ("sacrificed in battle"). If cannibalism had been the traditional Aztec response to hunger, there would have been little need for the civilian population to starve in this siege.

Usual Responses to Famine

Before invoking cannibalism, an unusual response to dietary insufficiency, it seems logical that we investigate the more common responses.

Historically, nations and groups have responded to famines by intensifying agriculture or by attempting to conquer new land. This, rather than an intensified cannibalism, is in fact what took place in Mexico.

The response to the famine of 1450 developed along lines that are traditional in other parts of the world. The Aztec emperors began great hydraulic works to separate and contain the salt- and freshwater lagoons in order to prevent floods and to permit the expansion of *chinampa* agriculture (31).

[I]n addition to the special climatic conditions, the insecurity of these types of agriculture, the exhaustion of the soil and the relative excess of population seem to have played a considerable role in the great famine in the epoch of Moctezuma I and Nezahualcoyotl

(1450's). . . . The crisis was resolved in northern Acolhuacan by the conversion from intensive swidden agriculture into *intensive irrigation* and terracing agriculture [*emphasis B.O.M.*]. It follows, in the same way that the development of the hydraulic works in the Kingdom of Texcoco coincided with the carrying out of similar works in Tenochtitlan and in other places in the valley of Mexico.

Construction of aqueducts and irrigation systems were a response to this famine; they also played a significant role in the subsistence patterns of Mesoamerica (32).

The other response to the famine was to expand the military conquests and the areas which paid tribute to the city, in order to ensure a supply of food from conquered territories. An analysis of the list of conquered towns in the Codex Mendoza (17) reveals that towns were conquered at a rate of 1.39 per year during the reigns of Itzcoatl and Motecuhzoma I (Moctezuma I), which occurred before and immediately after the famine, and at the rate of 2.6 per year under subsequent rulers until the arrival of the Spanish. The nature and direction of the expansion also changed. The early conquests under the reign of Itzcoatl were towns in the immediate neighborhood (Chalco, Xochimilco, Tlacopan, and Mixcoac) which were security threats. Their conquest was undertaken presumably for security reasons, although land was confiscated and turned over to land-hungry nobles. Conquests after the famine were directed toward areas in the south and on the east coast (Cuetlaxtlan, Tlatlahquitepec, Totoltepec, and Xaltepec, for example) (33). These were areas with assured rain and which are traditionally highly fertile. It is probably no accident that these were the areas into which the Aztecs had had to sell them-

Table 3. Potential protein contribution of cannibalism to the diet of the Aztecs.

Location	Protein need* (10 ⁶ kg/yr)	Available protein†		Annual need satisfied (percent)	
		Whole body (kg/yr)	Extremities‡ (kg/yr)	Whole body	Extremities
Tenochtitlan	1.2	78 × 10 ³	27.2 × 10 ³	6.5	2.30
Central Mexico	97.0	1.3 × 10 ⁶	0.45 × 10 ⁶	1.3	0.47

*Based on a population of 75,000 eligible consumers in Tenochtitlan and 6.25 million in Central Mexico. †Based on 15,000 annual sacrifices in Tenochtitlan and 250,000 in Central Mexico. ‡Assuming the extremities to be 35 percent of total body weight (41).

selves as slaves in exchange for maize during the famine of 1450.

The above consideration of the number of inhabitants that could be nourished on just tributary foodstuffs and the products of chinampa agriculture shows that these responses to famine were successful. It would therefore seem redundant to invoke the unusual response of cannibalism to the ecological stress of the famine of the 1450's.

Cannibalism as a Dietary Supplement

The general agreement seems to be that cannibalism has never served as the principal source of protein for human diets (34-37). There are differences of opinion concerning lesser contributions. Garn and Block consider that consumption of less than one man per week per group of 60 (equivalent to 87 percent of the population per year) would not be significant even as a supplement to a cereal or tuber diet (34). Vayda takes the position that cannibalism may be of critical importance as a source of protein to individuals who are wounded or under severe stress leading to a negative protein balance (36). Dornstreich and Morren (on whom Harner relies) argue that a contribution from cannibalism ranging from 5 to 10 percent of protein need would be significant and comparable to the contribution from pork in New Guinea (37). To achieve this level they required a consumption of 10 to 15 adults per year in a population of 100 (46 adults and 54 children).

