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Plenary Lectures — Rapports principaux — Hauptreferate

Geographic Peculiarities of Nutrition

L'Adaption nutritionelle a l'environnement

Geographische Besonderheiten der Ernährung

Geographic Peculiarities of Nutrition. Central America and Panama

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There are no significant variations among the nutritional requirements of individuals with different genetic backgrounds. The host factors are therefore of minor importance in the determination of differences in nutritional pathology observed throughout various regions. There is much truth in Ortega y Gasset's statement „Man has no nature, what he has is a history.“

History should be interpreted here as the sum of experiences which through the generations determine man's behavior. These experiences are influenced by the environment to which he is trying to adapt, and determine the social, cultural and economic characteristics of a given population group at any given time.

Within the context of these thoughts, we would like to analyze the nutritional deficiencies prevailing in the six countries of the Central American region at the present time. We will attempt to explain the differences observed within the area on the basis of the more important related ecological factors.

Initially, we would like to point out the main nutritional characteristics of the area with a significance in public health. They are:

- ✧ Protein-calorie malnutrition
- Vitamin A deficiency
- Nutritional anemias
- Endemic goiter
- Calcium "deficiency"

Table I shows food availability for the area, on a *per capita* basis and in relation to the amounts estimated necessary to supply the population with a minimum adequate diet [8]. The deficiency of adequate sources of protein, particularly foods of animal

¹) INCAP Publication I—401.

origin and the insufficiency of vitamin A sources are both clearly established. Availability of conventional dietary sources of calcium is also very low for the whole area. On the other hand, iodine deficiency, as the primary factor responsible for endemic goiter, is due to the geological characteristics of the area.

Table I. Food availability in Central America

Food items	Minimum adequate needs ¹⁾	Actual availability 1964 ¹⁾	% of Sufficiency
Milk	1.067 ²⁾	896 ³⁾	84
Eggs	2.468 ³⁾	1.163 ³⁾	47
Meats	337	215	64
Beans	266	250	94
Vegetables	660	231	35
Fruits	392	323	82
Bananas	501	981	196
Roots and Tubers	232	112	48
Corn	715	1.489	208
Wheat	395	116	29
Rice	258	285	110
Sugar	265	590	222
Fats	66	50	76

¹⁾ Millions of metric tons.

²⁾ Millions of liters.

³⁾ Millions of units.

The availability of food *per capita* in a given area is the result of two main forces: production plus or minus imports and exports on one hand, and demand on the other. Usually, it is reflected by the general nutritional state of the population. Notwithstanding, it would be misleading to analyze food availability in the aggregate for a whole area, even for one as small and apparently homogeneous as Central America. Table II shows adequacy of food availability for each one of the six countries of the area [8].

Table II. Food availability in the Central American Countries (Percent of sufficiency, 1964)

Food items	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama
Milk	117	106	49	76	114	69
Eggs	31	37	81	14	64	50
Meats	175	46	62	22	77	36
Beans	165	35	58	99	106	494
Vegetables	29	7	64	—	17	45
Fruits	89	75	67	60	90	629
Bananas	155	16	107	614	148	182
Roots and Tubers	77	21	36	9	50	109
Corn	105	138	243	223	249	468
Wheat	—	44	26	—	50	73
Rice	179	39	45	63	162	190
Sugar	241	229	202	163	341	283
Fats	—	58	65	18	236	97

It illustrates significant variations existing among the countries. Obviously, similar or even greater variations can be found among different regions within the same country. For the purposes of this seminar, however, we would like to take these countries as units in our analysis of the reasons for these differences, the bases of which are definitely ecological.

Protein deficiency is particularly prevalent and serious in children during the weaning and post-weaning period in the whole Central American area [2]. Within this region, we have taken two countries, Guatemala and Nicaragua with sufficiently contrasting characteristics to permit an illustration of the cause-effect relationships under discussion. The analysis of availability of adequate dietary sources of protein shows marked differences between these two countries. As cow's milk is the most important conventional dietary source of protein of high biological value for the above-mentioned age group, the comparison between the situation of the two mentioned countries is very interesting. Fig. 1 illustrates this comparison. We can see that the availability of milk



Fig. 1. Cow's milk availability in Central American countries, 1964 (ml per day, per capita)

per capita in Guatemala is 93 ml, compared with 341 ml for Nicaragua. The two countries are approximately the same in size. However, topographic differences and population density have caused a great difference between them in the area of land *per capita* that is utilizable for agricultural purposes, which consists of 1.66 hectares in Guatemala and 5.61 in Nicaragua. Under the "open-ranch" conditions used in both countries for beef and dairy production, this is an important factor. The difference in area of land

actually exploited for this purpose is even greater (0.18 hectares in Guatemala, 1.08 in Nicaragua, as shown in Fig. 2. The nature of this last difference is cultural and economic, depending on the differences in demand for the products by the population.

