American Anthropologist

NEW SERIES

VOL. 44 JANUARY–MARCH, 1942 No. 1

pp. 1–13

CLIMATIC EFFECTS ON GROWTH AND DEVELOPMENT WITH PARTICULAR REFERENCE TO THE EFFECTS OF TROPICAL RESIDENCE*

By C. A. MILLS

CONTROVERSY has long raged over the question whether the white race can successfully acclimatize to tropical residence without a considerable sacrifice in vitality and level of physical existence. Tropical debility of white migrants has usually been attributed to the infectious and parasitic diseases so prevalent there, as well as to the social and economic effects of the racial mixing which usually takes place. Nowhere have the direct effects of tropical climates been studied separately from these confusing social, economic, and disease factors. Such a study is here reported, at least in its first phases, with presentation of biologic evidences of a tropical depression in vitality seemingly dependent upon the climate itself. These human findings agree closely with those obtained on experimental animals under artificial climatic conditions simulating tropical residence. Difficulty in body heat loss seems to result in retarded growth and depressed vitality in man just as truly as it has been shown to do for experimental animals.

The Panama Canal Zone offers a unique opportunity to study the effects of tropical residence upon a white population mass that has migrated from an energizing temperate climate. Tropical infectious and parasitic diseases have been kept at a minimum by rigid attention to sanitation and public health measures throughout inhabited portions of the Zone and in the contiguous more heavily populated portions of the Republic of Panama. Food deficiencies so often affecting tropical populations have been obviated by wholesale importation of foodstuffs from the United States and their

* The collection of height, weight and menarchial data on Canal Zone school children was made possible through the interest of Brigadier-General M. C. Stayer, Chief Health Officer of the Panama Canal, and the cooperation of the school health personnel. Special credit is due Dr. George Eugene, school physician, for his use through the years of record forms which show length of residence in the Canal Zone in addition to other usual items of information. Actual collection and working up of the statistics by the author and his wife, Edith C. Mills, was made possible through an invitation from the Gorgas Memorial Laboratory to study in Panama the effects of tropical climates upon man.

sale on a non-profit basis through commissary stores in the Zone. Maintenance of the large Mindi dairy, where dairy cows largely imported from the United States are fed upon imported rations according to the best known formula, assures an adequate supply of good milk at all times. Water supply for the entire Zone is from Gatun Lake.

Into the rather mild tropical climate of the Canal Zone has gone a continual stream of American migrants, to live there under social, economic, dietary and sanitary conditions fully as favorable as exist in any of the northern communities from which the migrants came. Some American children born in the Zone have now grown to adulthood, while with American-born children of the Zone varying periods of tropical residence offer an opportunity of assaying the effects of the changed environment through the passing years. In very recent years the stream of migrants to the Zone has been much enlarged because of the new lock construction and increase in military defense forces. This affords a considerable mass of new migrants who have until recently been living in the United States, and the physical condition of these newcomers may well be taken as a yardstick in measuring the effects of the climate upon those who have already resided for varying periods of time in the Zone.

ENVIRONMENTAL TEMPERATURE DOMINANCE OVER ANIMAL GROWTH AND DEVELOPMENT

Before taking up the effects of tropical climates on man, it is well to consider the evidences of temperature dominance over the growth and development of experimental animals. Such dominance arises from the fact that growth is an energy consuming process, while the bodies of warm-blooded animals are not highly efficient as energy conversion machines. They utilize only 20–25% of their total combustion energy and must dissipate the remaining 75–70% as waste heat into the surrounding environment. The dissipation of this waste heat must be accomplished readily, else fever and serious disturbances in physiologic functions quickly ensue. An intricate and highly effective heat loss mechanism has been developed for proper heat loss control (sweating and vaso-motor control of blood supply to the skin), capable of meeting wide variations in ease of body heat loss over limited periods of time. But if the body be faced with any considerable difficulty in heat loss for 2 weeks or more, then a second type of control is brought into play to relieve the stress on the vasomotor and sweating mechanism. Cellular combustion is itself then reduced through lowered activity in the controlling endocrine glands (thyroid, adrenals, pituitary). Oxygen utilization may decline 15–25%, even in the resting state, when

animals or men are forced to adapt to 90°F temperatures for 3 weeks or more. And for recovery back to a normal rate again a similar period of stimulating coolness is required. Body response to sudden heat or cold is thus labile and quickly adaptive, but with more prolonged changes in ease of body heat loss there occur profound and more lasting alterations in the combustion rate of the body tissues themselves.