The amount of protein available to Aztec noblemen from cannibalism can be calculated on the assumption either that the total body was consumed or that more probably, and in agreement with Harner, only the extremities of sacrificial victims were consumed. I use the figures cited by Harner from unpublished data by Borah for the sake of the argument without implying agreement with the figures themselves. The estimates are certainly excessive because many wom-

en and children were sacrificed and their body weight would be much lower than that assumed for the purpose of calculation. Furthermore, many of the festivals during the year were dedicated to Tlaloc, the rain god, and victims sacrificed to him were usually buried intact (38). This practice would certainly reduce the ratio of victims consumed to the total executed.

The protein requirements for the portion of the population that was allowed to partake of human flesh (25 percent, according to Harner) is calculated by multiplying the daily protein requirement of 0.71 g of protein per kilogram of body weight (39) by an average body weight of 60 kg per consumer multiplied by the number of consumers times 365 days. Tenochtitlan's consumer population of 75,000 (300,000 × 0.25) would require 1.2 × 10⁶ kg of protein per year. The protein requirements of Central Mexico with a consumer population of 6.25 × 10⁶ (25 × 10⁶ × 0.25), would be 97 × 10⁶ kg per year.

Calculation of the protein available from sacrifices requires several assumptions. Assume that all victims are 60-kg males consisting of 16 percent protein with a digestibility of 90 percent. This percentage is between the values given by Garn and Block (34) and by Dornstreich and Morren (37) and is approximately the percentage of protein in lean beef (16.5 percent), lean lamb (16.5 percent), or lean pork (14.5 percent) (40). Skillful butchering would give a 60 percent dressed yield (34, 37). Thus, a 60-kg victim would yield 5.18 kg of protein (60 kg × 0.16 × 0.60 × 0.90). Information about the percentage of total body weight represented by the extremities is hard to find. The Wayne County Medical Examiner estimates that the weight of the extremities would equal 35 percent of the total weight if the buttocks and shoulders were included as part of the extremities (41). If only these extremities are eaten, the protein yield per 60 kg of captive would be 1.81 kg.

The only case where cannibalism

would fall in the range of 5 to 10 percent of dietary need would be that of Tenochtitlan (where Harner assumes that 5 percent of the population would be eaten annually), and only if the entire bodies of all the victims were consumed (Table 3). As stated above, the number and size of victims actually available was almost certainly smaller than the number on which Table 3 was based. Thus, the contribution of cannibalism to the diet of the Aztecs can hardly be considered significant.

Although cannibalism was not significant on a year-round basis, the possibility that it took place primarily at times of stress or need and thus made a significant contribution (at those times) needs to be considered. Table 4 correlates the annual ceremonies to the agricultural cycle in the Mexican highlands. If ritual cannibalism had arisen as a result of ecological necessity, the normal times of scarcity in the agricultural cycle should correlate with the number of victims sacrificed and eaten. This correlation is not apparent in the data presented in Table 4.

The three monthly periods cited in the sources as times when the larger numbers of victims were sacrificed and eaten were month 2 (Tlacaxipehualiztli—March), month 13 (Tepeilhuitl—October), and the largest in month 15 (Panquetzaliztli—November to December) (13, book 2, p. 47; 24, p. 95; 38, p. 63).

The biggest consumption of human meat took place in month 15, in the middle of the corn harvest. Month 2 was 90 days after the harvest, when presumably food reserves were still on hand. Month 13 came after the time for harvesting fruits and vegetables. Months 8 and 9 (Hueytecuilhuitl and Miccailhuitl) are mentioned in the sources as times of scarcity and correspond to July to August (225 days after the harvest), (38, p. 52; 13, book 2, p. 93). In month 9, the sources specifically mention that no people were killed and that the offerings to the gods were flowers and birds (13, book 9, p. 87; 38, pp. 52, 68). It is therefore difficult to find support for the thesis that cannibalism arose out of necessity. The biggest consumption of human flesh took place in the middle of the harvest; and no people were killed when, according to the agricultural cycle, the supply of grains would have been at its lowest ebb.

