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Biocultural Factors in School Achievement for Mopan Children in Belize

We were once much smarter people.

—Maya caretaker at archaeological site, Toledo District, Belize

MOPAN MAYA CHILDREN of San Antonio, Toledo, Belize, face a number of challenges to their success in school. Mayan ethnicity, language, and traditional economic strategies are rendered disadvantageous for school achievement by historical, social, cultural, and economic forces. Statistics on poverty and child growth indicate that Mayan children are poorer and more poorly nourished than other Belizean children, and they do less well on national achievement exams. In addition, they attend school structured on the British model and taught in English. In the past, biocultural approaches might model a causal pathway from poverty to nutritional status to cognitive development to school achievement. But the interrelationships among poverty, nutrition, and school achievement are more complicated than can be described by simple formulas or reductionist models. To understand these relationships, we need a combination of quantitative and qualitative information.

In research conducted between November 1990 and July 1991, I utilized both quantitative and qualitative techniques to explore the complex web of relationships among nutritional status, household factors, and school performance for Mopan Maya children. Combining quantitative and qualitative techniques in biocultural research, however, requires a rethinking of the research process. To incorporate qualitative methodologies into traditional statistical models of biological anthropological research is difficult because of the distinctly different nature of the two kinds of data produced. One approach to this problem is discussed by William Dressler (1995), who advocates using ethnography up front in the research design to construct culturally meaningful variables that can then be quantified for testing. Resulting models are able to account for local levels of meaning within the framework of "scientific" research.

Another approach is that taken by Thomas Leatherman (in press) and Brooke Thomas (in press). This political-economic approach uses quantitative measures of biological outcome but contextualizes the numbers by focusing "upstream" on conditions that produce stress and either facilitate or constrain coping responses. Thus households within communities undergoing rapid social and economic change become a critical focus, as does the agency of individuals and households in negotiating with local, national, and international forces to produce well-being.

Another approach is that used by Francis Johnston and Setha Low (1995) and Katherine Dettwyler (1992), which utilizes social behavior and cultural process as qualitative phenomena to assist the reader in interpreting quantitative results. In this approach, ethnography returns anthropology to biological anthropological research by providing a picture of how people go about their lives and by situating human biology in ecological, social, political, economic, and cultural contexts. More importantly, the approach allows research participants to *explain for themselves what is important in their lives*, how they go about making decisions, what they can and cannot do, and what the constraints are under

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which they live. This approach provides invaluable insight into the quantitative data in that it acknowledges the lived experiences from which the numbers were produced.

The research reported here was a first attempt on the part of this anthropologist to bring together quantitative and qualitative data, incorporating elements of all three approaches. I recognize that more extensive ethnography than was allowed in this research, or perhaps collaboration among multiple researchers, would improve the ability of the two kinds of data to inform each other, but that awaits the next field project. Nevertheless, even the limited ethnographic data collected in this research assisted in interpreting the biological data and yielded subtle insights into the cultural and social realities that shape the lives of Mopan children and their families in Belize.

Background Research

Over the years, in an attempt to understand the relationship between poverty and learning, much research focused on undernutrition and cognitive development. This research was predicated on animal research that identified deficits in brain structure as a consequence of early undernutrition.[1] Research with people, however, suggested a more complicated scenario, one that involved factors that went beyond simple nutrition and involved the quality of the child's overall environment (Winick et al. 1975). For example, studies of children in nonpoverty environments indicated that cognitive deficits resulting from severe undernutrition were often reversible.[2] And for undernourished children in poverty environments, "stimulating" experiences could increase cognitive test performance (Grantham-McGregor et al. 1983; Sinisterra 1987). These and other studies indicated that long-term functional consequences of undernutrition vis-à-vis cognitive development and behavior depended less upon the nutritional insult itself and more on the context in which it occurred.[3]

Extending this scenario to school achievement, we find that the situation is equally complex. School achievement is the result of an interplay among a variety of short- and long-term biological and social factors. On an individual level, poverty can lead to poor health and nutrition, compromising cognitive development, behavior, school attendance, and thus achievement. At the household level, limited resources may not allow for the purchase of school supplies and books, or payment of various school fees, and where children are economically productive members of households, a family's will or ability to release children from work may be lacking. At the national level, inequitable distribution of resources may lead to inferior school infrastructure, reduced operating expenses, and lack of quality teachers in schools situated among predominantly poor populations.

Along with these biological and social constraints, cultural factors may act as barriers to school achievement as well. For example, in developing countries, school is often taught in the language of colonizers, a language that is foreign to many indigenous children and compromises their ability to learn. And school curricula and pedagogy may be structured by cultural values equally as foreign. Where these conditions exist, especially where they exist concomitant with poverty, children may have great difficulty succeeding at school. Where economies, politics, and social structures are changing, this lack of success at school may translate to lack of economic success as adults, producing intergenerational poverty.

A limited body of literature deals with the relationship between nutrition and school achievement in developing countries, but it indicates a strong link between the two. The recent publication of the follow-up to the Institute of Nutrition of Central America and Panama (INCAP) intervention study of 1969–77 is an example.[4] In this study, Reynaldo Martorell (1995) and Ernesto Pollitt and his colleagues (1995) provide evidence for a long-term association between early nutrition and intellectual performance for a generally poor population, such that nutritional supplementation enhances "the educational returns to schooling" (Martorell 1995: 1135S) and acts as a "social equalizer." Other researchers report that achievement scores are higher (Clarke et al. 1991; Popkin and Lim-Ybanez 1982), grade attainment is higher (Jamison 1986; Moock and Leslie 1986), school duration is longer (Sigman and Neumann 1989), and grade scores are higher (Galler et al. 1984a) for well-nourished children compared to the undernourished growing up in poor environments. These mostly quantitative studies indicate a complex relationship that may be indirect—that is, occurring via cognitive deficits and/or behavioral deficits—and is often complicated by factors such as parental literacy, gender, school absence, relative socioeconomic status, and poverty.

One reviewer of this article questioned both the relevance of the concept of poverty measured by ownership of material goods for people in many parts of the world and the ethnocentricity of characterizing the lives of "peasant farmers" as unsatisfying. But the people of San Antonio often refer to themselves as "poor," especially in conversations with outsiders. San Antonio is a landlocked community with a large and growing population. Subsistence farming is becoming less of an option for everyone, and it is not desired by everyone. Parents told me that "farming is not profitable anymore,"

that it "won't have much for these children." Many parents hope that education will enable their children to find work off the farm, out of the bush. As one father put it, "Now, in these modern days, for every job you need qualification [*sic*]—even if it's a washerwoman. If not for my education, I wouldn't be what I am today."