It is this external temperature dominance over tissue combustion rate which explains most climatic adaptive changes man exhibits over the earth. Since practically all body functions are energy-consuming in nature, it is not surprising that every index of vitality should rise or fall with change in cellular combustion rate. With optimal ease of body heat loss growth is most rapid, sexual functions develop earliest and reach greatest activity, resistance to infection is highest, and there is the greatest abundance of energy available for thought or action. When body waste heat can be dissipated only with difficulty, on the other hand, growth is slower, development of sexual functions more retarded and held to lower levels, resistance to infection and ability to produce immune bodies sharply reduced, and the individual forced in every way to live at a lower existence level. Figure 1 illustrates the sharp difference in growth rates white mice exhibit at 65°F and at 90–91°F (70% relative humidity), when all existence-factors except ease of body heat loss are held constant and a well constituted diet is given in unlimited amount. Sexual cycles and fertility come on about 10% later at 90–91°F than at 65°F and conceptions are achieved with difficulty in the heat, although mating occurs just as freely as in the cooler environment. (For a more detailed presentation of such animal responses and literature citations, the reader is referred to the author's book *Medical Climatology* published by Charles C Thomas, Springfield, Illinois, 1939.)

Under natural climatic conditions domestic livestock show even more marked growth differences than those charted (Fig. 1) for laboratory animals. On the cattle ranches of Panama it takes 4–5 years to produce a 900-pound steer ready for slaughter. In Iowa or nearby areas of the United States a 1000-pound steer is usually marketed 1½ to 2 years after birth. And the 200-pound hog, made ready for market 6–7 months after birth in northern United States, takes 12–15 months for production in tropical heat. Tropical deficiencies in the animal diets may well be responsible for part of this growth depression, but from experimental studies we know that the major part of the growth retardation will persist no matter how perfect the diet used. Underfeeding and malnutrition would exist in the heat even with perfect food present in abundance, because the animals simply cannot dissipate the large amount of waste heat liberated by tissue utilization of the

higher food intake necessary for temperate zone growth rates. The tropical growth depression persists on to adult life, giving the small, lean stringy forms so commonly seen in moist heat regions.

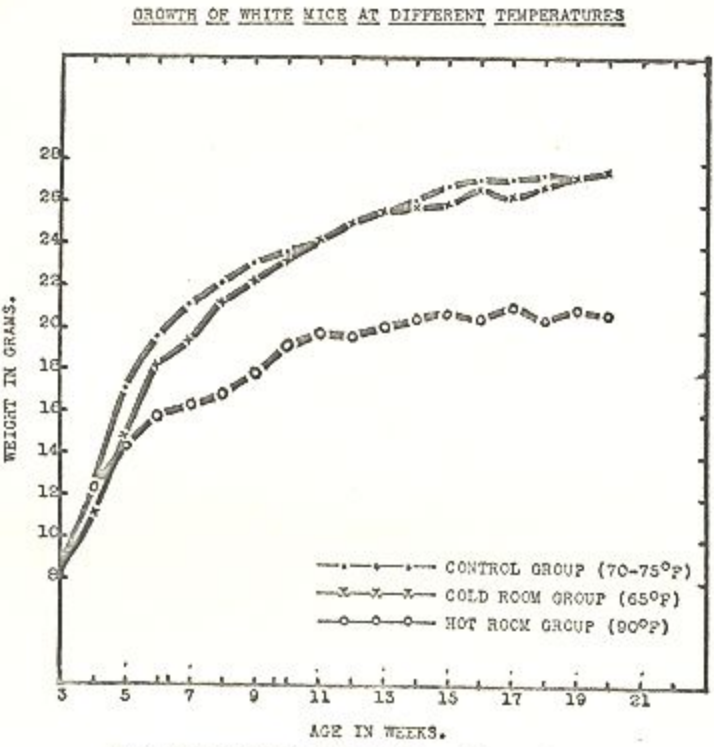

Fig. 1. Growth of White Mice at Different Temperatures.