An explanation which fits the facts much better is that the large number of sacrifices were a gesture of thanks and reciprocity to the gods—in the case of Panquetzaliztli for the corn harvest and in the case of Tepeilhuitl for the fruit

and vegetable harvest. The ceremonies in Quecholli (month 14) lend further support to this hypothesis. This month was dedicated to Mixcoatl, the god of the hunt. During the month a very large wild game hunt was conducted, and at its conclusion many captives were sacrificed and eaten (*I3*, book 2, pp. 25, 122; 38, p. 69). It makes more sense to consider these rituals a thanksgiving rather than a redundant search for meat at the conclusion of a large hunt for wild game.

Motivations for Sacrifice and Cannibalism

One of the weaknesses of the argument that cannibalism among the Aztecs was impelled by a protein shortage is the need to explain the pressure motivating the common man. Aztec citizens fought bravely in wars and submitted to sacrifice when captured, a seemingly large offering for the sake of a possible dietary supplement in the future. Aristocratic status was not inherited and could only be achieved through bravery in combat. Protein deficiencies are most crucial in childhood and adolescence. If in fact the Aztecs had needed a dietary supplement, it would not have been available at the time when the need for it was greatest, but only in adulthood after valor in battle had been demonstrated. The promise of an extra ration of protein would not be worth much to a warrior about to be sacrificed. Since the upper 25 percent of the population, who already received superior rations, were the only ones who ate human flesh, we have the anomalous proposition that the remaining 75 percent of the population was supposed to be motivated to fight and die in the expectation of a possible future reward that could only be of real dietary value to their children.

There is no need to invoke protein as the reward that impelled the Aztecs to fight, sacrifice humans, and indulge in cannibalism. We know that other more traditional motivations existed. Bravery in combat and the capture of prisoners for sacrifice was practically the only way for an Aztec to achieve wealth or high government offices (which were not hereditary) (42). A large variety of privileges distinguished nobles and plebeians. Nobles were the only ones allowed to drink chocolate (43), to wear cotton clothing and certain hairdos (25, vol. 2, pp. 330-331), and were honored at various ceremonies and festivities (42, p. 47). The custom that only nobles were allowed to have concubines and more than one wife was much more important from

Table 4. Comparison of the agricultural cycle with Aztec ritual ceremonies.

Aztec month	Christian* calendar	Agricultural† cycle	Ritual ceremonies‡
<i>Dry season</i>			
1 Atlcualo	02/14 to 03/05		Children sacrificed to Tlaloc
2 Tlacaxipehualiztli	03/06 to 03/25		Big kill, children to Tlaloc
3 Tozozotontli	03/26 to 04/14		Children to Tlaloc
4 Hueytozotli	04/15 to 05/04		
<i>Rainy season</i>			
5 Toxcatl	05/05 to 05/24	Planting of corn	Eating of victims possible but not mentioned
6 Etzalcualiztli	05/25 to 06/13	Planting of corn	
7 Tecuilhuitontli	06/14 to 07/03		Time of scarcity
8 Hueytecuilhuitl	07/04 to 07/23		
9 Miccailhuitl	07/24 to 08/12		
10 Xocotlhuetzli	08/13 to 09/01		No killing, no victims eaten
11 Ochpaniztli	09/02 to 09/21	Fruit harvest	Harvest feast
12 Teotleco	09/22 to 10/11		
13 Tepeilhuitl	10/12 to 10/31	Corn harvest	Big kill and eating
14 Quecholli	11/01 to 11/20	Corn harvest	
<i>Dry season</i>			
15 Panquetzaliztli	11/21 to 12/10	Corn harvest	Biggest kill and eating
16 Atemoztli	12/11 to 12/30	Corn harvest	No killing, no victims eaten
17 Tititl	12/31 to 01/19		Eating of victims possible but not mentioned
18 Izcalli	01/20 to 02/08		No killing, no victims eaten