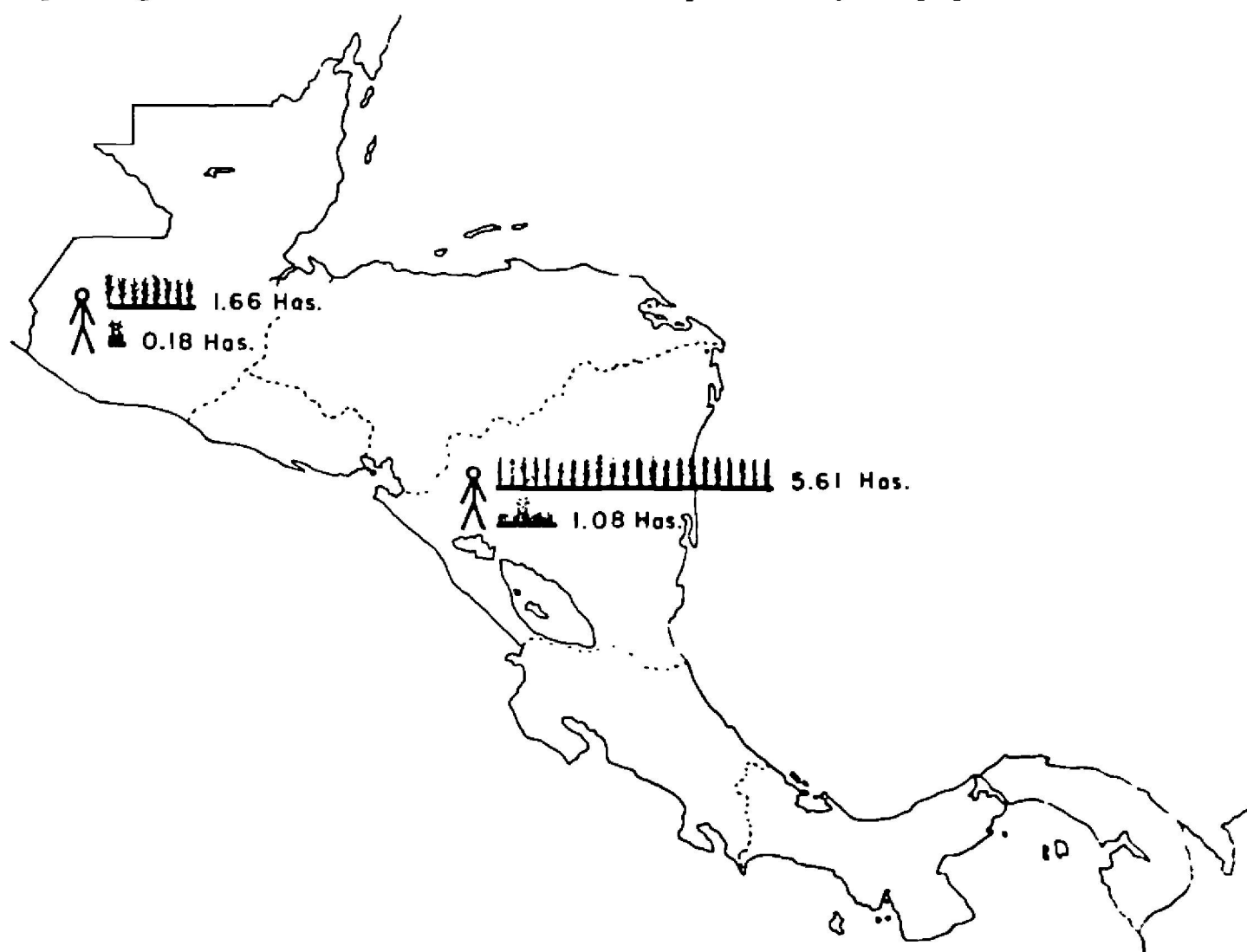


Fig. 2. Area of land utilizable for agriculture and exploited for beef and dairy production (1964) in Guatemala and Nicaragua (hectares per capita)