VITAMIN REQUIREMENTS IN TROPICAL HEAT

Proper ease of body heat loss is of course not the only factor dominating cellular combustion. Cellular oxidation of glucose, which supplies us with greater part of our existence energy, is an intricate affair and is activated in its various steps by chemical catalysts. Several of these catalysts have now been recognized and isolated. Mainly they belong to the class of B vitamins, the best known of which is thiamin. With any one of these catalysts com-

pletely-missing in the diet, animals or men are unable to utilize their food. Work of recent years has gone far to indicate just how much of each of these vitamin catalysts is required for health, and what symptoms may arise when their intake is inadequate.

Of greatest importance from a climatic standpoint, however, is the recent discovery[1] that the B vitamin requirements (for thiamin, pantothenic acid, and pyridoxine, at least) are sharply higher at 90°F environmental temperatures that at 65°F. Twice as much thiamin per gram of food is required at the higher temperature as at the lower. Symptoms of severe deficiency develop in the heat at food concentrations of vitamins that prove entirely adequate for animals kept in cooler quarters. No amount of increase in dietary vitamins, however, can bring growth rates in the heat up to those prevailing in the cold. Even with the best of diets, there remains about a 30% depression of growth rate in the heat.

During a recent visit to Panama there was presented an opportunity to study human vitamin inadequacies in the tropical heat there prevailing. Using thiamin excretion in the urine as a good index of a subject's status with respect to this vitamin, it was found that people living there on native foods (native meats particularly) were thiamin-deficient. Their daily thiamin output was at the lower limits of normal and larger amounts of the vitamin taken by mouth were required before their tissues became normally saturated than was the case with people of cooler climates. Tropically grown meats produced much less rise in thiamin excretion than did those imported from the United States. This was studied particularly with regard to lean pork, which is ordinarily very high in its B vitamin content. Pork loin from hogs grown in Panama produced only about half as much rise in thiamin excretion as did loin from hogs grown in northern United States. Eggs, usually another good source for the B vitamins, seemed to be deficient in Panama unless the hens were fed on rich imported food mixtures.

Although the subject still needs much more thorough investigation, it does seem that people living in regions of tropical moist heat face a twofold handicap. Their requirement (per gram of food) for the B vitamins seems to be higher than it is in cooler climates, while the supply available in the native meats is lower. These facts may well color the whole nutritional picture for tropical residents, since such vitamin inadequacy interferes with the cellular combustion from which must be derived the energy for all bodily activities and functions. Tropical climates may thus be doubly effective in

---

[1] C. A. Mills, *Environmental Temperatures and Thiamine Requirements* (American Journal Physiology, 133, 1941), p. 525.

reducing existence level—by producing a difficulty in heat loss that necessitates a lowered tissue combustion rate, and by inducing an inadequacy in the vitamin catalysts so essential in this combustion process. It is probably not by chance that the vitamin B deficiency diseases occur chiefly among tropical and sub-tropical population masses.

HUMAN GROWTH IN THE TROPICS

In Table 1 are shown the mean heights and weights of Zone school children by age groups, sex, and birthplace. With the native Panamanians are grouped also migrants from the nearby countries of Central and South America or from the West Indies. Many American employees of the Canal Zone now live outside the Zone itself because of the housing shortage but still enjoy commissary privileges, while some other non-Zone residents also send their children to the Zone schools (with payment of tuition) but do not have access to commissary supplies. It was not feasible to differentiate between these two groups in collection of the height-weight data from the Zone school children, hence "Panamanian-born" includes those born in the Zone itself and in the Republic of Panama.

