Genetic Improvement of Crop Foods

Genetic engineering is making it possible for farmers in even depressed areas to produce more food of higher nutritional value to feed the world in the next three decades. The time thus bought may enable man to gain control of population growth—unless the Emotional Environmentalists succeed in turning back the clock on modern agriculture.

by NORMAN BORLAUG, Ph.D.

My talk is about the genetic manipulation or improvement of cereal grains. But first, I would like to make some comments on overall increases in food production in the last few years. I am referring to what has been commonly called by the press "The Green Revolution" in food production, especially in Asia.

It would perhaps be more apropos to speak about changes in production patterns in the Western Hemisphere. Nevertheless, I think that the two cases that I have selected will illustrate the magnitude of these changes more easily than if I tried to speak about progress in a great number of countries. In India and Pakistan, we are dealing with 700 million people. Trying to tackle the complexities of expanding food production in this kind of situation is similar to the magnitude of the food production problems for all the Americas plus a good share of the population of Africa as well. Yet India and Pakistan, where the problem is greatest, are two relatively small countries. What has happened in these nations in the last four years? Take the case of wheat, for instance, considering only India for the moment. In 1965, which was a very favorable year, India's wheat output reached an all-time high of approximately 12 million metric tons. The most important fact is that this peak in wheat production was achieved largely by increasing yields per acre. This is very significant because there is very little additional land that can be brought under the plow. This increase in crops must be the pattern of attack for most of the densely populated countries of the world, which are already running out of arable land.

Dr. Borlaug is the father of the "Green Revolution." He was awarded the Nobel Peace Prize in 1970 for his work in developing high-yielding varieties of wheat. An Iowan, he is Director of Centro Internacional de Mejoramiento de Maiz y Trigo, Mexico, D.F.

HOPE DAWNING

Beyond increased food production, what else does this portend? I have restricted these comments to wheat, but I have no doubt that in the next four years—if we have peace—there will be a similar expansion in the production of rice. Considerable progress has also been made in the production of maize, or corn, in the past four years. So, for the time being, we have made a significant increase in food production in this very densely populated part of the world. This enables us to buy a little time—one, two or three decades—if we continue to work at this problem from all angles and receive continued support from the governments concerned so that food production may stay ahead of population growth. After this period, I hope man will have regained his senses and adjusted his population growth—in order that the absolute essentials for a decent life may be available to all born into this world.

I think the stepped-up production of wheat is having a very significant impact on the total economy. I would like to emphasize that in a country such as India or Pakistan and in most of the Near East and Southeast Asia, a vast segment—80%—of the total population lives on the land, supported mostly by a subsistence agriculture, and has very little to sell. They actually live outside the economy of their country, but if there is a sudden increase in grain production from 12 to 23 million tons, many of these small farmers will participate in the economy. They now have something to sell—a state of affairs which never existed previously.

A whole series of changes is thus set in motion at the village level. The peasants buy things they never had before—simple machines, more fertilizer, more pumps, more motors and casings—and most of these products are made in India. They start buying consumer goods. If you are the head of the household, you might buy a Singer sewing machine in order to provide better clothes for the family, or a transistor radio. The latter allows the Government to broadcast educational programs to all backward villages that were hitherto completely isolated. Most important of all, hope has replaced despair. You can't use a yardstick to measure what hope means in terms of indirect benefits, but I am convinced that they are very substantial.