The large majority of the population in Guatemala descends from the Mayan Indians. The Mayans were agricultural people, they did not know the cow and did not use milk to feed their children. This may explain why they wean their children very late, usually after one year of age, incorporating them directly into the family diet. Cow's milk is not considered essential by this population and, consequently, demand for it is low. The Indian civilization was less powerful in Nicaragua, where the Spanish influence predominated instead, constituting the basis for the culture of the present population. As a result, cow's milk has greater acceptance and demand there. Generally, other factors are influential in determining demand for the product, such as economics and available facilities for the utilization of milk as a safe infant food. However, there is no significant difference between the two countries concerning these two aspects. Also, we are considering the situation in countries where the economy is agricultural, and the majority of the population has to depend primarily on locally produced foods because imported foods are generally too expensive for their means.

These factors explain the differences observed in actual consumption by preschool children as illustrated in Table III. This is the most logical explanation for the greater prevalence of protein malnutrition in Guatemala than in Nicaragua, since other epidemiological factors are not very different. Large numbers of children with kwashiorkor

are seen in the Guatemalan hospitals, and they are relatively rare in Nicaragua. Furthermore, preliminary analysis of data from a recent nutritional survey of the rural population in both countries also supports these observations.

Table III. Milk consumption (g per capita per day)

Guatemala ¹⁾	125
Nicaragua ¹⁾	307

¹⁾ Rural populations

The next problem of the area in our analysis is endemic goiter [1]. The prevalence of this nutritional disease has a well-recognized geographical distribution, since its principal etiologic factor, insufficient iodine intake, is determined by the concentration of this mineral in the general diet of the population. For populations depending largely on locally produced foods, the concentration of iodine in their diet is determined by the concentration of this element in the soil and waters at their disposal. This condition, in turn, is the result of the geological characteristics of the area. In general, a high prevalence of goiter has been found in mountainous areas situated far away from the sea.

Studies carried out between 1950 and 1960 indicated that the prevalence of goiter was very high in all six Central American countries, as illustrated in Fig. 3 [9]. Higher preva-

