NEW GUINEA NATIVES

## More on nitrogen fixing

A prime characteristic of much of the world's malnutrition is a shortage of proteins; high-carbohydrate, low-protein diets are the affliction of much of the third world. The first step in the manufacture of amino acids, the building blocks of proteins, is nitrogen fixation, a key process in nature, perhaps second in importance only to photosynthesis. Leguminous plants, in symbiotic cooperation with nitrogen-fixing bacteria, are important producers of protein.

If it were possible for human beings to form such symbiotic relationships with bacteria, the symbiosis could be of immense importance for human nutrition. Australian scientists believe that there is evidence that certain New Guinea natives are able to accomplish it (SN: 6/27, p. 620).

Dr. F. J. Bergersen of the Australian Commonwealth Scientific and Industrial Research Organization was in Washington last week to discuss the Australian findings with U.S. Department of Agriculture scientists. The latter, although cautious, believe the discovery could be of great importance. "It certainly should be further pursued," says USDA's Dr. Charles Sloger, a plant physiologist and specialist in nitrogen fixation.

**Scientists** had observed several times in the past decade that certain sweet-potato-eating people in the New Guinea highlands were far healthier than they should be, given their high-carbohydrate diet. The natives subsist almost wholly on sweet potatoes and leafy greens, with a pig feast every two or three years the only apparent source of major protein intake. Estimates indicated the natives took only about two grams daily of nitrogen—as contrasted with the 16 to 18 grams in the usual European diet. Yet the natives are muscular and certainly not unhealthy. Their body height and growth rates are less than those of the average European, but this could be due to the high altitudes at which they live. There is little evidence of severe nutritional stress.

Several recent studies seemed to establish a negative nitrogen balance in the natives; that is, they excreted about twice as much nitrogen as they took in. The studies were performed under somewhat crude conditions in a mission hospital, and the fact that food had to be sampled on a wet rather than a dry weight basis was a possible source of error because it is difficult to determine the exact moisture content. But control work with potassium and calcium balances indicates a much smaller negative balance of these elements than that found for nitrogen; and work by Dr. Bergersen and Dr. E. H. Hipsley clearly establishes the existence of nitrogen-fixing bacteria in the guts of the natives. Dr. Bergersen is not yet prepared to say absolutely that the bacteria account for the negative nitrogen balance, but he thinks it is a reasonable hypothesis.

**Two methods** were used to establish nitrogen-fixation by bacterial cultures taken from the natives' intestines (where, incidentally, Dr. Bergersen, a specialist in nitrogen fixation, believes that anaerobic conditions are such as to be conducive to this process). So far, all nitrogen fixing bacteria discovered by man have also been able to reduce acetylene to ethylene, and acetylene reduction has become a standard test for nitrogen-fixation by bacteria. The New Guinea cultures were acetylene-reducing. The team also measured nitrogen fixation more directly with nitrogen 15; this established beyond doubt that the bacteria were nitrogen-fixing.

A provisional identification of the bacteria indicates four species involved: *Klebsiella aerogenes, K. pneumoniae, Enterobacter cloacae* and *Escherichia coli.* If the last two identifications are correct, it is the first time these species have been recognized as nitrogen fixers. *K. aerogenes* appears to be the most efficient nitrogen-fixer.

An interesting sidelight to the experiment is that the Australian researchers, working with European control subjects, discovered the nitrogen-fixing bacteria also to exist in European intestines (*E. coli*, of course, being one of the most common inhabitants of human intestines). But they exist in lower quantities than in the natives, and the hypothesis is that there is a direct correlation between the amount of protein in the diet and the numbers of the bacteria.

But if the bacteria exist in all human intestines, standing ready to begin multiplying when protein intake is low, this does not explain why in fact most human beings on a low-protein diet begin to suffer malnutrition. For example, neighbors of the sweet-potato-eating natives eat sago, a root which is high in carbohydrates just as are the sweet potatoes. But the sago-eating natives suffer from poor nutrition.

"It could be," says Dr. Bergersen, "that there is something magic about the sweet potatoes." That is, they may contain some substance that is vital to multiplication and nitrogen fixation by the bacteria.

**The source** of the nitrogen for the fixation is most probably blood plasma, in which it has long been clearly established that nitrogen from the atmosphere is dissolved in the lungs.

Dr. Bergersen concedes that a great deal more work must be done with the New Guinea natives. He and his associates are now trying to interest the International Biological Program and the Royal Society of London in supporting further research.

"The work has to be continued," he says. "If what we think happens is real, it is very, very important." □

TEST RESULTS

## Gout and achievement

Does body chemistry reflect or even shape human personality? Uric acid has been one of the most explored coefficients of this intriguing question. A recent study finds new evidence that uric acid may be a chemical signal of high achievement and suggests that cholesterol may be a signal of the reverse.

Debates about uric acid and genius have been a kind of British pastime. In his "Study of British Genius," Havelock Ellis assembled evidence that "gout is the one disease characteristically attacking great minds." A. B. Garrod, the long unacknowledged father of a field now at the leading edge of medical research—the genetic basis of many molecular diseases—showed in 1863 that gouty patients have a high level of serum uric acid.

**The dreadful pain** of gout is now known to be caused by deposit of urate crystals in the joints. Many researchers believe that primary gout is the result of an inherited flaw in the chemical machinery that breaks down the nitrogeneous base, purine, leaving an excess of uric acid in the blood serum. A building block of the nucleic acids, the materials of heredity, purine is synthesized in the body from small molecules and is ultimately, like other

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*Gout and personality: More evidence.*

nitrogen wastes, broken down and excreted in urine. But in gouty patients, the process is sometimes faulty.