Stature of the native Panamanians is seen to be decidedly inferior to that of Panamanian-born Americans. This is true of both sexes, of both height and weight, and of all age groups. Several factors can be considered to account for this physical inferiority. One is the fact that Panamanian children come of tropical parents who are themselves decidedly smaller than are the northern-born parents of the American children of Panamanian birth. Secondly, Panamanian residents and Panamanian employees of the Zone live on a lower economic level than do the Americans, using more of the cheaper native foods. This is particularly true of the meats which must serve as a large part of the source for their B vitamins. These three factors—smaller parental stock, poorly constituted dietary, and underfeeding—probably account for most of the stature differences between the Panamanians and American children of Panamanian birth.

American children born in the United States and residing in the Canal Zone less than one year are seen to be of larger average stature than are the Panamanian-born Americans of similar age groups. Numbers of cases in the various groups were inadequate to show differences of mathematical significance, but a general view of the statistics would seem to leave little doubt that the American-born children are of larger average size. This difference, however, is largely one of weight rather than height. In only three out of twelve age groups of boys, and two age groups of girls, did the

TABLE 1

HEIGHT AND WEIGHT OF CANAL ZONE SCHOOL CHILDREN
(By Age, Race, and Birthplace)

Age	Height							Weight				
	Panamanian-born		American-born Less than 1 yr. in Canal Zone					Panamanian-born		American-born Less than 1 yr. in Canal Zone		
	Panamanians		Americans					Panamanians		Americans		
	Boys											
	inches	No.	inches	No.	inches	%*	No.	pounds	pounds	pounds	%*	
6	46.26	128	47.03	37	47.02	100.1	43	45.04	47.77	49.83	104.3	
7	48.50	166	49.11	32	50.03	101.9	40	49.34	53.50	60.83	113.7	
8	50.22	170	50.84	36	51.43	101.2	49	54.79	58.19	60.46	103.9	
9	51.78	145	53.07	35	53.13	100.1	30	58.81	65.26	68.85	105.2	
10	53.73	173	55.91	35	55.27	98.9	35	65.10	76.64	75.93	99.1	
11	55.30	165	57.01	40	57.21	99.8	33	66.17	81.63	80.31	97.2	
12	57.27	180	59.42	25	59.26	100.2	95	78.76	89.17	92.85	104.1	
13	59.81	190	62.06	25	62.20	100.2	33	88.42	100.11	104.44	104.3	
14	61.85	115	65.10	25	63.25	97.2	24	99.64	109.09	108.75	99.7	
15	64.49	88	66.25	39	65.78	98.7	32	108.24	118.16	121.41	102.7	
16	66.47	31	68.01	40	69.08	101.6	25	120.56	132.25	134.10	101.4	
17	65.85	26	68.64	29	69.03	100.6	18	119.81	134.74	136.9	101.6	
	Girls											
6	41.41	102	46.04	52	47.27	102.7	43	43.82	45.33	48.72	107.5	
7	48.53	137	48.96	28	49.21	100.6	35	49.62	53.21	53.50	100.5	
8	50.17	154	51.82	56	51.60	99.6	31	53.60	58.89	61.37	104.2	
9	52.43	144	53.53	35	52.71	98.5	33	60.24	67.60	64.92	96.0	
10	54.64	183	54.99	43	55.42	100.8	24	67.66	74.36	75.00	100.9	
11	56.75	163	57.71	63	58.22	100.9	53	76.21	81.87	86.37	105.5	
12	59.18	152	60.14	25	60.94	101.3	40	88.62	95.50	104.13	109.0	
13	60.95	173	62.18	39	61.61	99.1	46	95.79	104.42	105.54	101.1	
14	62.26	101	63.76	40	63.65	99.8	19	100.33	117.38	111.97	95.4	
15	62.55	79	63.76	30	63.91	100.2	29	107.44	118.17	123.71	104.7	
16	62.37	47	63.60	20	63.96	100.6	24	105.00	114.17	118.33	103.6	
17	62.67	18	63.94	11	64.39	100.7	9	111.11	119.77	124.72	104.1	

* Percentages are calculated on basis of Panamanian-born American heights and weights as 100%.