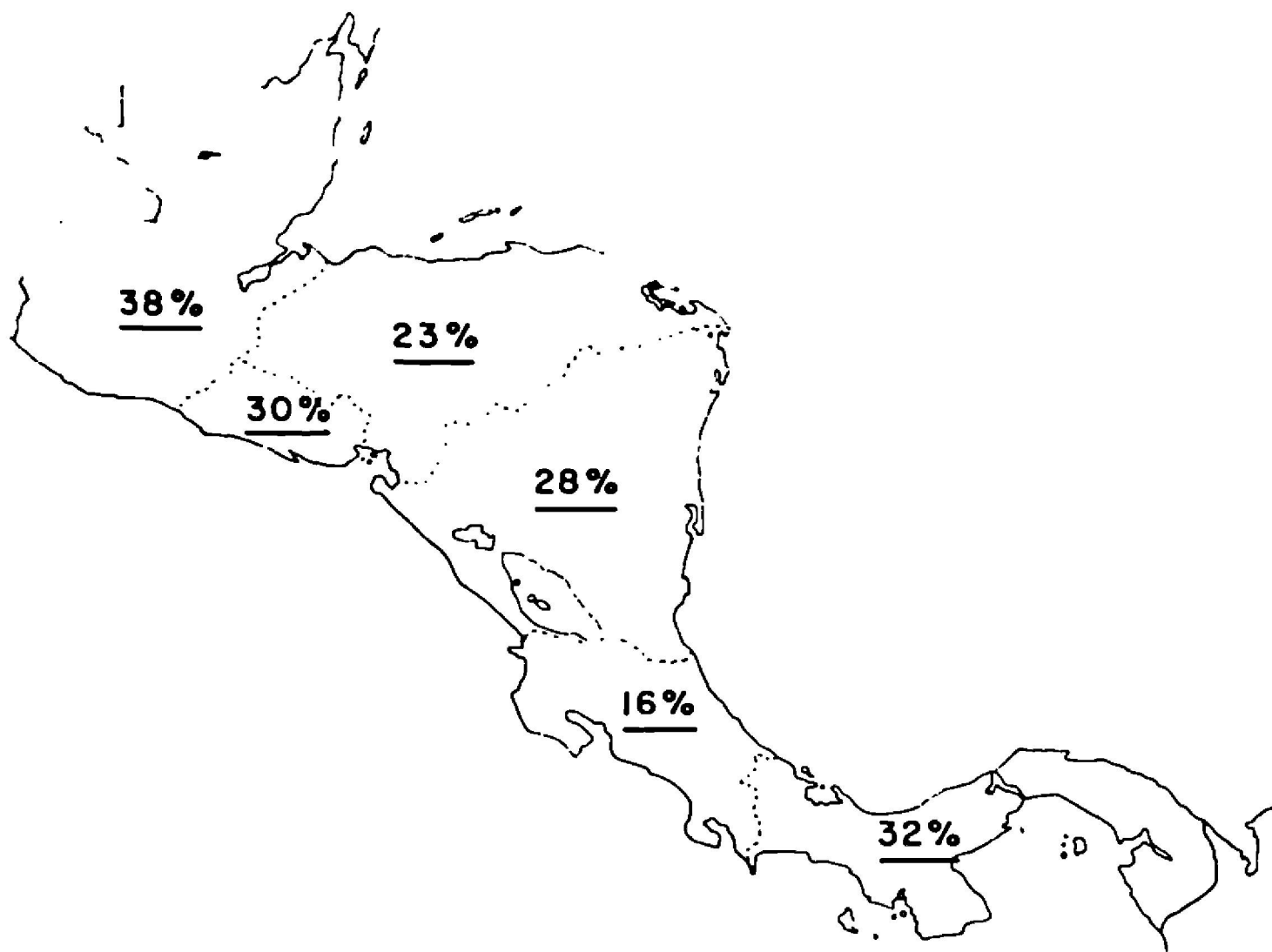


Fig. 3. Prevalence of endemic goiter in Central America (1950—1960)

lences were found in the mountains, and a definite association was discovered between prevalence and altitude. Nevertheless, high prevalences were also encountered in low coastal areas of this tropical region.

As it is well known, this is a condition in which man can modify and correct the responsible etiological factor and therefore, the ecology by utilizing regular salt as a vehicle to provide the needed supplementary iodine. In Guatemala, the government implemented compulsory iodization of salt at a national scale in 1960. It has been since enforced and controlled very efficiently. At the present time, only small proportion (about 5 %) of all the salt consumed in the country is not iodized. This salt comes mostly from small producers which cannot implement the iodization process. Table IV illustrates the result of the above governmental measure showing the prevalence of goiter in the country, as indicated by consecutive surveys [3]. The effectiveness of salt iodization is evident. The effect becomes even more dramatic, than the one shown by the country average prevalence if one looks at those areas where the prevalence was higher as illustrated by Fig. 3. However, it was interesting to note that in three of the forty villages included in the survey, the prevalence of goiter was still high and apparently it has not been changed.

Table IV. Effect of salt iodization on goiter prevalence in Guatemala

	Prevalence of endemic goiter %
1952	38.5
1962 ¹⁾	15.0
1965	5.2

¹⁾ Salt iodization started in 1960.

During the 1965 survey, samples of salt collected from all the villages under investigation were analyzed for iodine content [5]. Iodine was also determined in urine samples collected from the population. As expected, the values of iodine concentration in salt, and the urinary excretion of this mineral, were generally high and concurred with the clinical data. When the situation in the three villages with high prevalence was studied, it was found that urinary excretion of iodine by the population was low in two of these. The concentration of the mineral in samples of salt from the same two villages was also low. One of these villages is very close to the Border of the neighboring country (El Salvador) and to a Salvadorian city where the villagers go to market. Salt is not iodized in that country. The other village was close to an area where salt is produced in a very small scale and is still not being iodized. The third village with high prevalence was interesting because, in contrast with this high prevalence, urinary excretions of iodine and salt concentration were both high. This village is also close to the border of another neighboring country (Honduras) where salt is not iodized. It seems that the population of that village was obtaining the salt and other market items from that country until very recently, when a new road rendered the market in a nearby Guatemalan town accessible for them. Thus, iodized salt was not introduced into that village until very recently, and has not modified the goiter situation as yet.