MIXED BLESSING

There are certain disadvantages, however, of which we must be aware. The cereal grains are displacing some of the natural sources of protein on which millions of people in the near Middle East subsist. They are displacing such important protein crops as chick beans, pigeon peas, beans and lentils. This is a most undesirable development and must be corrected. There are serious protein deficiencies in the developing nations, in contrast to the more affluent countries. If we look at total protein production and total human protein consumption in the world, we find that approximately 70% of the total represents plant proteins and only 30% animal proteins. Cereal grains constitute

50% of total production. Relative costs of food in different countries must also be taken into account when we look at this problem of nutrition. Here in the United States, where there is an abundance of food, only 17% of the total take-home pay goes into expenditure for groceries. Compare this with even advanced countries in Western Europe, where approximately 40% of the total take-home pay is spent on food, and with the situation in India and Pakistan, where perhaps 70% of the total take-home pay is spent on food. This leaves very little margin for emergencies. Cost is therefore an important factor influencing the choice of food to be consumed. It is very difficult to justify the conversion of cereal grains into animal products in a country already short of food. Even under ideal conditions of management and modern technology, it takes approximately 3 lbs. of grain to produce 1 lb. of chicken meat, 4½ lbs. of grain to produce 1 lb. of pork, and 6½ lbs. of grain to produce 1 lb. of prime beef. So it is readily apparent why—in most of these developing countries—there is a serious scarcity of animal protein which could bring about some semblance of a balanced diet—in dire contrast to the more privileged people of this country with their easy access to animal protein.

"And he gave it for his opinion, that whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one would grow before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together."
Voyage to Brobdingnag in Gulliver's Travels by Jonathan Swift, 1726.

GENETIC ENGINEERING

Most people in the developing countries rely heavily upon cereals as their principal source of protein. We must take a look at the limitations of these cereal proteins. In the first place, none of them provide enough of one or more of the essential amino acids if they constitute a large part of the total dietary protein intake. Lysine, an essential amino acid, is of course lacking in all the major cereal grains. The second most limiting amino acid will vary with the different cereal grains. Nonetheless, we can start out with lysine. How can we do something about improving the nutrient value of our cereal proteins? There are three general approaches: (1) We can breed new varieties of grain with an improved balance of essential amino acids. This is a relatively new approach. It has been developed only in the last seven years. I call this "genetic engineering." (2) Using genetic engineering, we can develop varieties that are higher in total protein production by manipulation of genes. (3) We can develop improved cultural practices for any conventional variety, or better yet, for varieties that have built-in genetic improvements or an improved amino acid balance, increasing their production through such manipulations as proper application of chemical nitrogenous fertilizers—or growing cereals and certain legume crops in rotation. We can also increase the total percentage of proteins in this way.

These three avenues are open to us when we try to do something about the protein problem through the cultivation of plants. This genetic breeding—or genetic engineering or manipulation of genes—came into being as recently as 1964 with the discovery of the potential importance of the Opaque-2 gene in corn. I would like to point out that the Opaque-2 gene in corn, used as a genetic marker, was discovered and described in the 1920's by Jones and Singleton in Connecticut. But no consideration was given at the time to the significance of its other potentialities. Not until 1964, at Purdue University, did Nelson and Bates discover that the gene also produced higher than normal levels of lysine in Opaque-2 corn. It turned out also to have much higher levels of tryptophan—lysine and tryptophan being the two most limiting amino acids in corn. Normal corn has about 2% lysine in the endosperm protein; the Opaque-2 corn has about 3.39% lysine in the endosperm protein. This is a very significant increase. It is not only evident from chemical analysis but the biological value likewise reflects it. When the growth rate of rats fed Opaque-2 corn was compared with their growth rate on normal corn, important differences were found. The same was true when weanling pigs were fed similar diets in which the main or only source of protein was either Opaque-2 corn or normal corn. They grew at a much more rapid rate. This work was done at Purdue and in Colombia.

The final "clincher" was the discovery that when children suffering from kwashiorkor were fed Opaque-2 maize by Dr. Pradillo and his group at the Zambali Medical School in Cali, Colombia, they responded beautifully.

SHORTCOMINGS OVERCOME

There were many shortcomings in the original Opaque-2 corn. First of all, this was a very poor corn for a basic type. If you are going to use these genes, you have to incorporate them into the background of a whole series of corn varieties or hybrids that are peculiarly adapted to the region. This takes time. It takes a whole series of crosses and backcrosses. You have to be able to follow these in segregating populations so as not to lose this gene. As long as you are dealing with the original Opaque-2, it is self-evident because this is a soft endosperm or soft kernel type and you can spot this easily in the different kernels in an ear of corn, for example.