*Correlation of Gregorian and Aztec calendars according to Caso (57).
 †Agricultural cycle correlation (58).
 ‡Characteristics of ritual ceremonies particularly involving sacrifices and cannibalism taken from a survey of (*I3*; 38; 51, p. 432).

the traditional viewpoint of evolution and ecology than a doubtful protein supplement (38, pp. 48-49; 42; pp. 178-182; 44).

Both nobles and plebeians were motivated by religious fervor to conquer new tribes and to increase the number of human sacrifices. The belief that they were the "chosen people" and that the end of the world could only be avoided by "feeding" the sun with human blood and flesh has been elucidated at length (25, vol. 2, pp. 63, 259; 42, pp. 98-99; 45). Considering the lengths to which Western man has gone to defend minor doctrinal differences—the Inquisition, the alternate massacres of Catholics and Protestants in England after Henry VIII, the massacres of the Huguenots—the power of religious zealotry to sustain warfare or cruelty cannot be denied.

The acquiescence of the sacrificed victims to their fate, which seems so strange to us, is also explainable in terms of their religious ideology. The fate of a man after death depended not on how he lived but on how he died. Thus, only sacrificial victims and battle casualties could go to a heaven associated with the sun and later be reborn as hummingbirds and butterflies (*I3*, book 3, p. 47, book 6, pp. 38, 74). The ability of religious fervor for salvation to motivate willing martyrs is also not unknown in our cultural history.

Sacrificial victims were believed to

have become sacred. Eating their flesh was the act of eating the god itself. This communion with superior beings was an important aspect of Aztec religion. Their ingestion of psychotropic plants is explained in this way (46). The name for the *Psilocybes* species of mushroom translates flesh or mushroom of the gods, which lends support to this concept (*I3*, book 11, p. 130). Many of the victims sacrificed in the ceremonies described in book 2 of the Florentine Codex are specifically described as human images or "impersonators" of the various gods (*I3*). Duran mentions that the Aztecs held human flesh to be divine and that the flesh of the sacrificed victims was eaten as if it were something from heaven (24, pp. 108, 140). Communion, in conjunction with a belief in the real presence (which some Christian religions practice), is no different in symbolism to the actions of the Aztecs in consuming what they considered to be the flesh of the gods.

Reliability of Sources

There is no doubt that ritual cannibalism took place in Central Mexico. The extent of this sacrifice and the proportion of the population eaten is more debatable. It has been argued above that both factors are lower than the 250,000 for Mexico and 15,000 for Tenochtitlan

accepted by Harner, because sacrifices to Tlaloc were not usually eaten and because several Aztec "months" were free of sacrifices.

Harner argues that Mexicans and anthropologists have ignored or have minimized the evidence of Aztec cannibalism and that the early Spanish chroniclers are more reliable in this area. No author is free from the influence of his background and the sociopolitical conditions of his time, so these should also be examined. The letters of Cortes were not just a straightforward account of the events of the conquest but a cleverly slanted version designed to appeal to Spain's King Charles' cupidity and to provide him with an excuse to conquer Mexico (that is, in order to convert and save pagan Indians) (47). Cortes depicts the Aztecs as sodomites who sacrifice men, women, and children and tells the king that it is his and the Pope's duty to bring these sinners to the "true faith" (47, pp. 36-37). These statements are contained in his first letter sent on 10 July 1519, 2 months after landing in Veracruz and before embarking on his journey to Tenochtitlan.