Therefore, I argue that research of this type is particularly important in countries like Belize where access to resources is limited for many and where it may be ethnically and/or geographically influenced.[5] Asaad Shoman (1994), a Belizean, points to a strong relationship between poverty and education in Belize. Since Mayans are the poorest of the poor there, "the most disadvantaged and exploited peoples in the land" (Shoman 1994:297), the value of education may have particular salience for this population of Belizeans.

The Research Setting: Belize Today and Yesterday

Belizean radio and newspapers often describe Belize as "the Caribbean beat in the heart of Central America" (SPEAR 1990). Situated south of Mexico and east of Guatemala on the Caribbean coast of Central America, Belize has a unique history. Unlike the rest of Central America, which was colonized by the Spanish, Belize was colonized by the British. Its location and pattern of colonization, based on timber extraction rather than plantation agriculture, created a unique dialectic among colonizers, indigenous people, imported populations of slaves and indentured servants, and immigrants from the north (Bolland 1988). These interactions ultimately led to patterns of stratified social relations which still characterize Belizean society.

Today, the dominant culture in Belize is Creole, the fundamental elements of which are European and African. For the Maya, as well as other ethnic groups (such as Garífuna, Mestizo, East Indian, and Chinese), this necessitates taking part in a two-tiered system, the successful negotiation of which may be predicated on competence in both their own culture and the dominant Creole culture. One way to gain competence in the national culture may be through the educational system, but this is made problematic by classism, racism, economic barriers (all embedded in a complex history), and present-day engagement with the international community.

Belize's position in the world economy is tenuous at best. It is a developing country, the economy of which rests on a narrow agricultural base of sugar, citrus, and bananas. As such, it relies heavily on a volatile world market. The 1980s recession hit the Belizean economy particularly hard, following which agreements with the International Monetary Fund and United States Agency for International Development led to structural adjustment. This adjustment required that Belize privatize many of its assets and institute development policies that emphasized low-wage labor and export-oriented industries, particularly agriculture and tourism (Shoman 1994). As a result, disparities in wealth increased while expenditures for social programs decreased, leading to deterioration of the health and education systems, especially in the rural areas where most Belizean Mayans live.

Maya are the original inhabitants of Belize, and Mayan ruins there date from 1200 B.C., the pre-Classic period.[6] Scholars suggest that by the late Classic period, around A.D. 800, anywhere from 400,000 (Bolland 1986) to 1 million Mayans (Shoman 1994) were living in Belize, supported by complex agriculture that included irrigation and ridged-field systems. This agricultural base also supported great ceremonial centers and a complex culture that included mathematics, astronomy, and writing, as well as the arts and institutionalized religion.

At the time of Western contact in the early 16th century, Classic Maya society was no longer in evidence in Belize, but Mayan communities continued to thrive. Throughout the 16th century and into the 17th, first the Spanish and then the British sought to exert control over Maya in Belize, encountering fierce resistance.[7] Historians have suggested that Belize was uninhabited at the time of British colonization, indigenous Mayans having abandoned the area in response to earlier Spanish encroachment. This, however, is a colonizer's fiction. Mayans were present and continued to resist.[8] Clashes were constant as British loggers encroached on Mayan land (Bolland 1986). When the logging industry declined late in the 19th century and the British turned to farming, they recognized the potential of Mayans as agricultural laborers. Changing their policy toward Mayans, the British incorporated them into the colonial process but denied them access to permanent lands, ensuring their dependency and contribution to the economy as wage laborers.

Thus the story of Mayans in Belize is a long one, going back further than our knowledge. By the time of Western contact, Mayan society was already millennia old, and today Mayans continue to migrate to Belize (Bolland 1986; Thompson 1988). One group, Mopan Mayans from San Luis in the Peten, came to Belize in protest against the oppressive policies of Guatemalan landowners in the 1880s (Gregory 1984; Thompson 1930), finally settling at the site of San Antonio, Toledo, where this research took place.[9]

San Antonio, Toledo District, Belize

It's 4:00 in the morning and the roosters are crowing. I hear our neighbor chopping the morning firewood:

thunk . . . thunk . . . thunk. . . . Within an hour babies are crying and the noises of women and children become clear. Everyone is up and busy.

I lie in bed and listen to mothers bark directions in Maya. The little ones, still sleepy, whine, and the older children scurry about their chores. Eusebio goes off to the farm to do chores for his grandmother.[10] When he returns, he frantically searches for his schoolbooks, remembering an assignment that is due today.

I can smell the smoke of the morning fire; the oldest daughter, Margarita, must be preparing the cooking hearth. She is 14 and no longer attends school; she would like to continue, but her parents say she is too old (she has reached menarche). I hear water hitting the bottom of the metal teapot and then the sounds of Margarita grinding the morning corn. In a little while comes the pat-pat-slap of tortillas being made.

Next door, the sounds are of children taking care of children. The littlest ones are washed, cleaned, and fed by their older sister, who then heads to the pump to "back" water.

By the time I make it to the family kitchen, the day is well underway for the families of San Antonio. The men and some women have gone off to their farms or other jobs, the rest of the women are getting their own morning meal, and the children, it seems, have done a full day of work before they leave for school. (See Figure 1.)

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The village of San Antonio, Toledo, lies in the most southern and remote district of Belize.[11] Often called the "Forgotten District" because of its geographical and political distance from the capital, Toledo is one of the poorest districts in a poor country. It has the highest rate of unemployment in the nation, 46 percent, and the highest percentage of people in the lowest income categories (Central Statistical Office 1991).

Health statistics in Toledo District reflect poverty as well. Infant mortality is 21.8 per thousand, the highest in the country. Compared to other developing countries, this is fairly low, but newer aggregate national statistics reported in *Belize Today* (Centers for Disease Control 1993) indicate the rate is probably twice that. This may be especially true in rural areas, where infant mortality often goes unrecorded. My experiences in San Antonio indicate that this is the case. But even with low rates, infant mortality does not always provide an accurate picture of health. As countries develop and infant mortality goes down, child health does not always follow at the same rate. This appears to be the case in Toledo District, where malaria is endemic and worm infestation affects the majority of children. Despite these high rates of illness, health services in Toledo District

Figure 1
A family of children in San Antonio. On the day I visited, the two older girls spent much of their time attending to the two younger children: they played with them, washed the baby's clothes, fed him his bottle, and the oldest helped in the kitchen. Photo by Deborah L. Crooks.

are limited (Crooks 1994b) and the lack of potable water is a significant risk to public health (District Medical Officer, personal communication, May 25, 1991).