This kind of corn also has serious innate defects. Since the kernel is opaque, light is not transmitted through it as it is through a normal kernel such as may be seen in translucent hard endosperm corns. Also, these opaque kernels have low density. Therefore, the same number of kernels per ear will yield less—generally 8-10% or even as much as 14% less—grain. Offhand, this corn would therefore be completely unacceptable to the ordinary farmer, especially the small traditional farmer. Moreover, this soft kernel texture makes it vulnerable to damage by insects, both in storage and shortly before harvesting. Many of these kernels are also damaged by fungi before the ear matures. So there are considerable handicaps in trying to use these genes to improve the nutri-

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(continued from page 21)

tional value of maize. Moreover, the kernels are much less attractive and have different milling characteristics and different dough-handling properties, all affecting their possible acceptance by the farmer.

What is the current status of developing varieties and hybrids that will be acceptable for commercial use in the case of Opaque-2 derivatives? Many varieties and hybrids are being converted to Opaque-2 types. The disadvantages I have mentioned have prevented their full acceptance in most cases up to now. Nevertheless, in Brazil and especially in Colombia commercial acreages—very large ones in some places—are being grown, notably by farmers who have an integrated corn and hog production since they have high feed costs. This is an especially important consideration when high protein food supplements, such as soybean meal, are not available. There are certain contract growers in Colombia and Brazil who are growing Opaque-2 corn derivatives or hybrids for companies producing specialty foods such as baby foods. None of these new varieties, however, has yet come into general use in large-scale farming or in the area in which my organization is particularly interested, small subsistence-farming. It is here that you can make the greatest contribution to improving the nutrition of the underprivileged people, for they buy only the minimum. It is hard to get extra food supplements or food concentrates into the stomachs of these rural people. You might achieve this by supplementation and of course you must do this in hospitals, schools, and —insofar as is possible—in urban populations. But when dealing with rural people, it would be far better if one could incorporate these benefits into the seed and let the farmer grow it. Once he buys the seed—or once he has been given the seed—he can continuously resow it each year and benefit from it. This method has these built-in advantages.

FUTURE PROMISING

The future, then, looks promising. Particularly in the past year or two, hope has been growing that the Opaque-2 corn derivatives or hybrids will find large-scale acceptance. The reason for optimism is that there are now several known genes that will correct the softness of the kernel. Using these, you can maintain the high lysine and high tryptophan values of the original transfer from the Opaque-2 type. However, highly reliable analytical procedures in the chemical laboratory are vitally necessary to make certain that the gene for high lysine and high tryptophan hasn't been dropped in the process of incorporating the genes for hard texture, thereby masking the soft kernels used to transfer the original genes.

Our group working at the International Center for Maize and Wheat Improvement in Mexico under the direction of Dr. George F. Sprague, and others collaborating with us, feel there is a good chance that within two years large, commercial quantities of seed will become available that will not only have high nutritional value but will comprise a broad built-in adaptability to altitudes, temperatures and latitudes. Corn, unlike certain other varieties of crops, unfortunately does not lend itself to this sort of adaptation by ordinary breeding techniques. However, some very promising lines that do possess this breadth of adaptability for growing at different elevations of terrain and, we hope, also across fairly wide latitudes, have now been produced by our group. If this seed, which also has high nutritive value, proves successful, then seed production and seed distribution, too, will be simplified. The prospects for accomplishing this very soon are excellent.

CEREAL, MAN-MADE

What are the possibilities on other fronts, using other cereals? In 1967, a gene with a similar effect was found in barley. It has been called "hy-proly." This was found in an indigenous Ethiopian variety, a natural mutant. Swedish research workers, especially Akerberg, Karlson and Munk, are incorporating it into improved barley varieties and aim to use it as a more efficient source of feed for producing animal proteins. We at International Center are interested in, and beginning to develop, a program for incorporating this gene into high-yielding barley varieties for use in the low-rainfall areas of North Africa and the near Middle East. Where barley is used as a food, this is grown in areas of lower rainfall than wheat usually requires.