The situation described is a very good example of the influence of geography on a condition which, as stated, is definitely dependent upon ecology. In the other countries

of the region it has not been possible as yet to iodize the salt. Recent studies in most of them have indicated that the prevalence of goiter has not changed since the first surveys of more than ten years ago [5].

The existence of vitamin A deficiency in the Central American region has received general recognition. From within this limited geographic region, however, areas with different degrees of the problem are beginning to be identified. This variability presents an opportunity to analyze the ecological factors which determine this nutritional deficiency.

We would like to remind you of the proximity of the countries, Guatemala and El Salvador, which have been studied from the nutritional point of view as part of a comprehensive nutrition survey of Central America and Panama, which is now in progress and which we shall use as our example [5].

In 1962 the World Health Organization investigated in many areas of the world, the occurrence of clinical manifestations of the eye which could be related to vitamin A deficiency [7]. The information collected from Guatemala and El Salvador was obtained mostly from hospital records revealing the existence of a problem to a serious degree. From this study as well as from INCAP's field observation during several years, the impression prevailed that the situation may have been more serious in El Salvador. However, data subject to direct comparison have only been available until recently. We have data on 1800 blood plasma specimens from a representative sample of the rural and semi-rural area of Guatemala and El Salvador. The data are presented in Fig. 4 as distribution curves for the total sample studied in each country. The distribution curves of values describe, in a quantitative manner, the magnitude of the problem. Blood plasma