**Among the famous** said to have been tortured by gout are Kublai Khan, Alexander the Great, Goethe, Francis Bacon, Isaac Newton, Thomas Sydenham (the 17th century physician whose description of the disease has been unsurpassed), Charles Darwin, and Benjamin Franklin, who brought back from Paris what is still the most specific treatment—colchicine, first found in the meadow saffron of Asia Minor, a flower like the autumn crocus.

Some other purines—caffeine for example—are thought to be mild brain stimulants, and some researchers suggest that a high blood level of uric acid may have the same effect. Man and the higher apes are the only mammals with a high serum level of uric acid. Advocates of uric acid as a correlative of genius have suggested that the superior brains of the species may be the result of a mutation that eliminated the capacity to produce the enzyme lower mammals use to convert uric acid.

In the recent study, a collaboration between workers at Yale School of Medicine and the Institute for Social Research of the University of Michigan, blood samples from 155 high school and college boys were used. The researchers used statistical techniques to correlate blood levels of uric acid and cholesterol with an abundance of data on grades, test scores, vocational aims and other matters. These were available since these males had been a part of a nationwide study of adolescent boys: "Youth in Transition," published in 1967 by J. G. Bachmen and colleagues of the institute.

**Uric acid** is positively associated with over-achievement, high grades, college entry, participation in activities and speed in completing certain aptitude tests, Drs. Stanislav V. Kasl, George W. Brooks and Willard L. Rodgers report. Uric acid shows only a very weak correlation with I.Q. scores, but some association with independent attitudes that have caused mild "troubles with the family." It is negatively associated with anxiety about taking tests.

On the other hand, a high level of blood cholesterol is positively associated with anxiety before tests, the researchers say in the Aug. 17 and 24 issues of the JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION. They suggest that "subjects with strong test anxiety are those who have high fear of failure and who will, as a consequence, avoid achievement situations."

They also find that a high level of blood cholesterol seems to cancel out the effect of high uric acid in some elements of behavior—high grades are an example. □

FOUR TO THE MOON

## Picking Apollo goals

The year after the moon landing has been an agonizing one for the National Aeronautics and Space Administration. An almost disastrous budget cut resulting in personnel losses and program alterations and the resignation of the agency's Administrator, Dr. Thomas O. Paine, added to the abort of Apollo 13, led many to doubt not only the chance of future space programs but the survival of the current one—Apollo.

There was no question that Apollo and lunar science would suffer, but no one was ready to speculate how much or in what way.

Now, following a month's review of space science options by the National Academy of Sciences (SN: 8/1, p. 93), a decision about Apollo is in the making. Dr. Paine and top officials are meeting with the Lunar and Planetary Boards and directors of Manned Space Flight to make a decision about the remaining seven Saturn 5 boosters earmarked originally for Apollo flights 14 through 20.

And it looks like the decision will be to fly only four more craft to the moon —Apollos 14, 16, 17 and 18 (with 19 still open), and do this before the launching of Skylab (SN: 7/25, p. 53). This would delay Skylab for about a year, from 1972 to 1973.

**Change** is not foreign to the much juggled Apollo program; one Apollo Saturn booster has already been earmarked for Skylab A. Before the abort of Apollo 13, and the subsequent three-month delay of Apollo 14, the schedule called for Apollos 13 through 17 to be launched before the fall of 1972; at that time three different flight crews would begin operations of Skylab. Then Apollo 18 and 19 would fly in 1974.

At a time when NASA had money and personnel to send up Apollos every two or three months, six-month intervals between lunar explorations seemed undesirable because of the effect on crews and costs. Now with budgetary and personnel cuts, NASA finds it cannot fly Apollos more frequently than at five-or-six-month intervals. A longer stretch-out in the flight schedules, however, including the year and a half to sandwich in the flight of Skylab, is too long. And Dale Myers, Associate Administrator for Manned Space Flight, and Apollo Program Director Rocco Petrone may want to avoid such a delay by flying all the Apollos before Skylab. The reasoning behind this scheduling is that lengthy intervals reduce effectiveness all the way down the Apollo line —from the astronauts to production and test crews and launch personnel. Not only is it difficult to maintain high performance levels, but costs soar.

NASA

*Myers: All Apollos before Skylab.*

High performance requires stimulus, constant drive, a consistent work load. Without these, safety of the crew becomes a major problem.

In addition to the time lag to accommodate Skylab, that project itself introduces new concepts in ground support and communications training and operations. The workshop will be in continuous operation for months, compared to the 10-day lunar flights. In addition, flying the Apollos before Skylab would allow concentration on one flight-mode at a time. The previous plan to sandwich Skylab between Apollos would now be too costly for the reduced budget.

If the decision is made to fly only four more Apollos, several alternatives are open for the use of the two remaining Saturn boosters. They range from use as another Skylab (which would be called Skylab B), as a space station, or as a booster for the nuclear rocket, NERVA, to be tested near the end of this decade (SN: 5/2, p. 440).

Also, by using Apollo 15 hardware for other purposes, the last three lunar excursions would make use of the advanced series of spacecraft which can carry heavier surface and orbital scientific payloads, as well as the 600-pound lunar rover.

**Lunar exploration** in this decade beyond Apollo 18 may utilize new concepts and technology already under study. At the recent NAS review at Woods Hole, Mass., lunar scientists recommended that Apollo 18 (or 19, depending on the decision), be followed with the cheaper unmanned probes to the moon. These could include small lunar satellites to study from orbit lunar characteristics, such as mascons, which alter gravitational effects of spacecraft.

Another possibility for later explorations of the moon would be the use of