In evaluating all early statements, from both Cortes and Diaz del Castillo about what the natives told them, we should keep in mind that none of the Spaniards knew Nahuatl. All conversations had to be translated by Dona Marina, their single native interpreter, from Nahuatl into Maya. They were then translated by Geronimo de Aguilar into Spanish (48). Anyone who has done translation knows the difficulties that this arrangement must have created. Cortes' statement was based purely on hearsay accounts from enemies of the Aztecs and filtered through two translations. It must be considered an attempt to manufacture a cause for war to justify to himself and to his king the conquest of the Aztecs, who had up until then made no hostile moves. In order for Cortes to justify massacres such as those in Cholula or Tenochtitlan (in each of which the conquerors killed several thousand defenseless people), it was necessary to dehumanize the Aztecs and allege great cruelties (13, book 12, p. 53; 47, p. 73). This psychological mechanism of dehumanizing enemies in order to justify any actions against them is of course not unique to Cortes, yet because of it we should not accept his information uncritically.

The accounts of Diaz del Castillo suffer from the same problems: (i) the need to justify the aggressive acts of the conquerors and (ii) ignorance of the natives' language. An additional disadvantage is

that he wrote his account 40 years after the conquest, when he was in his seventies. The accusation that the Aztecs were sodomites is picked up and amplified in the *Relation of the Anonymous Conqueror*, published in 1556. The Aztecs are accused of liking human flesh better than any other, of going to war solely for the purpose of obtaining human meat, and of being sodomites and drunks (49, p. 598). Diaz del Castillo repeats the accusations of drunkenness and sodomy in the last chapter of his book. Keen (50) feels that Diaz del Castillo may have copied this detail from the *Relation of the Anonymous Conqueror*, which appeared while he was writing his book.

In fact, drunkenness and sodomy were considered abominable in Aztec society. They were the subject of admonitions by parents to children (13, book 6, pp. 68, 71; book 10, p. 37) and in adulthood brought severe punishment, including the death penalty (13, book 3, p. 57; book 6, p. 70). Duran (24) complains about the prevalence of drinking in his time and praises the restraint, prohibitions, and penalties, including death, which existed in pre-Columbian times (24, pp. 202-203). The errors of Cortes and Diaz del Castillo with respect to the attitude of the Aztecs toward sodomy and alcohol should make us take a skeptical view of their claims of the extent of cannibalism and human sacrifice.

Although Duran and Sahagun are much more sympathetic and knowledgeable about Aztec civilization, they too are creatures of their times. An important factor is that they were both priests and thus considered Aztec religion a work of the Devil that had to be eradicated. Their books were originally intended to educate other priests about Aztec religious practices so that these could be identified and eliminated. Thus, they have trouble dealing objectively with human sacrifice and ritual cannibalism. Although, as stated above, both of them mention that human flesh was considered sacred, it would have created too much psychological dissonance for them to have equated this practice to the doctrine of the real presence in Christianity.

The political climate in Spain in the latter half of the 16th century swung in favor of those who wanted to exploit the Indians as cheap labor. In order to justify this, it was necessary to consider them savage brutes and not brothers under God (50, pp. 69-95). This policy opposed the earlier view of the monastic orders which considered the Aztecs a civilized people led astray by the Devil but who could be saved (51). Sahagun's writing of

the Spanish version (25) of the Florentine Codex (13) in 1575 to 1577 was precipitated by the need to defend himself against allegations of heretical sympathy with Aztec religion, and to defend the whole thrust of the Franciscan missionary effort from the inquiries of the Inquisition. One example of this is that in book 1 of Sahagun's work, which deals with a description of the gods worshipped by the Aztecs, the appendix is dedicated to refuting the idolatry of the Aztecs. It fills one half of the volume.

In the Spanish version of the Florentine Codex Sahagun inserted material on cannibalism that is not present in the Nahuatl text. In one case Sahagun inserts a paragraph which includes the following phrase (25, vol. 1, p. 69),

[T]hey gave them abundant food and drink and bathed them in warm water, so that they would fatten up because they were to eat them.

The equivalent passage in the Florentine Codex makes no reference to fattening or eating the victims (13, book 1, p. 43). In the description of the feast of Panquetzaliztli, the Spanish version reads (25, vol. 3, p. 43),

The merchants held a banquet in which human flesh was eaten . . . they washed and regaled [the victims] so that their flesh would be tasty when they would kill and eat them.