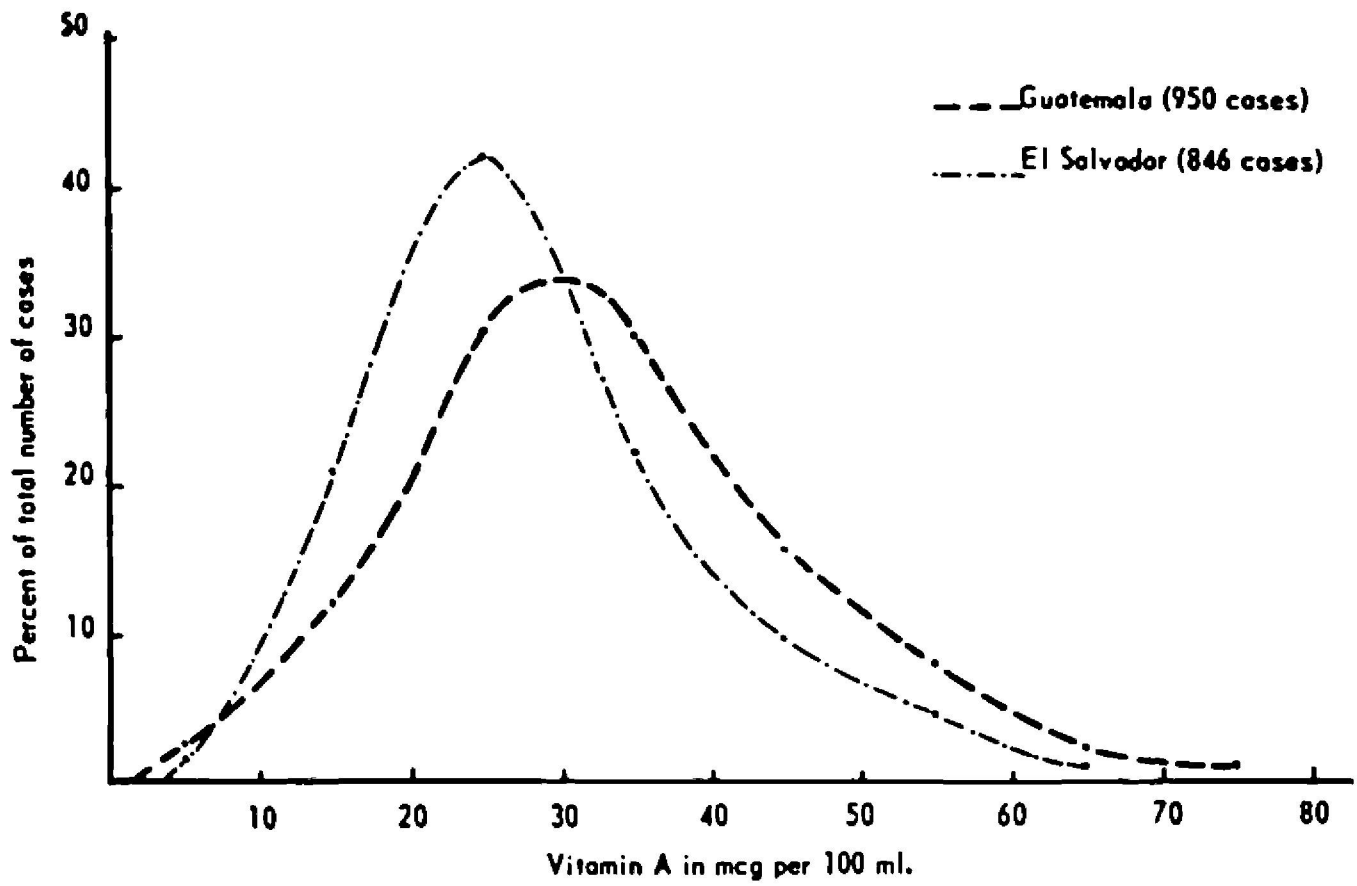


Fig. 4. Distribution curves of blood serum vitamin A values in Guatemala and El Salvador (1965)

values of 19 mg/100 ml or below deserve attention from the Public Health point of view [6]. The high prevalence of these low values in these two countries is in agreement with the high frequency with which severe manifestations of the deficiency are seen in patients admitted to the hospitals with malnutrition. It can also be seen that the problem is markedly more serious in El Salvador than in Guatemala.

The first obvious possible cause of this situation lies in the dietary pattern of these two populations, which we shall now analyze and discuss [4]. A feature of the national "food availability" patterns of both countries is a low availability of dietary components of animal origin, as shown in Table II, prepared by INCAP. This means that for all practical purposes the people have to depend on carotene as a precursor of vitamin A. If we now compare the figures for adequacy of availability of the main food source of carotene (vegetables) in these two countries, we find a marked advantage of Guatemala over El Salvador, the former having nearly ten times as much mixed vegetables available than the latter.

Data on the estimated daily intake of vitamin A (either preformed or from carotene) have also been collected during the Central American survey; on a *per capita* daily basis the intake is 690 mcg in Guatemala, against only 230 mcg in El Salvador.

If all of these agricultural and food consumption data are truly representative of the situation, one would expect the blood plasma concentrations of carotene to reflect the marked difference in the consumption of vegetable sources of vitamin A by these two groups of population. Fig. 5 illustrates the distribution values of carotene in the blood plasma and leave no doubt as to the direct relationships discussed in previous paragraphs.