We have worked for six years on a man-made cereal which, however, has yet to attain any commercial importance. It is called "Triticale" from the Latin words *triticum* for wheat and *secale* for rye. Triticale is a cross between wheat and rye. It was first described as a naturally occurring hybrid —amphiploid—in 1888. But it was not until about the mid-1930's, when the technique for doubling chromosome numbers came into being with the use of the alkaloid colchicine, that it was possible to make many of these combinations of wheat and rye, and to double their chromosome number so that they would be partially fertile. Researchers in Europe and Japan—among them Muntzing of Sweden, Sanchez-Monge of Spain and also Hungarian and Russian workers—have spent a lifetime working with these plants.

We became interested in the possibilities of using this wheat-rye combination as a prime source for protein in order to attack the world nutritional problem, and we formed a joint venture with the University of Manitoba. This cooperative program has made great progress. Initially, we had to contend with partial sterility of the plants and with plants producing big ears or heads but having few seeds. These difficulties have now been overcome. We have improved the architecture of the plant so that it will respond better to improved cultural practices and improved use of fertilizer, and we have thus increased the yield of grain. It is still not as high as in the case of our best-yielding wheat. But one of the curious things we have found in the past two years in working with Dr. Fred Elliott of Michigan State (and we used an original test organism) is that some of these lines have unusually good protein efficiency ratings: the full equivalent and perhaps considerably better than Opaque-2 corn! This discovery is very significant. It hasn't been checked out in higher animals yet, except for preliminary experiments with chicks. Within the next few months, however, we hope feeding experiments with the new, man-made cereal can be conducted in pigs and, as soon as justified, in underprivileged children suffering from serious protein malnutrition.

Triticale offers a new possibility. Here is an entirely man-made cereal. If we can overcome one defect that still remains—grain plumpness—then there is an excellent chance that this cereal can compete successfully with any of the other small-grain cereals such as wheat, barley and oats and can serve a very useful purpose in areas where small grains are the basic source of plant protein.

What about wheat and rice? They

are the two most important grains. Up to now we haven't done too well with them as far as the change in amino acid patterns goes. We hope that progress will be made shortly by increasing the total levels of grain protein in both these crops. The genes are known, and some varieties have already been produced which will yield 1-2% more total grain protein than their progenitors. There is plenty of opportunity for further improvement while we continue our search for genes with better amino acid patterns. Genes have been found for both wheat and rice, but they have not been easy to use so far. More efficient ones may yet be discovered.

TWO DANGERS LURKING

To summarize: Considerable progress has been made in the last two years in expanding cereal grain production. But it is modest indeed compared to total needs. We must remember that, according to the Food and Agriculture Organization and also the World Health Organization, half of the world's people are still undernourished, badly nourished or malnourished. This is not a very pleasant picture! We cannot allow this situation to continue any longer and maintain our food supplies simply on a par with current population growth. The solution to the problem will probably require an expansion of 30% in cereal grain production, which could be done very rapidly if it were merely a question of producing it anywhere in the world. All you would need to do is to turn loose the American farmer and give him the necessary incentive – the same with the Canadian, Australian, Argentinian and Soviet farmer. But this wouldn't solve the problem of malnutrition and undernutrition in the developing nations because they wouldn't have the necessary money to buy the additional 30% of cereal grain needed. And even if their governments were in a position to do this, the people who sorely need it have such low incomes that they couldn't purchase the grain from their own government! At the same time, therefore, we have to work at putting money into the pockets of the people of the developing nations – who represent nearly 80% of the total population – to give them the necessary purchasing power. This is the approach which has proved successful up to now. We must proceed to provide this economic help faster than ever. There is no room for complacency because of the monster lurking in the wings – population growth!