Again, there is no mention of the fattening of victims or their consumption in the equivalent passage in the Florentine Codex (13, book 9, p. 45). There is evidence that future victims were chosen among those in good health and physical condition and without blemishes (13, book 1, p. 43). If the impersonator of the god Tezcatlipoca got fat, ". . . they gave him salt water so that he would become slender. . ." (13, book 6, p. 66; 25, vol. 1, p. 153).

Conclusion

It is generally agreed that the Aztecs practiced ritual cannibalism but there is no agreement about the extent of this practice. Human sacrifices, cannibalism, and the behavior of Aztec warriors can all be attributed to and explained by motivational factors, such as religion and the desire to achieve status in society. These have been shown to be extremely powerful motives in other societies, including our own. There is no need to invoke an ecological explanation based on cannibalism as a dietary supplement, especially when neither need for a supplement nor the significance of the dietary contribution of human flesh is clearly established.

References and Notes

1. M. Harner, *Am. Ethnol.* 4, 117 (1977); *New York Times*, 19 Feb. 1977, p. 25C; *ibid.*, 3 March 1977, p. 32B; *Nat. Hist.* 86 (No. 4), 47 (1977); *Smithsonian* 8, 24 (1977).
2. T. T. Poleman, *Science* 188, 510 (1975).
3. R. Cravioto, E. E. Lockhart, R. K. Anderson, F. de P. Miranda, R. S. Harris, *J. Nutr.* 29, 317 (1945); E. Davalos Hurtado, *Rev. Mex. Estud. Antropol.* 14, 107 (1954-55); R. O. Cravioto, R. K. Anderson, E. E. Lockhart, F. de P. Miranda, R. S. Harris, *Science* 102, 91 (1945).
4. D. B. Jelliffe and E. F. P. Jelliffe, *Science* 188, 557 (1975).
5. M. Behar, in *Biomedical Challenges Presented by the American Indian* (Pan American Health Organization, Washington, D.C., 1968), pp. 114-119.
6. S. H. Katz, M. L. Hediger, L. A. Valleroy, *Science* 184, 765 (1974).
7. L. Kaplan, in *Man and His Foods*, C. E. Smith, Ed. (Univ. of Alabama Press, University, 1973), p. 76.
8. J. L. Marx, *Science* 198, 40 (1977).
9. J. Santos Oliveira and M. Fidalgo de Carvalho, *Econ. Bot.* 29, 255 (1975); W. J. S. Downton, *World Crops* 25, 20 (1973).
10. Advisory Committee on Technology Innovation, *Underexploited Tropical Plants with Promising Economic Value* (National Academy of Sciences, Washington, D.C., 1975), pp. 14-19.
11. R. N. Adams, in *Human Nutrition Historic and Scientific*, I. Galston, Ed. (International Univ. Press, New York, 1960), p. 8.
12. C. Gibson, *The Aztecs Under Spanish Rule* (Stanford Univ. Press, Stanford, Calif., 1964), p. 337.
13. C. E. Dibble and A. J. O. Anderson, *Florentine Codex, General History of the Things of New Spain* (Univ. of Utah Press, Salt Lake City, 1950-1969), 12 books; book 10, p. 79; book 11, pp. 117-136.
14. F. Hernandez, *Historia Natural de la Nueva Espana* (Universidad Nacional Autonoma Mexico, Mexico, D.F., 1959), vol. 2, pp. 296-310, 369, 379; vol. 12, p. 343.
15. R. L. Taylor, *Butterflies in My Stomach or: Insects in Human Nutrition* (Woodbridge, Santa Barbara, Calif., 1975), pp. 53-61.