Panamanian-born American children show a heavier average weight than did those newly arrived from the United States.

The effect of varying length of residence in the Canal Zone upon children migrating there from the United States was calculated in a different manner. Numbers in each age group were inadequate for calculating means or stable averages, so the height and weight of each child was calculated on a percentage basis, using the height and weight of the corresponding age group of Panamanian-born Americans as the normal (100%). Percentage figures for all age groups were then lumped together and classified by years of residence in the Canal Zone. Table 2 presents the findings obtained from this calculation.

Average height of boys migrating to the Zone and residing there for more than one year is seen to be *below* the standard of the Panamanian-born Americans of similar age until residence in the Zone has been extended to 10 years or more. The same is predominantly true of the girls' height. The weight percentages are more variable but of practically the same significance. Although the incoming American children with more than one year of Zone residence average slightly heavier than those born in the Canal Zone, they weigh less than do those newly arriving from the United States. American-born boys and girls weigh about 3% more during their first year of Zone residence than do those of similar ages born in the Zone, while in height they are only very slightly superior. After more prolonged Zone residence this weight advantage is almost all lost. The retarding effects of more prolonged residence in the Canal Zone are therefore about equally evident in the height and weight changes. Table 2 shows that in actual numbers there are more of the migrants below the Panamanian-born American standards, in both height and weight, than there are above.

While Americans born in Panama are roughly 10% heavier and 3% taller than native Panamanians of similar age, they are at the same time about 3% lighter and slightly shorter than are the American-born children who have been living in the Zone less than one year. After more prolonged Zone residence, the incoming American children are actually shorter (in average height) than are those born in the Zone, and they have lost most of their weight advantage resulting from former temperate zone residence.

DEVELOPMENT OF SEXUAL FUNCTIONS

Menarchial data previously presented[3] has pointed out the fallacy of the belief in early tropical maturity. This belief, however, has been widely

[3] C. A. Mills, *Geographic and Time Variation in Body Growth and Age at Menarch* (Human Biology 9, 1937), pp. 43–56.

TABLE 2

HEIGHTS AND WEIGHTS OF AMERICAN-BORN CHILDREN RESIDING MORE THAN ONE YEAR IN THE CANAL ZONE

(Heights and Weights of Panamanian-born Americans = 100%)

Years in Canal Zone	Height				Weight			
	% of Pan.-born Amer. normal	Number of Cases			% of Pan.-born Amer. normal	Number of Cases		
		Below 100%	100%	Above 100%		Below 100%	100%	Above 100%
Boys								
1.0- 1.9	99.6	87	22	69	99.1	88	23	54
2.0- 2.9	99.7	29	15	27	99.6	41	7	24
3.0- 3.9	98.7	21	3	10	98.5	28	8	10
4.0- 4.9	99.1	18	3	11	98.9	15	5	10
5.0- 5.9	99.1	13	4	11	101.2	7	4	11
6.0- 6.9	99.0	15	1	8	100.4	7	4	6
7.0- 7.9	98.6	7	2	5	102.7	0	2	2
8.0- 8.9	97.0	10	0	1	97.5	8	1	3
9.0- 9.9	99.0	5	1	2	98.8	9	2	2
10.0-10.9	101.1	4	2	4	97.8	7	3	2
11.0-11.9	100.1	8	5	7	98.9	7	1	7
12+	101.7	4	2	3	99.3	17	11	14
All	99.4	216	60	158	99.2	234	71	145
Girls								
1.0- 1.9	102.7	85	6	79	101.4	85	4	75
2.0- 2.9	99.7	28	3	26	100.2	40	1	30
3.0- 3.9	102.5	18	0	15	99.1	22	0	22
4.0- 4.9	97.6	19	0	13	99.7	14	1	12
5.0- 5.9	99.5	17	1	8	103.5	8	1	12
6.0- 6.9	99.4	11	0	10	97.4	13	0	6
7.0- 7.9	99.9	7	1	7	105.0	3	0	3
8.0- 8.9	92.0	8	0	3	100.2	9	0	6
9.0- 9.9	104.7	4	0	4	93.9	8	1	4
10.0-10.9	107.7	2	1	7	94.0	6	1	6
11.0-11.9	104.5	13	1	6	105.8	5	1	8
12+	106.0	5	0	4	101.2	16	1	22
All	101.4	217	13	182	100.5	229	11	206