Indices of educational status in Toledo District are also low. Although education is universal and compulsory, it is of uneven quality, the rural areas being at the greatest disadvantage. Toledo has the lowest percentage of people reaching the secondary school level (6.2 percent) (Central Statistical Office 1991). In addition, children of Toledo exhibit the poorest performance on the Belize National Selection Examinations (BNSEs) (Central Statistical Office 1990). This exam is given at the end of the primary school career and is the benchmark that determines who is eligible to go on to secondary

school. The Ministry of Education states that it assumes equal distribution of "intelligence" among children in all areas of Belize; therefore geographic variation on the BNSEs is likely due to unequal distribution of resources (Ministry of Education n.d.). (See Figure 2.) This is supported by other statistics. For example, Toledo District has the highest proportion of "untrained teachers" among all districts (Chief Education Officer Raymond, personal communication, May 14, 1991).[12]

The economy of Toledo District, especially outside of the district capital, Punta Gorda Town, is farm based. Toledo produces most of the country's corn, rice, and beans and some pork for domestic consumption, along with honey, cacao, and citrus for export (Wilk and Chapin 1990). Mopan Maya are traditionally subsistence farmers, but now it is common for San Antonio men and women to combine a number of economic strategies. Some households cash-crop, raising everything from the national staples of corn, rice, and beans to cacao (from which chocolate is made) to peppers, pineapples, and plantains. Other San Antonians work for wages at the nearby lumber mill or army base, or run small shops; some raise animals for sale or produce crafts. Many San Antonian households successfully combine strategies, becoming relatively wealthy by Mayan standards, but production of traditional crops is seldom abandoned completely. During my stay in San Antonio, I knew of only two men who no longer went to the plantation, one because he had been crippled by snakebite and had to find other employment. When my research assistants were ranking families by socioeconomic status, one female-headed household was lowered from rank 2 to rank 1 (the lowest) when my assistant remembered there was no one to farm for the household. On the other hand, the children of many of these families are now working and living out of town. One was a high school principal, another was a policeman; there were a number of teachers and members of the Belize Defense Force, and one woman was a successful marketer of indigenous crafts in Belize City.

Because of their close connection with the market economy, the people of San Antonio travel to Punta

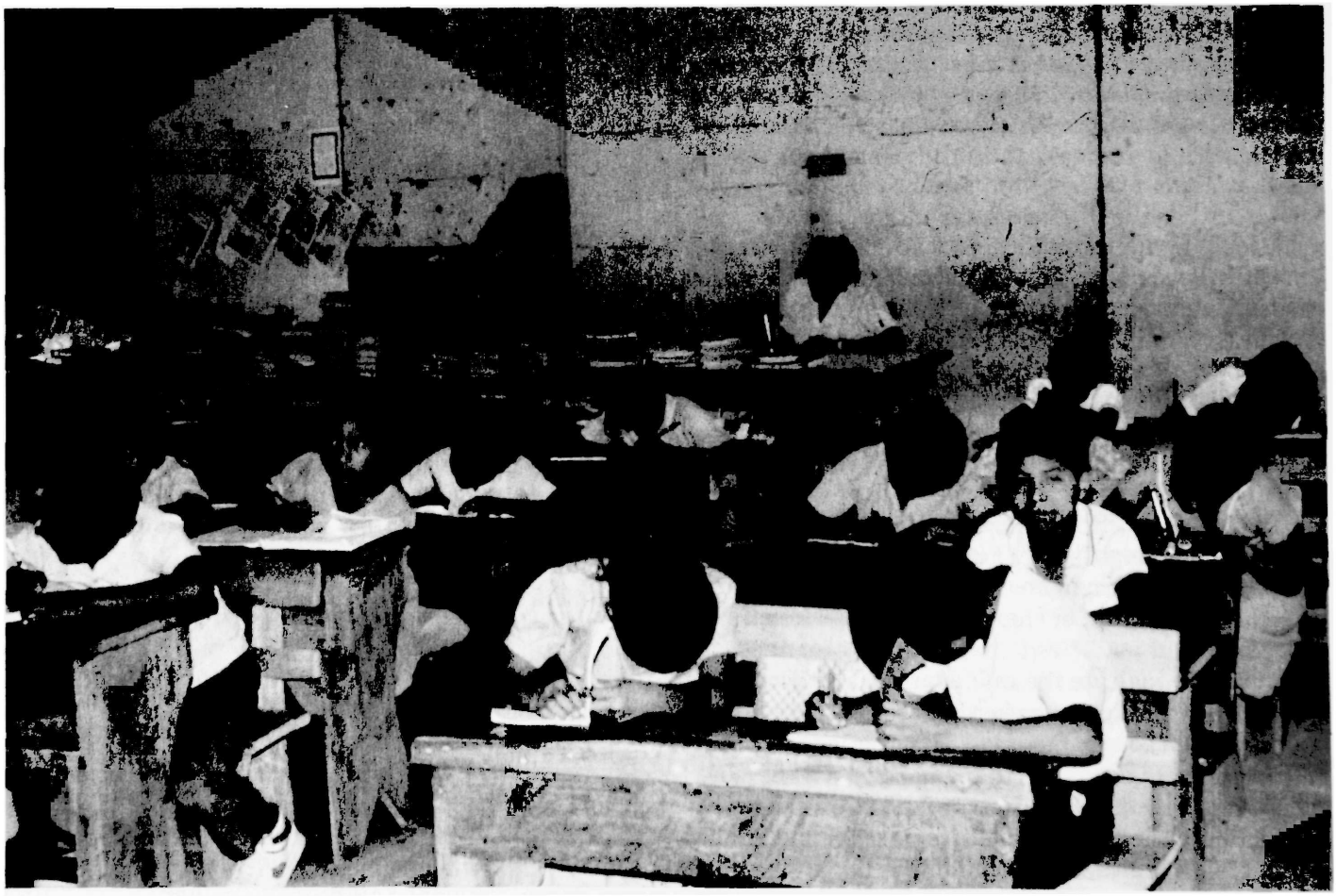

Figure 2

Typical classroom at San Luis Rey School in San Antonio. There are few resources available to Mopan children compared to those available to children in other towns and districts. Photo by Deborah L. Crooks.

Gorda quite often, a trip of one and a half hours. In 1990–91, the bus ran four times per week, transporting villagers for a variety of reasons, including buying or selling at the market or shops, doctor appointments, official business with the offices of the Agricultural Ministry or Social Security, and visits with friends or relatives in town. The bus also transports the occasional tourist to San Antonio, where travelers from all over the world come to stay at the sole guesthouse in the interior of Toledo. Thus the all-weather road, which came through to San Antonio around 1940, has been a prime instrument of change for this community for some time (Gregory 1984, 1985).