There is another great danger lurking on the horizon that threatens our ability to expand food production: the emotional environmentalists, who are attacking on two different fronts. On the food production front, they are using an organic gardening experiment, based largely on a few tomato plants grown in the backyard, to project ahead how to feed 3.7 billion people! It is questionable whether this experiment is a very good foundation upon which to make such calculations. When they are back home in their privileged nations (such as this one), they work on another front – trying to bring political pressure to bear to pass legislation outlawing the use of chemical fertilizers. If this should come to pass, we are all – sooner or later – doomed to starvation. On the pesticides front, there are these lobbies of emotional environmentalists – I shan't dignify them by calling them ecologists. I started out as an ecologist and I worked with wildlife, watershed management and forestry, the integrated use of land in its broadest sense, and these extremists, I assure you, are not ecologists. We have these lobbies attempting to legislate against pesticides that are needed when used wisely, which I am certainly advocating to protect our food crops. I am sure that most of you in the medical field are aware of the effect that this legislation – already passed in the U. S. – will have on the use of DDT and also, therefore, on the world malaria problem, which has been under controlled study for 25 years. Malaria still runs rampant in vast areas of the world. We have no satisfactory substitute for DDT available. It is one thing to pass legislation here in this country when measures may not be needed at the moment. But I have no doubt whatsoever that soon after that is achieved there will be some twisting of arms of the developing nations. They will be told by the governments that have succumbed to the emotional environmentalists: "We have corrected the fouling of the environment with fertilizers and pesticides. Now it is up to you to do likewise." This, I suppose, is reasonable and just.

LAST BIOLOGICAL SECOND

Nonetheless, I am very optimistic about the future of man. He has come a long way during the 2 million years since he stood up on his hind legs after he emerged – probably from the bush in East Africa. And particularly so if we look back to the time 9,000 years ago, when, after having subsisted as a hunter, man discovered agriculture. After the introduction of agriculture and animal husbandry, which permitted the specialization of labor, we had the first pottery makers and metal workers and basket weavers, who exchanged their products for food produced by farmers. Villages were born. Then cities. And thus modern civilization came into being, with a myriad of problems which still confront us. Man has indeed come a tremendous distance in this last "biological" second . . .

We should not be cynical even though we haven't – as yet – solved all the problems underlying the basic social ills that have so far hampered the equitable distribution of our social benefits. And, of course, we have been depleting our non-renewable resources without developing proper substitutes. I am referring to the deterioration of the environment. We have certainly done an excellent job of fouling up our rivers, streams and lakes and smogging our atmosphere! I am sure, however, that we are well on our way toward correcting some of these abuses. We can do so for the next ten years, but what will it be like, 30 years from now, when we have doubled the world population that we have now? I am confident that political stability hinges largely upon our ability to provide a decent standard of living for all who are born into this world. This, I believe, we can only hope to achieve if we continue to redouble our efforts to control population growth and to increase food production at the same time.

LETTERS

Letters to the Editor are welcomed and will be published, if found suitable, as space permits. They should be typewritten, double-spaced, and of reasonable length. As is custom, they will be subject to editing and also abridgment.

ALL CALORIES DON'T COUNT . . . PERHAPS

Sirs: I fail to see that the studies cited by Dr. Schauf (NUTRITION TODAY, Sept.-Oct. 1971) produced findings "different from what the conservation of energy principle would lead one to expect."

In the study by Watten *et al.*, for example, fasting men lost an average of seven pounds of fat tissue in ten days. This is in good agreement with the expected fat loss in adult males of average physical activity; seven pounds of fat tissue represents approximately 24,500 Calories, or an average output of 2,450 Calories per day.

It would be impossible to evaluate the results of the study using a "ketogenic, high-fat, 4-percent carbohydrate diet," since no figures are given for caloric intake or urinary losses. I would question the advisability of any diet that would produce a state of ketosis severe enough to result in a significant loss of calories through urinary ketone body excretion. A urinary loss of 75 g of ketone bodies per 24 hours, as seen in severe diabetic acidosis, would represent a considerable loss of calories, but could hardly be recommended.