held over the earth among all races and back through historical times. All references to the subject in medical literature, back through the centuries to Hippocrates in Early Greece, proclaim the belief but always without supporting evidence. Certainly no statistical evidence at present available shows sexual maturity to be hastened in regions of tropical heat. Onset of the menses and of fertility are now earliest in middle temperate latitudes and markedly retarded in tropical heat or polar cold. It may well be that the firmly held belief in early tropical maturity had its origin several thousand years ago nearer the last Ice age, when present middle temperate latitudes had polar climates and optimal climatic conditions for man were to be found only in what are now tropical or sub-tropical lands.

Using illegitimate first birth statistics, it was shown a few years ago[3] that there exists a real retardation in the onset of fertility in regions of tropical moist heat such as Manila, Hong Kong, or Panama. In Manila the maternal age at first birth is the same whether this birth be legitimate or illegitimate—21.8 years with both groups. During a recent visit to Panama a limited number of first birth records were made available at the Santo Tomas Hospital, which handles the greater part of the charity hospitalization for Panama City. Table 3 presents the findings obtained from 150 first-birth records of charity cases. Similar data obtained in Cincinnati, Richmond, and Manila are included for comparison.

TABLE 3

MENARCHAL AGES AND MATERNAL AGES AT FIRST BIRTH IN PANAMA
(CHARITY CASES ONLY)

Subjects	No. of Cases	Mothers' Age in Years at		Lag in Fertility (Menarche to First Conception)
		Menarche	First-birth	
Married	18	14.22±0.25	20.22±0.72	5.2
Unmarried	132	14.05±0.08	20.08±0.19	5.2
Unmarried Negro girls of				
Cincinnati	33	13.44±0.13	18.08±0.28	3.9
Richmond	56	13.46±0.09	18.21±0.19	4.0
Filipinos in Manila	22	14.73±0.16	21.72±0.50	6.3

In Table 3 we see, among charity patients in whom sexual restraint is probably at a minimum, practically the same maternal age at first birth

[3] C. A. Mills, and Cordelia Ogle, *Physiologic Sterility of Adolescence* (Human Biology, 8 1936), pp. 607–615.

whether the mother be married or unmarried. The menses come on earlier than in Manila but later than in Cincinnati or Richmond, and illegitimate first births also come at an earlier age than in Manila but later than in Cincinnati. The so-called "lag in fertility" at Cincinnati is 3.9 years, at Panama 5.2 years, and at Manila 6.3 years. These human findings are analogous to those reported on experimental animals subjected to moist heat and stimulating coolness. It would therefore seem that the age-old belief in early tropical maturity so widely held by man should be abandoned.

Menarchial data on Canal Zone school girls were also obtained from the seventh to twelfth grades. Table 4 presents the change in mean menarchial age that occurs with prolongation of Canal Zone residence. The menses are seen to have begun latest in the Panamanian-born American girls and earliest in those newly arrived from the United States. It should be borne in mind that the ages given here are of comparative value only, for many of the girls in these grades had not yet begun to menstruate. Similar data collected only from girls of the eleventh and twelfth grades in one school are included in Table 4 to show what the more nearly final menarchial ages of the various groups would be.