* * * * *

I remember the first time I came to San Antonio. We bounced along a dirt road through the oppressive afternoon heat for what seemed like forever. The old school bus was crammed with Garífuna and Mayan women and children; a few men were at the back sitting among large parcels of seed, other agricultural supplies, cases of pop and beer, and cartons of goods with which to stock the village shops. I expected to find a small village of look-alike thatch-roofed huts, with peasant farmers tending their nearby fields. But this was not the San Antonio I found and have come to know. Yesterday during my household visits, Maria and I passed a number of new houses being constructed out of concrete block. "Why so many concrete houses these days?" I asked her. "There's much money in town now," she told me; then she lowered her voice, "ganga [marijuana]," she whispered. But today on the bus, as we pass thatch-roofed structures with dirt floors, Caribbean-looking raised-wooden structures, and the less common concrete-block homes with zinc roofs, some with two stories, I know that it is more than the marijuana trade. The economic success of many San Antonio families, in addition to choice of lifestyle from more traditional to less, creates the panoply of house styles. On the outskirts of the village, my friend Marcelo smiles and waves from his shop. We stop, unload supplies for his store and his chicken-raising enterprise, and say good-bye to his wife, who has been selling tamales in town. We continue through the village: more stops, more people get off with their envelopes, packages, and boxes, and finally I am home. The men unload supplies for another store, along with huge bags of pig feed for two farmers who raise hogs some distance back in the bush. I deliver the goods I purchased for my family: plastic bowls, cilantro, and bread. Miss Regina is tending the family shop while her husband is off delivering bags of cacao for sale to Hershey. She wants an accurate accounting of the cost of the goods I bought. "Miss Debi, you paid too much for the cilantro." I usually do.

The Research

I utilized both quantitative and qualitative methods as well as population and household perspectives. Quantitative methodologies are described elsewhere (Crooks 1994a, 1994b) and include collection of data on child growth, health, and household characteristics such as demography, inventory, and economic activities. In addition, I interviewed parents in their homes concerning their attitudes toward education and their hopes and aspirations for their children. The interviews were conducted in English when parents were comfortable using this language, or in Mopan Maya via an interpreter. These interviews were structured but open-ended, allowing parents an opportunity to provide further information beyond that addressed in the interview protocol. Many people took advantage of this opportunity.

My research provides four sets of analyses. The first documents the growth status of school-aged children, indicating a growth pattern that is typical of Latin American populations experiencing chronic undernutrition: a high percentage of children are stunted, but few are wasted by World Health Organization (WHO) criteria (Crooks 1994a). In addition, most children have adequate body composition, as measured by arm circumference, arm fat, and arm muscle, although there is great variation (Figures 3 and 4). WHO criteria call for comparing child growth to National Center for Health Statistics (NCHS) references via z-scores, which measure the distance of the child's individual measure from the mean of the reference group. Where sample children exhibit heights below –2 standard deviations (SDs) of NCHS references, they are said to be "stunted," representing chronic undernutrition. Where weights are below –2 SDs, they are said to be "wasted," representing acute undernutrition. In addition, weight-for-height is often used as a measure of current nutritional status, but since there is controversy over this measure,

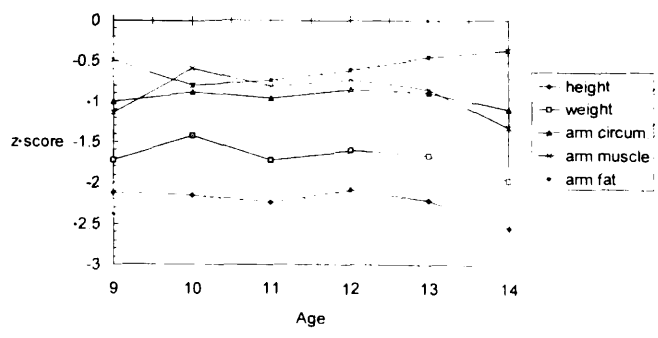

Figure 3

Nutritional status of San Antonio boys, as indicated by height, weight, arm circumference, arm muscle, and arm fat z-scores. Z-scores for height and weight calculated via NCHS data; z-scores for arm circumference, muscle, and fat calculated via NHANES data.

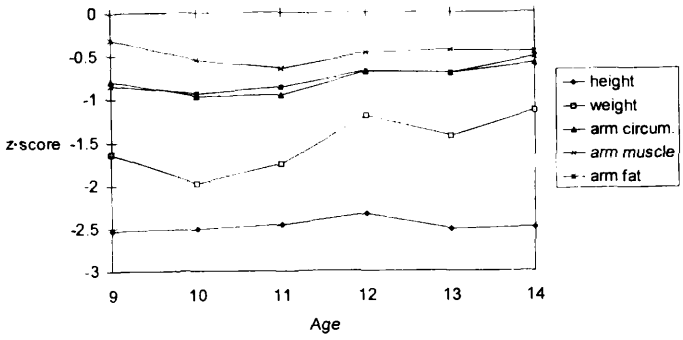

Figure 4
Nutritional status of San Antonio girls, as indicated by height, weight, arm circumference, arm muscle, and arm fat z-scores. Z-scores for height and weight calculated via NCHS data; z-scores for arm circumference, muscle, and fat calculated via NHANES data.

arm circumference and the derived measures of arm fat and arm muscle are included here. Since NCHS data do not include these measures, z-scores were calculated via National Health Examination Survey (NHANES) reference data (Frisancho 1990). The pattern of undernutrition evident in these figures usually results from a synergistic action between inadequate nutrition in terms of quantity and/or quality of diet and high rates of illness.

The second analysis includes a number of environmental factors that were hypothesized to influence children's growth and nutritional status. These factors were household-level measures but were considered in context of both local and national-level policies and statistics (Crooks 1994b). Regression analysis indicated that child growth in San Antonio is most influenced by local socioeconomic status, birth order, home environment, and gender (Table 1). This occurs in a part of the country where unemployment and health risks are high and where access to health resources is limited.

The third analysis, the relationship between nutritional status and school achievement, and the fourth, the qualitative analysis of interviews with parents, are reported here. Given the findings of the first two analyses and given the relationship between malnutrition, cognitive/behavioral functioning, and school achievement reported in the literature, I hypothesized a positive relationship between nutritional status and school achievement. But given that this relationship is not a simple one and is based on the literature, I used discriminant analysis to explore the relationship between school achievement and a number of independent variables, including growth and nutritional status, household demographic characteristics, and aspects of the "stimulative" quality of the home.