While it is true that glucose can be converted to acetyl-coenzyme A, the same is true for fatty acids. While it is true that glucose metabolism via the shunt pathway provides NADPH for the reductive steps in fatty acid synthesis, acetyl-coenzyme A to be reduced is essential as a substrate for this synthesis to occur. Also, alpha-glycerophosphate can be produced from inorganic phosphate and glycerol (derived from fat) in the liver. All of these facts suggest that body fat can be synthesized as readily from dietary fat or protein as from dietary carbohydrate.

Incidentally, when the word follows a number, it is spelled "Calories" (capital C) since it designates kilocalories rather than the chemist's calories.

Thora J. Runyan
Assist. Professor
Iowa State U., Ames

Dr. Schauf replies:

The point has been made concerning the body composition studies in starvation by Benoit, Martin and Watten (Annals of Internal Medicine *63:* 604, 1965) that 2,450 Calories of fat were oxidized per day. However, what was not mentioned is that there was a simultaneous loss in lean mass, 64.6 percent, as opposed to 35.4 percent fat. This is precisely my point. Although the law of conservation of energy is irrevocable, that is, body weight is lost if caloric input is less than output, it becomes apparent that the kind of weight lost must be identified. The ketogenic diet utilized by these investigators contained 1,000 Calories – 82 percent fat, 14 percent protein, and 4 percent carbohydrate. On this diet there was a mean weight loss of 13 pounds with only 3 percent due to lean mass. The diet was well accepted by the patients, and although ketone bodies were produced, it was felt that this was not the explanation for the high percentage of fat oxidized. I feel more fat was oxidized by an increased metabolic rate (due to the increased fat ingestion) and owing to the fact that the total number of lean cells oxidizing fat had not decreased significantly.

The second point, that body fat can be synthesized as readily from dietary fat or protein or carbohydrate, I dispute. Alpha-glycerophosphate is synthesized *in situ* at the fat cell from glucose, which is a key substance mandatory for lipogenesis, and insulin is likewise necessary. Fatty acids can supply acetyl-coenzyme A, but they can neither supply alpha-glycerophosphate nor provoke insulin secretion. Glycerol mobilized from the fat cell reaching the liver can be converted to glucose, supplying less than 10 percent of the total glucose pool. The stated production of alpha-glycerophosphate from inorganic phosphate and glycerol in the liver, if it occurs, would appear insignificant compared to that produced from glucose at the membrane of every fat cell in the body.

It would appear that a combination of both glucose and fatty acid metabolic processes is essential for fat production and storage and that, if carbohydrate is restricted in a high-fat diet, the weight loss will be mainly fat.

George Edward Schauf, M.D.
Riverbank, California

Sirs: I am writing in response to the article by Dr. George E. Schauf entitled "All Calories Don't Count, Perhaps" which appeared in your Sept./Oct. 1971 issue. The first two and a half pages of the article give a highly lucid explanation of why fat loss rather than weight loss should be the objective of any reducing program. Unfortunately, just when Dr. Schauf has his readers convinced, he weakens his entire hypothesis by recommending a carbohydrate-restricted diet which is justified as effective in promoting *weight* loss. No evidence is presented to show that such a diet causes a specific loss of body fat and, indeed, our experience has been quite contrary to this hypothesis.

We reported in 1967 (Amer. J. Physiol. *213:* 347) that a high-fat, carbohydrate-restricted diet fed to mature rats did promote a greater weight loss than a high-carbohydrate diet providing the same, restricted caloric intake. However, body composition analysis indicated that this greater weight loss was due to a reduced fluid volume in the gastrointestinal tract. On an equal caloric intake basis there was no difference in ingesta-free body weight between the animals on the two diets, and the animals on the high-fat, carbohydrate-restricted diet had significantly more body fat. Similarly, Dr. Walter M. Bortz and associates at Lankenau Hospital in Philadelphia reported in 1969 (Amer. J. Clin. Nutr. *22:* 119) that a primary function of carbohydrates in human patients is to promote electrolyte and fluid retention. Reducing carbohydrate intake to below approximately 12 percent of the daily caloric intake is an effective way to dehydrate the body.