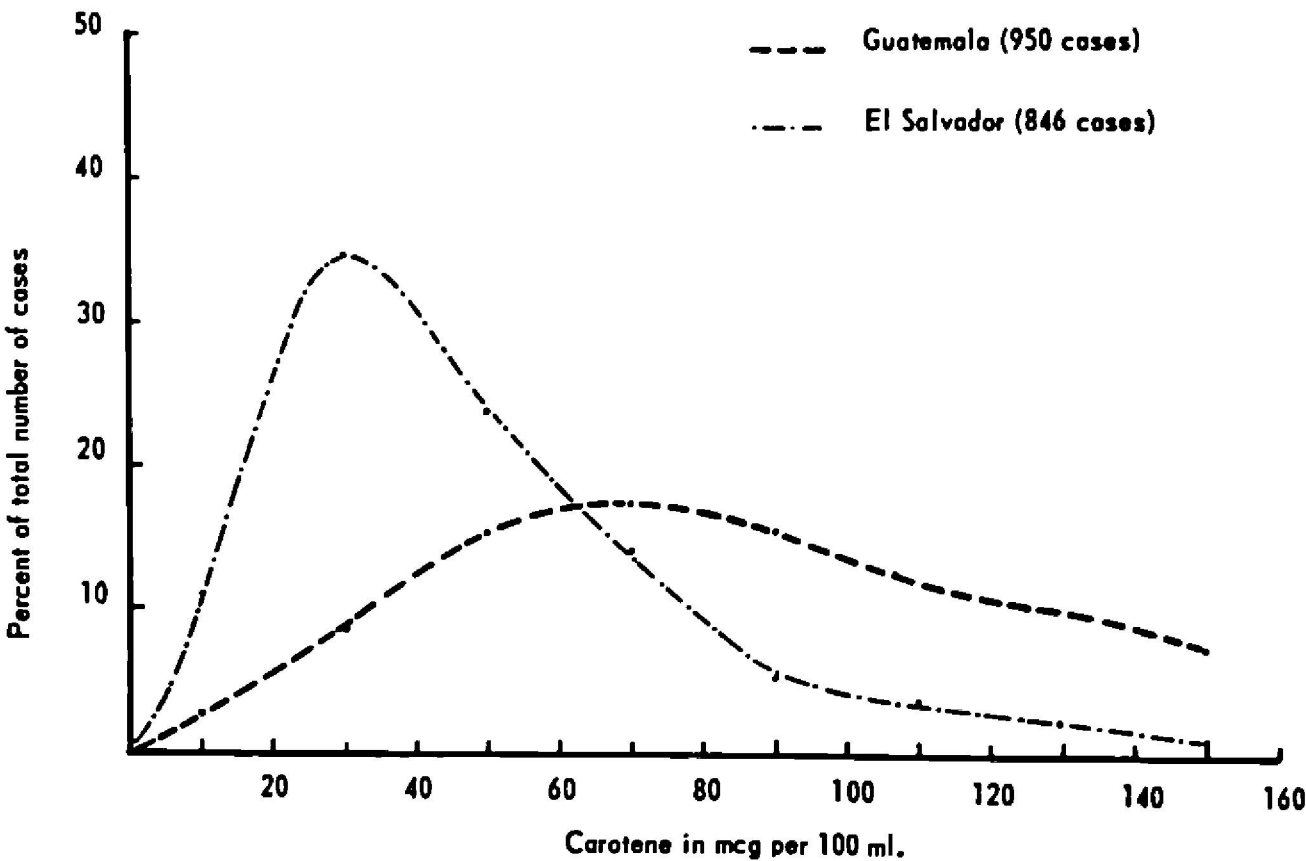


Fig. 5. Distribution of blood serum carotene values in Guatemala and El Salvador (1965)

In the case of vitamin A nutrition just described, several factors are, again, playing a role. A low demand for vegetables is evident in El Salvador as indicated by our studies on dietary habits. This may have as principal cause a cultural characteristic. Cultural factors seem to be responsible also for a marked preference for white corn for human consumption over yellow corn. But the most closely related outstanding difference between these two countries is that El Salvador is a much more populated country, 125 inhabitants per square kilometer, than Guatemala, 38.6 inhabitants per square kilometer. Perhaps as a consequence of this, people in El Salvador devote a very large part of their arable land to the production of cash crops and most of the rest to basic energy rich foods commonly very low in carotene, such as beans and white corn.

The last question that we would like to discuss is calcium intake. Calcium intakes in Central America [4] offer another opportunity to illustrate a pattern of geographic distribution which in this case can be explained mostly by the effect of cultural factors. Fig. 6 shows the average calcium intakes per country in decreasing order. The same listing order is obtained if we go from one end to the other in the map, as seen in this same figure. We do not intend to say that latitude is determining calcium. Let us look instead at the shaded area which indicates the extent and magnitude of influence of the Mayan Indian culture and we find again the same relationship, stronger in Guatemala with the higher calcium intake, weakest in Costa Rica and Panama with the lowest calcium intake.