Discriminant analysis is an analytical technique that tests the relationship between a categorical dependent variable and multiple metric and dummy independent variables. It involves deriving the linear combination of multiple independent variables that best differentiates between two (or more) groups of the dependent variable (Hair et al. 1987; Norusis 1988). It is particularly useful in complex anthropological research

Table 1
Regression analysis for growth z-scores and household variables

Outcome variable	Significant predictor variable	B	SE B	Beta	Mult R	Variation explained
Stature	HOME score	.24	.07	.39		
	gender (M/F)	−.38	.17	−.25	.47	21.8%
Weight	HOME score	.16	.06	.34		
	birth-order rank	.68	.28	.29	.47	22.5%
Arm circumference	SES	1.25	.30	.45		
	birth-order rank	.56	.21	.29	.55	30.0%
Arm muscle	SES	1.10	.39	.32		
	HOME score	.13	.06	.27		
	gender (M/F)	.29	.13	.25	.54	29.4%
Arm fat	age	.07	.03	.29		
	SES	.61	.19	.35		
	birth-order rank	.36	.14	.28		
	gender (M/F)	−.15	.07	−.23	.61	37.6%

Note: Final regression models for each anthropometric outcome variables tested are given, along with the regression coefficients (B) for individual variables in the final model and the standard error of the coefficient (SE B). But since *variables are measured in different units*, the magnitude of individual regression coefficients may be easily misisnterpreted. Therefore, units of measure are standardized and coefficients are provided as beta coefficients (Beta) for easier comparison. Finally, the Multiple R (Mult R), which represents the correlation coefficient between the observed value of the dependent variable and the predicted value based on the final model, is also provided; squaring Mult R provides the percentage of variation in the outcomes variable explained by the model.

because it accounts for relationships among independent variables as well as their individual relationships with the dependent variable. In this case, the dependent variable is school achievement as measured by year-end grades. "Achievers" are those with a grade-point average of 70 or better, and "nonachievers" are those with a grade-point average below 70. This is the cutoff for passing, set by the school principal. Using discriminant analysis, we can identify how school achievers' lives may differ from those of nonachievers.

The sample population included 63 children randomly selected from all children in standards 3–6 (grades 5–8) at San Luis Rey School. Standards 3–6 were chosen to control for possible bias resulting from language ability. Most children in San Antonio begin school speaking Mopan Maya; they learn English, the language in which school is taught, at varying rates. The teachers and school principal felt that, by standard 3, fluency in English was no longer a problem for most children.

Based on the hypothesized model, the following variables were entered into the discriminant analysis:

(1) *Growth.* Two growth variables were entered. Height-for-age z-score (HAZ) represented long-term chronic undernutrition, while upper-arm fat z-score (UFAZ) represented current nutritional status.

(2) *Early malnutrition.* A considerable body of literature indicates the most damaging influence of undernutrition occurs prenatally and in the first few years of a child's life (for example, Martorell 1995; Pollitt et al. 1995). The variable (MALNUTR) was used to indicate whether a child was diagnosed by the village health nurse with undernutrition prior to the age of five. The information was obtained from the health clinic files.

(3) *Sociodemographic measures.* Household socioeconomic status (SES) was assigned based on the average ranking of families by three village research assistants. This measure correlated well with other often-used measures of SES, including house style, presence of electricity, and possession of modern appliances, among others (see Crooks 1994b). Dependency ratio (DEPEND) was calculated as the number of unemployed offspring in the home divided by the number of adults in the home. No single age cutoff was used to determine this designation since many children leave school as early as age 14 to marry or work full-time for their families, while others may still be in school as late as the age of 20. Father's and mother's literacy (FATHLIT, MOTHLIT) was assessed via parents' self-report.

(4) *School.* Two school-related variables were utilized. The first is the number of days absent from school (DAYSGONE), which may be due to illness, work responsibilities, or other reason. The second is the grade level of the child (GRADE), that is, standards 3–6.

(5) *Home environment.* The child development literature indicates that development is, in part, a function of the stimulation the child receives in the home. This stimulation can come from various sources, including material aspects of the home environment such as visual and audio stimulation (e.g., pictures on the walls, access to music), stimulating experiences outside the home (e.g., visits with friends), and the kinds and quality of caretaker/child interactions. The variable used in this research (HOME) is derived from the Growth Fostering Materials and Experiences subscale of Caldwell and Bradley's HOME Instrument (Caldwell and Bradley 1984), modified for use in San Antonio, and includes such items as access to radios, books, and pictures in the home.

(6) *Other.* Gender was also included in the analysis.

Results of the Discriminant Analysis

Stepwise discriminant analysis was performed using the computer program Statistical Package for the Social Sciences (SPSS-PC+), version 2.0. Results are presented in Table 2, including goodness-of-fit statistics. Standardized discriminant function coefficients, which represent the relative contribution of the variable to the function, are presented; these must be interpreted with caution, however. As in regression analysis, the value of the coefficient for a particular variable depends on the other variables in the function. Therefore, variables with large coefficients may be powerful discriminants,

Table 2
Results of stepwise discriminant analysis of household variables and school achievement

Variables in the model (in order of significance)	Standardized coefficient	Loading
Father's literacy	.75	.52
Grade level	.49	.44
Days absent	−.62	−.29
Gender	.49	.18
SES	−.57	.05
Arm fat z-score	.32	.25
HOME score	.26	.28
Variables not in the model:		
Dependency ratio	—	−.23
Height z-score	—	.19
Malnutrition	—	−.13
Mother's literacy	—	.06
Goodness-of-fit statistics:		
Eigenvalue	0.75	
Canonical correlation	0.65	
Variation explained	42.80%	
Wilks's lambda	0.57	
Chi square	31.59	
Significance	0.00	
Hit rate	85.71%	

	HAZ	UFAZ	Maln	SES	De-pend	Fath Lit	Moth Lit	Days Gone	Grade	HOME	Gen-der
HAZ	---	.38#	-.15	.20	-.20	.24*	-.04	-.05	.06	.38#	-.30+
UFAZ	.38#	---	-.14	.35+	-.30+	.14	.08	-.004	.42#	.31+	-.25*
Maln	-.15	-.14	---	.05	.08	-.19	.08	-.03	-.02	-.17	.10
SES	.20	.35+	.05	---	-.08	.43#	-.03	-.05	.09	.36+	.03
depend	-.20	-.30+	.08	-.08	---	-.11	.03	-.05	-.31+	-.20	-.02
fathlit	-.24*	.08	-.19	.43#	-.12	---	.07	-.004	.19	.24*	.08
mothlit	-.04	-.004	.08	-.03	.03	.07	---	.19	.23+	-.16	.10
daygone	-.05	.14	-.03	-.05	-.05	-.004	.19	---	.12	-.08	.15
grade	-.06	.42#	-.02	.09	-.31+	.19	.23*	.12	---	.22*	-.05
HOME	.38#	.31+	-.17	.36	-.20	.24*	-.16	-.08	.22*	---	-.09
gender	-.30+	-.25*	.10	.03+	-.02	.08	.10	.15	-.05	-.09	---

Figure 5
Chart showing Pearson correlation coefficients among independent variables used in discriminant analysis. $^{*}p \leq .05$; $^{+}p \leq .01$; $^{\#}p \leq .001$

but the reverse cannot be assumed for variables with small coefficients; these may be partialed out because of colinearity with other variables (Hair et al. 1987; Norusis 1988). In this model, a number of variables are weakly but significantly correlated (see Figure 5), but discriminant analysis is robust with respect to this situation; therefore, these low-to-moderate correlations do not preclude use of the procedure.