It is not surprising that carbohydrate stimulates lipogenesis more than fat does since carbohydrate must be converted to fat, whereas dietary fat is already there. High-fat diets are utilized more efficiently to produce body fat than are high-carbohydrate diets, and this has been reported by a variety of researchers for a number of years. I think that Dr. Schauf would find a controlled study comparing his carbohydrate-restricted diet with a more balanced one to be a very disillusioning experience if he followed the body composition changes in his patients.

Richard A. Ahrens
Assoc. Professor
U. of Maryland, College Park

Dr. Schauf responds:

The object of the diet proposed in "All Calories Don't Count, Perhaps" is to secure a ". . . steady reduction in accumulated fat and a simultaneous resynthesis and maintenance of vital lean tissue." Fat has weight, though all weight is not fat. Naturally, one will lose weight if one loses the great excess of his body fat. I have judged this clinically by skinfold measurements and by outlining the muscles between my thumbs. Dr. Charlotte Young has shown in controlled body composition studies with college students that weight loss, fat loss, and percent lost as fat are inversely related to the amount of carbohydrates and directly related to the amount of fat in isoprotein, isocaloric diets (Amer. J. Clin. Nutr. *24:* 290, 1971).

George Edward Schauf, M.D.
Riverbank, California

Sirs: The article "All Calories Don't Count, Perhaps" in the last issue of NUTRITION TODAY is a milestone in medicine since it clearly refutes the caloric theory regarding the etiology of obesity and offers a plausible alternative. I had the opportunity to hear Dr. Schauf present his new QQF Theory at the Annual Convention of the American Medical Association in Atlantic City, June 1971, and wish to congratulate NUTRITION TODAY for publishing this article. It dispels the fallacy of counting calories to lose "weight" and will no doubt be of invaluable help to the millions of Americans suffering

from the ravages of obesity.

Raymond E. Dietz, D.O.
Chairman, Am.Bd. Bariatric Med.
Harrisburg, Pa.

Sirs: I want to congratulate you on the very fine article on obesity and dieting by Dr. Schauf in NUTRITION TODAY. This represents a new and exceedingly important point of view, and I have taken the liberty of sending it around to a number of the doctors at the clinic, and also to several of my patients who are intelligently working on their weight problem. This is a stimulating and provocative article. I'm sure it will provoke comment. In my opinion it is a real contribution to the subject, which is more important than most people realize.

Again, congratulations on the quality of the journal in general, particularly on such articles as this one.

Russell V. Lee, M.D.
Palo Alto, Calif.

FLOOD WARNING

Sirs: NUTRITION TODAY has always been an informative and attractively prepared publication, but the July/August issue was of special interest to those of us involved in the improvement of the health care delivery system in the Pacific.

The article on health in the South Pacific islands will find its way into physicians' files, and the piece on the Hawaiian luau will find its way into many a housewife's recipe file. I only hope you aren't inundated by letters stating that the pig in the imu illustration on page 33 is covered with ti leaves instead of banana leaves.

Thank you for bringing attention to one of our most cherished traditions: Hawaiian luau.

Masato Hasegawa, M.D.
Exec. Director
Reg'l.Med.Pgm.
Honolulu, Hawaii

EXPLOSION ALERT

Sirs: Your July/August issue contains an article on a luau at Hana, Maui. There is one bit of information in this article that is very dangerous, concerning the selection of stones for an imu. This must be done with great care to avoid explosion of the rocks, which become almost white-hot in the high-draft hardwood fire. I have personally witnessed the explosion of a piece of smooth beach stone under conditions of much less heat. It was placed under a piece of sheet metal at the bottom of a barbecue grill, with the coals above. The force of the explosion blew a hole in the metal and wrecked the grill. It might easily have been lethal. Only porous volcanic rock of a particular type is used in the imu, and even this breaks under the stress of heat on occasion. I believe you would face a grave responsibility if anyone were tempted to try your luau directions with the wrong kind of stones.