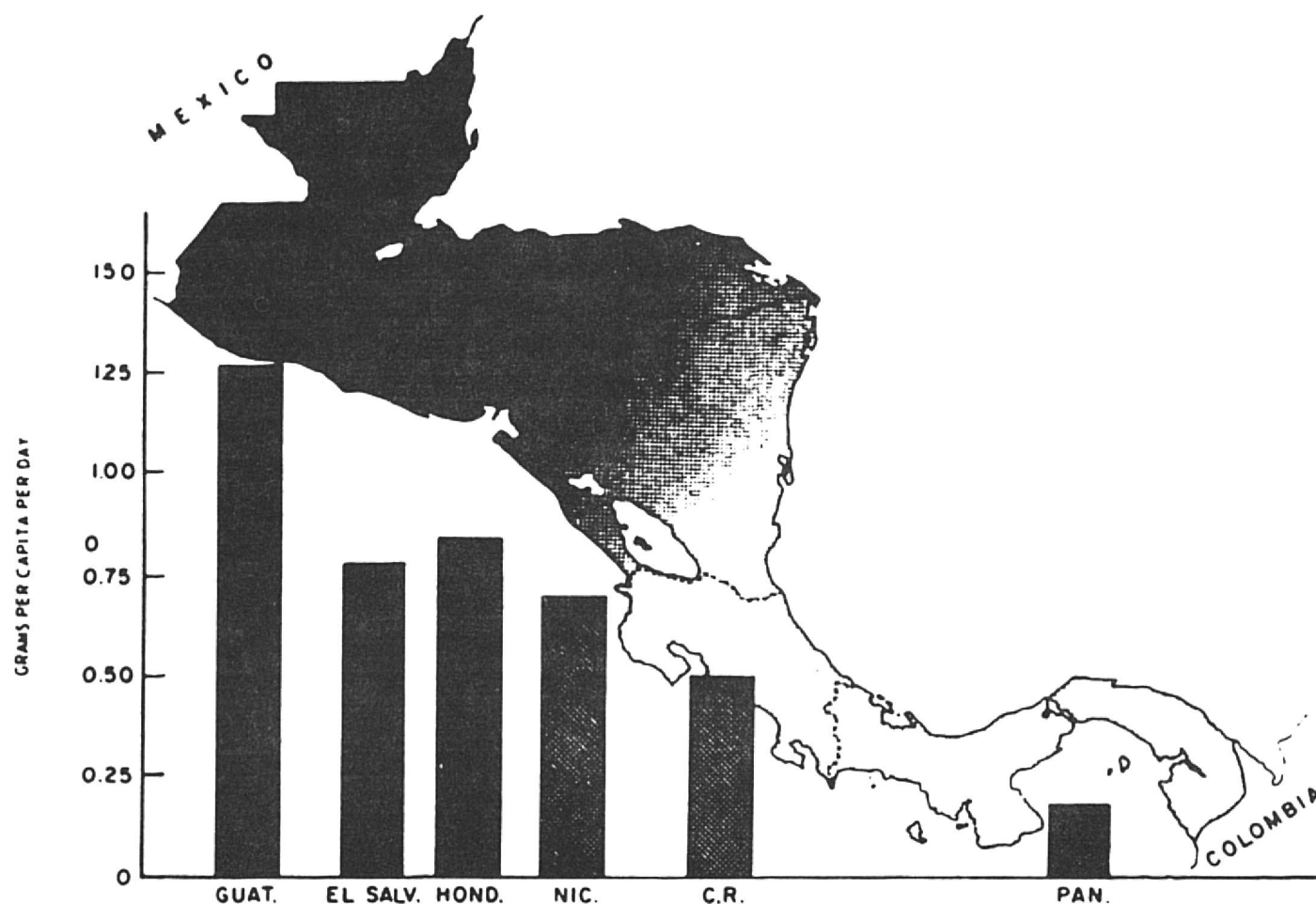


Fig. 6. Calcium intake and Mayan culture influence in Central America

A true cause-effect relationship is found here. The Mayans and Mayan influenced populations consumed large amounts of corn cooked with lime water and made into *tortillas*. *Tortilla* by actual analysis contains 124 mg of calcium per 100 g, while untreated corn contains only 4 mg per 100 g [10]. Excluding the Mayan *tortillas*, the rest of the diets of the Central American countries do not differ significantly in calcium content. It can be then demonstrated that it is the consumption of lime-treated corn, directly dependent on the cultural background of the peoples what determines the odd distribution of calcium intake throughout this small geographical area.

"The states of health and disease are the expression of the success or failure experienced by the organism in its efforts to respond adaptively to environmental challenges."

René Dubos

The statement quoted from Dr. René Dubos does not set forth a new concept. Hippocrates has already said that "Health is the expression of harmonious balance between the various components of man's nature and the environment and ways of life." However, attention has not concentrated sufficiently on the relationship between environment on the one hand and both the nature and the prevalence of disease in a given area or in certain population groups on the other. Nutritional deficiencies are not an exception with respect to this relationship. On the contrary, as was illustrated in this presentation, ecology is probably even more influential on them than in many other diseases.

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