Discriminant loadings, which measure the relationship between the variables and the function, may provide a better assessment of individual contributions than do coefficients. These are presented for all variables entered into the analysis and indicate that the two best predictors of achievement in the final model are father's literacy and grade in school, followed by days absent from school, the home environment, and current nutritional status (arm fat z-score). Both gender and socioeconomic status, originally specified in the model, have loadings that are generally considered insignificant (below .20; Hair et al. 1987). It is likely that these were partialed out because of their correlation with other variables in the model.

Other statistics in Table 2 indicate that the function is a good discriminator of achievement. The eigenvalue, or ratio of the between-groups to within-groups sum of squares, is sufficiently large, and the chi-square is significant. The square of the canonical correlation indicates that 42.8 percent of the variance in achievement is accounted for by the function. The "hit rate," or the percent of cases correctly classified by the function, is much improved over that which would be expected by chance alone, that is, 83.9 percent versus 50.0 percent.

Qualitative Analysis

"Dioos." I walk very slowly through the front yard. I am cautiously watching for dogs, but I also do not want to appear too suddenly in the open doorway of this family's home. "Dioos," calls my research assistant and good friend, Regina. She is just ahead of me, always mindful of the dogs, always ready to protect me from a sudden bite. "Mind the dogs, Miss Debi." As they snarl at us, she barks back at them—something in Mopan—and they retreat. It has been a long walk in the humid heat to the Chos' house; they live outside of the village. Just before we reach our destination, we smell smoke and I can feel the heat of the fields being burned prior to planting. As we turn a corner in the road, I see the fire. While I get my camera out of my pack, Regina explains the ritual that will ensure successful planting,

> You put the corn seed in a bag and put it up on a high place. Then the man burns copal all around it. This is done at night. He prays in Maya, sometimes in English, to the Soul of the Hills and Animals—and to God—and asks that the animals don't get into the corn. After, he lights a candle and it burns through the night. Early in the morning, he goes to the plantation and buries copal in the center of the field. Then he waits for his helpers.

"Dioos," comes an answer from the doorway. Francisca invites us in. She hurriedly tidies the floor and places small carved wooden stools for us to sit on. The

house is a large traditional home; it is light and airy, unusual for San Antonio houses, which tend to be dark inside. While we wait for her husband to come, I ask Francisca if she will speak with me in English or if she would prefer Mayan. She prefers Mayan, so Regina translates our small talk. I ask after her family, her children. She is more comfortable with me than most women I interview, because I have been here before. I know this family and this farm outside of town in the midst of the rain forest. "Welcome, Miss Debi." Soon Lucio, a successful farming entrepreneur, comes in with a smile and a handshake. He has been out burning the fields. We begin to talk in English. He tells me that he is a self-taught man; when he was a boy, he "fooled around" in school and later realized the importance of education. He got books, he read, and he "traveled to other towns to learn about the world." When I ask about the importance of education, he tells me education is very important. "I don't want my children to be like me," he says. "Make they find it easier."

* * * * *

The Chos, like many people in San Antonio, tell me they have lived a hard life. While they value farming and their own traditions and customs, they have experienced increasing demands for cash with little consequent means to produce it. Parents voice the opinion that education will benefit their children by providing the means to future advancement in a variety of ways (Table 3). One father says,

> School is important: to study, to see what is good, it's better than to work on a farm. It is important for my children to be better when they get grown, not like I am. My parents didn't send me to school. I want my children to be better.

A mother told me in reference to her daughter,

> I am sending her to school to read and try to explain herself, for her future. I like to educate my children. I grew up in the bush and had no education; if my mother had sent me to school, I wouldn't be sitting here. [She says this with her eighth child at her breast.]

But while parents want their children to have better lives, the routes to that betterment may vary. While analyzing the qualitative data, I noticed that parents of school achievers seemed to respond somewhat differently than parents of nonachievers to the question "Why is school important?" (Table 3). Parents of school achievers most often mentioned school's value for getting a good job, defined by them as something other than subsistence farming for boys and marrying early for girls. In addition, the next most often mentioned explanations were the ability to deal with outsiders and the chance for a better future. These parents wanted their children to be better able to interact with non-

Table 3

Most often mentioned responses to the question "Why is school important?" for parents of achieving and nonachieving students. (Note: Most parents gave more than one response.)

Response	Achievers	Nonachievers
To get better job	37	32
To read and write	23	36
For their future (life)	26	32
To talk to outsiders	26	14
To be better/not like me	23	18
Farming not profitable	9	11
To grow/sell better	9	11
For a better/good life	3	11
To get wide knowledge/higher education	3	4
For their living	3	0

Mayans, to be better equipped than they had been to negotiate a changing world. An achieving student's father told me,

> Education is important. Many people are unable to answer questions, as we are talking here today. In the future, farming won't have much for these children. With education, they could find a job. It is sad for those who are not educated.

An achieving student's mother says,

> Yes, school is important. Because when you can read and write, you can move from one place to others; you can talk with people and understand those around you. Not like me.

Parents of nonachieving students also expressed hope that their children would be well-equipped for their future lives and that they would be able to get "good" jobs. But they were less likely to express a concern over the ability to deal with outsiders and more likely to express the more limited goal of being able to read and write. One mother says, "School is important: to read and write and to do math. We are poor; with education, we could find work."

Finally, in order to evaluate whether parents' hopes and aspirations for their children differed between school achievers and nonachievers, I asked parents what their child would be when she or he grows up. Table 4 indicates the most often mentioned answers. Parents of school achievers were more likely to express aspirations toward a "professional" job (such as teacher or medical professional) than were parents of nonachieving students. Parents of nonachieving students were more likely to mention the traditional occupations of farmer or housewife; or they could not say what their child would be. But whether parents' aspirations are leading to differential achievement or whether parents

Table 4
Most often mentioned responses to the question "What will your child be in the future?" for parents of achieving and nonachieving students

Response	Achievers	Nonachievers
Teacher	31	7
Farmer/house/stay home	14	36
I don't know	14	32
Doctor/nurse/dentist	14	0
Go onto higher studies	9	0
What they want to be	9	7
Agricultural extension agent/ agricultural project	6	11
Shop clerk	3	4
A sister (a nun)	3	0

have different aspirations because of differential achievement is not known.