16. *Charales* (a small dried fish, eaten whole) is 61.8 percent protein and has 60 mg of niacin per 100 g (three times the daily requirement) and 3200 I.U. of vitamin A (3, p. 324); grasshoppers are 50 percent protein and contain 7.5 mg of niacin per 100 g (15, p. 202); G. Aguirre Beltran, *Programas de Salud en la Situacion Intercultural* (Instituto Indigenista Interamericano, Mexico, D.F., 1955), pp. 56-58.
17. J. Cooper Clark, Ed., *Codex Mendoza* (Waterlow, London, 1938).
18. M. D. Coe, *Sci. Am.* 211, 98 (July 1964).
19. E. A. Calnek, *Am. Antiq.* 37, 104 (1972).
20. P. Armillas, *Science* 174, 653 (1971).
21. F. de Alva Ixtlilxochitl, *Obras Historicas*, A. Chavero, Ed. (Editora Nacional, Mexico, D.F., 1952), vol. 2, pp. 206 and 266.
22. J. B. de Pomar, "Relacion" in *Poesia Nahuatl*, A. M. Garibay, Transl. (Universidad Nacional Autonoma Mexico, Mexico, D.F., 1964), vol. 1, p. 187.
23. J. de Torquemada, *Monarquia Indiana* (Editorial Porrua, Mexico, D.F., ed. 5, 1975), vol. 2, p. 266.
24. D. Duran, *Historia de las Indias de la Nueva Espana e Islas de la Tierra Firme*, A. M. Garibay, Ed. (Editorial Porrua, Mexico, D.F., 1967), vol. 1, pp. 241-243.
25. B. de Sahagun, *Historia General de las Cosas de la Nueva Espana*, A. M. Garibay, Ed. (Editorial Porrua, Mexico, D.F. ed. 2, 1969), vol. 1, pp. 118, 174.
26. H. A. Tezozomoc, *Cronica Mexicana*, M. Mariscal, Ed. (Universidad Autonoma Nacional Mexico, Mexico, D.F., 1943), pp. 35-38.
27. Anonymous, *Codex Telleriano-Remensis*, E. T. Hamy, Ed. (Duke de Loubat, Paris, 1899).
28. Anonymous, *Historia de la Nacion Mexicana: Codice de 1576 (Codex Aubin)*, C. E. Dibble, Transl. and Ed. (Coleccion Chimaliztac, Madrid, 1963).
29. Chimalpahin Cuauhtlehuanitzin, *Relaciones Originales de Chalco Amacamecan*, S. Rendon, Transl. (Fondo de Cultura Economica, Mexico, D.F., 1965), pp. 100, 200.
30. Cited in M. Leon Portilla, *The Broken Spears: The Aztec Account of the Conquest of Mexico* (Beacon, Boston, 1962), pp. 109, 138.
31. A. Palerm and E. Wolf, *Agricultura y Civilizacion en Mesoamerica* (Sepsetentas, Mexico, D.F., 1972), pp. 121-126.
32. R. McC. Adams, *The Evolution of Urban Society* (Aldine, Chicago, 1966), pp. 72, 166; F. Katz, *The Ancient American Civilizations* (Praeger, New York, 1969), pp. 153-155.
33. M. Orozco y Berra, *Historia Antigua y de la Conquista de Mexico* (Editorial Porrua, Mexico, D.F., 1960), vol. 3, p. 367.
34. S. M. Garn and W. D. Block, *Am. Anthropol.* 72, 106 (1970).
35. M. E. Randall, *ibid.* 73, 269 (1971); S. Walens and R. Wagner, *ibid.*, p. 269.
36. A. P. Vayda, *ibid.* 72, 1462 (1970).
37. M. D. Dornstreich and G. E. B. Morren, *Hum. Ecol.* 2, 1 (1974).
38. T. de Benavente o Motolinia, *Memoriales*, E. O'Gorman, Ed. (Universidad Autonoma Nacional Mexico, Mexico, D.F., 1971), pp. 63, 66.
39. FAO/WHO, *Protein Requirements* (FAO Nutrition Meetings Report Series No. 37, Rome, 1965), p. 22.
40. Consumer and Food Economics Research Division, *U.S. Dep. Agric. Agric. Handb.* 8, 1 (1963).
41. W. Spitz, personal communication.