John Bose, II
Librarian, Maui Environ.Info.Ctr.
Haiku, Hawaii

LITERARY NOTE

Sirs: Since you called Dr. Lucia's book on "Wine and Your Well-Being" to the attention of your readers (Sept./Oct. 1971, page 13, "Of Books and Wine"), I would ask that you do the same for mine. When someone purchases a bottle of wine or spirit, I tell him how to cook with it and, indeed, use it in moderation with the meal.

I would appreciate this very much as there are no books on the art of wine and spirit cooking. Enclosed is a resume so you can read that I have the background for the book. After four hard-cover editions, the book is now in paperback and is selling extremely well. The name of it is "Cooking with Wine and High Spirits," published by Cornerstone Library Inc., 630 Fifth Avenue, New York, N.Y. 10020, and it costs $1.25 in any store.

Rebecca Caruba
Wine and food consultant
Maplewood, N.J.

ANNALS OF NUTRITION

Sirs: Alligator bites are rare. A successfully treated case and courageous bacteriologic studies are reported. Basic surgical principles and anticlostridial chemoprophylaxis constitute the optimal care of patients ravaged by alligators. Here is a case report.

A 49-year-old farmer complained of having been bitten either by the devil or an alligator. From numerous versions of the event, the following facts are given credence. One hour before appearing in the emergency room, the farmer was returning home on foot from a prayer meeting in a rural island area, on a path which led through a swamp. Suddenly, to the accompaniment of hissing and scuffling on the muddy bank of the path, the patient felt his right thigh locked in the jaw of some large beast. The patient was able to extricate his leg from the apparent alligator by beating it about the head with the family Bible.

Debridement, cleansing of the wound, and open drainage resulted in a successful outcome. Psychological trauma was offset by the patient's recent attendance at the prayer meeting and a shot or two of *spiritus frumenti* en route to the emergency room.

Comment.—Lack of information about bites of alligators prompted a field trip and bacteriological study. An intrepid group journeyed to a nearby wildlife exhibit to sample the mouths of one small (4-foot) and one large (12-foot) alligator. Members of the group holding lesser academic rank were encouraged to capture and hold open the mouths of the two alligators while the more experienced members obtained bacterial cultures. The alligators were housed in an enclosed swamp, which duplicated their natural habitat.

The aerobic and anaerobic cultures from these two alligators and from typical swamp water yielded similar *Clostridium* species, enterococci, Citrobacter, and others. Omission of antibiotics in this case accompanied the announcement by the patient's relatives that the alligator was being brought to the emergency room.

From review of the medical literature, there appears no reason to believe that this type of trauma is either increasing or decreasing, nor do we know of a report of a man biting an alligator. Like Goldsmith's dog that died, the ultimate lethal effect was upon the biter, not the bitten.

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Charleston, S.C.

The foregoing dispatch on nutrition progress in historic Charleston first appeared in JAMA and is reproduced here with permission. The dramatis personae were not available for comment . . . Ed.

LEAKY FRAMEWORK

Sirs: Before inertia or other activities again overcome my impulse, I want to comment on your article "The Virtue of Theory" in NUTRITION TODAY's Jan./Feb. issue.

I was considerably impressed by your remarks for reasons which have little to do with the validity of Pauling's proposal. Your analysis was indeed trenchant, and your point about our "divine faith in proof" squarely hits the nail on the head with regard to one of our anomalies of thinking. As you well know, our scientific method can be—and is—often distorted to the point where it becomes a party line. One of the resulting anomalies is a virtual suppression of insights. If I may say so, we are inundated with facts, and our framework is leaking.

Articles such as yours are much more constructive than those which, for example, increase precision by another place to the right of the decimal point.

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