Discussion

The original hypothesized association between growth in stature and school achievement was not supported by the data from this population of poor Mayan children. Why this is so is unclear, since a number of other studies do report such an association.[13] But research in Guatemala suggests that in some cases, social and cultural factors may override nutritional ones as important predictors of school achievement. Working with children of various socioeconomic and grade levels in Guatemala City, Barry Bogin and Robert MacVean (1983) reported no association between growth and achievement scores, except for low correlations among cognitive tests and height and weight for boys in grade 3 and height for boys in grade 5. On the other hand, they did find consistent associations between socioeconomic status and growth and socioeconomic status and achievement. They concluded that socioeconomic factors were at least as important as nutritional factors in school achievement, if not more so, especially where undernutrition is moderate rather than severe, as it is in San Antonio. In a later study among Mayan children, Bogin and MacVean (1987) again reported a lack of association between nutritional status and school outcome, in terms of school continuation. They suggested that cultural ideals concerning the purpose of school and the economic value of children are more important than health and nutrition in determining school continuation. A similar factor may be operating in San Antonio, or it may be—as reported by Johnston and Low (1995), who also found no direct effect of stature on school achievement—that the relationship is indirect, mediated through cognitive development, a variable that I did not measure.

On the other hand, the lack of association between stature and school achievement for San Antonio children may be due to the pervasive influence of stunting within this population. Data reported elsewhere (Crooks 1994a) indicated that 66 percent of the sample children were stunted; another 28 percent were below −1 SD. Therefore, there may not be enough "chronically well-nourished" children in this small sample to indicate statistical significance with achievement.

Current nutritional status, measured here by estimated arm fat, does predict school achievement. Current nutritional status likewise contributed to school achievement for Nepalese children (Moock and Leslie 1986), Chinese children (Jamison 1986), and Philadelphia children (Karp et al. 1992). For Jamaican children (Clarke et al. 1991), weight-for-height predicted school achievement, but the association disappeared once socioeconomic variables were controlled. This again indicates the effect may be indirect, and Naomi Clarke and her colleagues (1991) argued for an indirect relationship between current nutritional status and school achievement via attendance, a relationship that does not appear to hold in San Antonio (that is, there is no correlation between the two; see Figure 5). Barry Popkin and Marisol Lim-Ybanez (1982) also argued for an indirect relationship via the effects of hunger on the ability to concentrate for poor Filipino school children, a finding not uncommon in the United States but one that was not tested in San Antonio.

Given the variation in research outcome outlined above, it can be argued that models that are limited to exploring a direct relationship between growth and achievement tell us little even when a relationship is indicated. The environments in which children grow are complex, and child growth is merely a *marker* of the conditions of those environments. If we are to truly understand the association between growth and school achievement, we need to focus more on the conditions of the environment that produce the growth. Ethnographic detail provides the means to grasp the elusive nature of this relationship.

Clearly, in San Antonio poverty is a factor in the lives of its children. The national phenomenon of poverty constrains Belizeans in their struggle to achieve, but Mayan children are at greatest risk. Focusing upstream, we find that inequitable distribution of resources to Toledo District, where the majority of the country's Mayans live, limits the ability of San Antonio families to respond to stressful social and economic circumstances. Access to land is limited and is controlled by an outdated reservation system that continues to deny Mayans ownership (Wilk and Chapin 1989). Statistics presented earlier indicate that off-farm employment is limited as well and that social services, particularly

health and education services, are minimal compared to the rest of the country.

But within these constraints on well-being, families respond differentially, some more successfully than others. In San Antonio there is a range of socioeconomic variation that may affect or be related to household attitudes and responses to schooling. Father's literacy, home environment, days absent from school, and grade in school are primary predictors of school achievement. The first three may indicate a difference in parenting styles. That is, the homes of literate fathers may provide more school-supportive kinds of experiences, including help with homework, reading materials, national radio broadcasts, and an insistence that school not be skipped for other activities. This may be facilitated by higher socioeconomic status; the correlations provided in Figure 5 indicate weak-to-moderate but significant associations of father's literacy with socioeconomic status and the HOME score. On the other hand, there may be another factor not accounted for in this research that precedes both parenting styles and higher socioeconomic status in certain families. More ethnography could help sort this out.

The association between grade level, the second-best predictor, and school achievement is also an interesting finding. Class size remains fairly stable, with 40 to 50 or more students, through standard 4, after which there is a precipitous drop to a class size of 24 in standard 5 and 20 in standard 6.[14] It may be that children who advance to standards 5 and 6 are those who have become more successful at negotiating the dominant culture than those who do not advance. It would be interesting to compare these children to school leavers in terms of their parents' ideas about the value of school, but I have no data on school leavers. I do, however, have information that grade level is negatively associated with dependency ratio and positively associated with current nutritional status. Thus it is likely that families with children in higher grades are those with fewer dependents and can thus invest more heavily in them, producing better-nourished and better-educated children who then advance to higher levels.

Irma Otzoy and Enrique Sam Colop (1988, 1990) argue that, for Mayans in Guatemala, education in the dominant language and culture is an important addition to, not replacement of, their own cultural repertoire. Following Richard Wilk (1991), I take the implication to be that this provides flexibility in response to both local and national circumstances. This greater adaptive repertoire allows for more flexibility as indigenous peoples actively negotiate their position with respect to others locally and nationally; it allows for the maintenance of tradition within the context of change. This may become increasingly important as Belizean development policies move from export agriculture to tourism, particularly ecotourism. During a brief return visit to San Antonio in 1996, I noticed a number of new guest houses along the main and back roads. Some of these were in operation; some had already closed. I also heard of promotions in which small groups of tourists were being brought to Toledo District for short-term stays in Mayan and Garífuna villages. Thus, as Toledo becomes the target of these kinds of development policies, Mayans are likely to be interacting more with outsiders on a number of levels.