TABLE 4

MENARCHIAL AGES OF AMERICAN GIRLS IN THE CANAL ZONE SCHOOLS

Group	7th to 12th Grades	11th and 12th Grades Only
Panamanian-born American-born	12.89±0.05 (197)	13.75±0.23 (24)
Less than 1 yr. in C.Z.	12.51±0.11 (85)	13.06±0.21 (16)
1.0 to 1.9 yrs. in C.Z.	12.78±0.08 (87)	13.36±0.11 (43)

(Figures in parentheses indicate number of cases.)

These menarchial statistics on the Zone school girls bear out the data on height-weight changes presented on an earlier page. Growth and sexual development seem to have progressed most rapidly in the children who have only recently left temperate coolness to enter the Canal Zone warmth. With prolongation of the residence, more and more of the advantages of former temperate zone residence are lost.

* * *

Unsatisfactory as are these statistics on Canal Zone school children because of lack of adequate numbers to establish mathematical significance of the observed group differences, they still carry a considerable value as indicating a tropical depression of growth and development under living

conditions almost ideal except for the tropical heat factor. Much more detailed study might well be given to the Canal Zone population in an effort to establish with greater certainty the extent of the climatic effects. Comparison of adult stature of Zone-born Americans with that of their American-born parents would be valuable, for it would seem that one might expect to find such tropically-born offspring to be smaller than their parents instead of larger as has been the rule for recent generations in the United States.

Man does indeed seem to be dominated in his growth, speed of development, and final adult stature by the ease or difficulty with which he is able to dissipate from his body the waste heat of his cellular combustion. Human anthropology must take into account this dynamic responsiveness to environmental temperatures exhibited by man and other warm-blooded animals. Mass differences in stature or development seem more likely to depend on proper food supply or on the facility with which food utilization in the cells can be carried out than on racial or inborn characteristics. All foreign stocks of inferior racial stature have shown marked stature improvement after migrating to the intense climatic stimulation of the central latitudes of North America. Individual stature may well be influenced to a major degree by parental factors, but with population masses food availability and climatic stimulation seem to overshadow the hereditary elements.

It is impossible yet to say just how much of the growth depression observed in Canal Zone school children is due to tropical heat and how much to the higher vitamin requirements there existing. Much of the stature difference between native Panamanian children and the Zone-born Americans may be on the basis of greater vitamin deficiency in the former, for the Panamanian families of the Zone use meats tropically produced while the Americans use some imported meats. There is at present being made an assay of the differences in vitamin content of meats produced under varying climatic conditions and with varying degrees of vitamin inadequacy in the animal diets. Much indeed yet remains to be learned concerning the nutritional problems population masses face and particularly concerning the wide variations in these problems under different climatic conditions. This study of the Canal Zone school children would seem, however, to provide at least a partial answer to the question whether there really is a growth depression in tropical heat. Migration from temperate zones to the tropics does indeed entail a developmental retardation, no matter how great the precautions taken to avoid dietary deficiencies and disease dangers.

These findings of growth retardation in tropical warmth may be of significance in regard to the growth tide reversal that seems now to be taking

place in American college youth.[4] With the unseasonable warmth so largely prevailing since 1929, there has been encroaching upward from the South a distinct tendency toward smaller stature and retarded development among college youth. Any such depressing effect of rising earth temperature levels upon human growth is probably due to the more severe summer heat periods rather than to a rise in mean annual temperatures. Association of human growth rates and general vitality with prevailing temperature levels at once gives us a direct interest in future temperature trends on earth. With a generally rising trend in evidence for almost a century now, the suspicion is aroused that perhaps we are descending into another millenium of heat such as afflicted the earth during the Dark Ages, and that the present beginnings of growth recession may turn into a profound racial decline. It is this aspect of climatic effects that calls for all possible accumulation and study of whatever statistics may be available.

UNIVERSITY OF CINCINNATI
CINCINNATI, OHIO

[4] C. A. Mills, *Oncoming Reversal of the Human Growth Tide* (Science, 92, 1940), pp. 501–512; also *Further Evidences of Reversal in the Human Growth Tide* (Human Biology, 1941, in press).