42. J. Soustelle, *Daily Life of the Aztecs* (Macmillan, New York, 1961), pp. 40, 45-46.
43. J. de Durand-Forest, *Estud. Cult. Nahuatl* 7, 67 (1967).
44. W. Krickeberg, *Las Antiguas Culturas Mexicanas* (Fondo de Cultura Economica Mexico, D.F., 1956), p. 71.
45. A. Caso, *The Aztecs: People of the Sun* (Univ. of Oklahoma Press, Norman, 1958), p. 12; M. Leon Portilla, *Aztec Thought and Culture* (Univ. of Oklahoma Press, Norman, 1963), pp. 25-61.
46. P. T. Furst, Ed., *Flesh of the Gods* (Praeger, New York, 1972), pp. 261-278; C. Viesca Trevino, in *Psicotropicos de Origen Vegetal. Sus Implicaciones Historicas y Culturales*, X. Losoya, Ed. (Instituto Mexico Estudio Plantas Medicinales, Mexico, D.F., 1976).
47. H. Cortes, *Letters from Mexico*, A. R. Pagden, Ed. (Orion, New York, 1971), pp. xxi, xl.
48. B. Diaz del Castillo, *The Discovery and Conquest of Mexico*, A. P. Maudslay, Ed. (Farrar, Straus and Giroux, New York, 1956), p. 68.
49. "El conquistador anonimo," in *Coleccion de Documentos para la Historia de Mexico*, J. Garcia Icazbalceta, Ed. (Editorial Porrua, Mexico, D.F., 1971), pp. 368-398.
50. B. Keen, *The Aztec Image in Western Thought* (Rutgers Univ. Press, New Brunswick, N.J., 1971), p. 575.
51. J. L. Phelan, *El Reino Milenario de los Franciscanos en el Nuevo Mundo* (Universidad Autonoma Nacional Mexico, Mexico, D.F., 1972), pp. 79-92.
52. N. S. Scrimshaw and V. R. Young, *Sci. Am.* 235, 51 (Sept. 1976); M. Flores, Z. Flores, B. Garcia, Y. Galarte, *Tabla de Composicion de Alimentos de Centro America y Panama* (Instituto de Nutricion Centro America y Panama, Guatemala City, 1960).
53. W. Borah and S. F. Cook, *Price Trends of Some Basic Commodities in Central Mexico, 1531-1570* (Univ. of California Press, Los Angeles, 1958), p. 11.
54. N. Molins Fabrega, *Rev. Mex. Estud. Antropol.* 14, 303 (1954-55).
55. M. Carrera Stampa, *Hispanic Am. Hist. Rev.* 29, 2 (1949); E. Anderson and R. H. Barlow, *Ann. Mo. Bot. Gard.* 30, 413 (1943).
56. S. F. Cook, *The Historical Demography of the Teotlalpan* (Univ. of California Press, Los Angeles, 1949), p. 39; F. Katz, *Situacion Social y Economica de los Aztecas Durante los Siglos XV y XVI* (Universidad Autonoma Nacional Mexico, Mexico, D.F., 1966), p. 103.
57. A. Caso, in *Handbook of Middle American Indians*, R. Wauchope, Ed. (Univ. of Texas Press, Austin, 1971), vol. 10, p. 344.
58. J. A. Vivero Escoto, in *ibid.*, vol. 1, pp. 198-199; R. E. Reina, *ibid.*, vol. 6, p. 325; Wm. Madsen, *ibid.*, in vol. 8, p. 634; O. Lewis, *Life in a Mexican Village: Tepoztlan Revisited* (Univ. of Illinois Press, Urbana, 1963), pp. 148-157.
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AAAS Travelers . . .

AAAS has been asked to send a representative to the French Association for the Advancement of Science meeting to be held 6-8 July 1978 in Mulhouse, France. AAAS members who expect to be traveling in the area at this time or know of colleagues working in France who might be available to attend should contact the Office of International Science at the AAAS address.