This is not to suggest that up until now Mopan Mayans of San Antonio have lived an isolated existence. They are active local and national marketers of their agricultural and other products; they seek and utilize national social and health services; many work as wage laborers; others are politically active, having elected representatives to the National Assembly; and many are a major force behind the Toledo Maya Cultural Council, a national indigenous rights and cultural preservation group. Thus many residents of San Antonio are dealing with outsiders on a daily basis through work, through accessing services, and through politics. And many San Antonians indicated the importance of being able to interact on a par with outsiders. One Mopan man told me, "When you meet strangers, you can't speak without education. They may want to form some kind of organization; for that you need education." Another said, "It is important to be able to speak with others, to be able to communicate. Otherwise, you stay like you're vexed with each other [that is, you don't talk]." Finally, another parent told me, "It is important to learn; because like we [meaning Mayans], we don't understand what people say."

Both Bogin and MacVean (1983) and Johnston and Low (1995) refer to respect as an important concept to indigenous Maya, although the interpretation of respect in these two studies differs. Bogin and MacVean (1983) report that Mayan mothers say that school is important for learning manners and respect for authority and that this is important for getting a job. Johnston and Low (1995) indicate that parents suggest the value of school lies in attaining respect *(respeto)* and obtaining a job. Eve Danziger (in press) finds respect *(tzik)* to be the basis of relationships among Mopan Maya in San Antonio. Traditional, religious respect is not simply an individual attribute, but a shared relational attribute between Mopan people. Thus, respect arises out of relationships and is demonstrated through appropriate behavior. Although she cautions (personal communication, June 1996) that this is a concept that operates *between Mayans only*, it may be that as San Antonians interact more and more with the outside world, obtaining respect in outsider relationships is becoming more and more important as well.

In sum, school achievement for Mopan Maya children in San Antonio, Toledo, Belize, is the result of social, cultural, and biological factors within a complex social, cultural, political, and economic environment. Toledo District, in which San Antonio is located, is a poor district, receiving less than its share of limited national resources. Poverty is a real factor in the lives of San Antonio families and compromises the health, nutrition, and education of the children. But within this greater context, variation in household environment is associated with school achievement for children and may relate to family attributes and attitudes. Still, caution is advised in this assessment in that these relationships are complex, indirect, and often of indeterminate direction. The fact that over half the variation is left unexplained indicates that other factors may be important or that the variables in this model were insufficiently operationalized or measured. Johnston and Low (1995) point out the difficulty in operationalizing complex conceptual variables such as socioeconomic status, stimulation, and nutritional status. They further argue that the ability to show any significance at all is a testament to the importance of these factors in the lives of children; likely, the reason is related to both.

* * * * *

It's graduation day. There is much excitement and the village is buzzing with it. I have been invited to a number of graduation parties. Thank goodness I picked up trinkets in Punta Gorda Town last week; they will come in handy as gifts. I join the throng heading to the church for the ceremony.

"Good morning, Miss Debi, are you coming to the graduation?"

"I wouldn't miss it!"

People in their Sunday-best are coming up the dirt road: proud fathers in their clean, long-sleeved shirts, buttoned up to the throat despite the heat; excited mothers in their traditional embroidered blouses and long skirts or newer satin dresses and colorful hair decorations; and the graduates themselves, girls in white dresses, boys in white shirts and ties. Sixteen children are graduating, not very many.

As we sit expectantly in church, they come solemnly down the aisle to receive their diplomas and to take communion with the rest of us. After the ceremony, the graduates pose for pictures outside. I am asked by many parents to take a picture for them, and I do so. As I focus on these recent graduates, I cannot help but wonder what this education will do for them. Will they be better equipped for their lives? Only four children passed the BNSEs with 50 percent or better, so only four would ordinarily be eligible to attend secondary school in Punta Gorda. But the cutoff for Toledo has been lowered to 30 percent, and an additional four will be eligible to attend.

But there are new challenges to school achievement for these eight children, challenges to be overcome before they can attend their first class. They must find a way to pay for school; tuition, books, and room and board can run as high as $1,550 per year: quite a challenge for poor farmers. They must also find accommodations in town as the bus does not run between San Antonio and Punta Gorda on a daily basis. But parents are reluctant to allow this; they fear that their children will "run around" and "get into trouble." They fear they will return to the village with "bad ways."

For now, everyone is excited and happy. We move from house to house, from party to party. We eat tamales, barbeque, and cake. We drink soda, beer, and rum. We celebrate the children, their families, and their accomplishment. It is for their future.

Notes

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1. Bedi 1987; Lytle et al. 1984; Shoemaker and Bloom 1977.

2. Beardslee et al. 1982; Lloyd-Still et al. 1974; Stein and Susser 1985.

3. For example, Barrett and Radke-Yarrow 1985; Bogin and MacVean 1983; Galler et al. 1984a; Galler et al. 1984b; Galler et al. 1983a; Galler et al. 1983b; Irwin et al. 1978; Johnston et al. 1987; Richardson et al. 1972.

4. The INCAP longitudinal study took place in Guatemala between 1959 and 1977. It tested the hypothesis that early undernutrition would lead to deficits in mental development for Mayan children. It involved nutritional supplementation of two types, one of high-protein/high-calorie content and the other of no-protein/lower-calorie content; both also provided vitamins and minerals. The original findings of the study were reported in a variety of publications but have been recently recapped in various articles in a special supplement to the *Journal of Nutrition* (Martorell and Scrimshaw 1995). Also included in this supplement are results of recent analysis of a follow-up study conducted in 1988–89 to determine the long-term effects of the intervention.

5. Although 23 percent of all people in Belize live in poverty, 41 percent of those in Toledo District do so (reported in Shoman 1994); these are mostly rural, mostly Mayan people.

6. Chase 1990; Ford 1990; Hammond 1991.

7. Shoman 1994 does a fine job of recounting the history of Maya-Spanish encounters during this time. I refer you to this text.

8. Bolland 1986, 1988. See also Shoman 1994 and Thompson 1988.

9. This is a very interesting story. Further detail can be found in Thompson 1930.

10. All the names of people mentioned in this article have been changed.

11. Not to be confused with another Mayan village, San Antonio, Cayo District.

12. Teacher training in Belize is a complicated issue. Teachers can be (1) "degreed" (the highest level involving a bachelor's degree from an accredited institution); (2) "trained" (i.e., three different levels of training involving a teacher's certificate or diploma); or (3) untrained (i.e., having received a high school diploma [First Class], having completed 3 years of high school [Second Class], or minimally, having passed the BNSE at 50 percent or greater [First Teacher]).

13. For example, Clarke et al. 1991 for Jamaica; Jamison 1986 for China; Karp et al. 1992 for urban Philadelphia; Moock and Leslie 1986 for Nepal.

14. One reviewer suggested that it may be that smaller class sizes in the higher grades may indicate more personal attention and therefore better achievement. But although class size does drop, classroom size remains fairly stable. That is, the lower standards have more classrooms per grade. Therefore, there is not much variation in the number of students per teacher.

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