Space Journal

Volume 2 | Number 2 Article 7

12-1-1959

A Search for the Space Man's Food

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THE FIRST MANNED FLIGHTS into Space will be of short duration, primarily designed to demonstrate successfully that a human operator can survive the extremes of acceleration, temperature, motion, and confinement, while maintaining his ability to make a sequence of correct decisions which will bring the ship safely back to Earth.

Painstakingly detailed study of this first vehicle and its one-man crew will reveal faults in construction of the ship and in the performance of the operator which can be used immediately to improve subsequent trips. Aside from the magnitude of forces involved, this excursion will resemble flights made routinely in high-performance aircraft now in use.

The crewman will be carefully selected, trained, and briefed. He will carry along a sufficient quantity of liquid oxygen to suffice for the projected length of the trip with a safety factor which will be adjusted to the best use of space and weight. A little water will be necessary to replace losses normal to the cabin environment of his Space ship.

Food during these first experimental flights will be carried along in small amounts or not at all. If food is included it will be used either for quick stimulation or for its psychological value, perhaps in combination with drugs, and certainly highly correlated with the personal desires of the crewman. This can be assumed from the fact that studies of nutritional patterns of human subjects under great stress more than suggests that the degree of emphasis on food decreases as the situation becomes more strenuous. Thus the immediate results of increasing the length of an excursion into Space will be to increase in proportion the demand for oxygen, water, and ultimately food.

While variety is not a factor in the provision of oxygen and water, it is an important one with food. The simplest diet may suffice for the shorter flights; but, in contrast, longer flights will quickly generate the desire for variety in the menu of the Space man.

For journeys of more than a few days, some method of preservation will be used to maintain the food supply in a safe and edible condition for the required length of time. With this in mind, all the common methods of preservation have been suggested and each has its merits. For example, precooked frozen foods would serve best on short and intermediate range flights where low temperatures could be maintained in insulated storage without mechanical refrigeration.

If the food supply were loaded into the Space vehicle at —200°F., the food itself would provide refrigeration sufficient to allow operation for a few days or even a few weeks —the exact time depending on the effective use of insulation. It is apparent that due payment must be made for the privilege of carrying foods at this low temperature in terms of a high energy requirement for thawing prior to use. This might still be an attractive method if the crewman agrees that the quality of his food is significantly better than that provided by other methods. Also, if cabin cooling is a problem, the food at very low temperatures would act as a heat sink for cabin temperature control.

Canned foods are recommended by their rugged stability but, in this case, not by their high water content nor the necessity for heavy metal containers.

Dehydrated foods have been suggested for use in Space vehicles with the idea that their low moisture content makes them an especially efficient cargo.

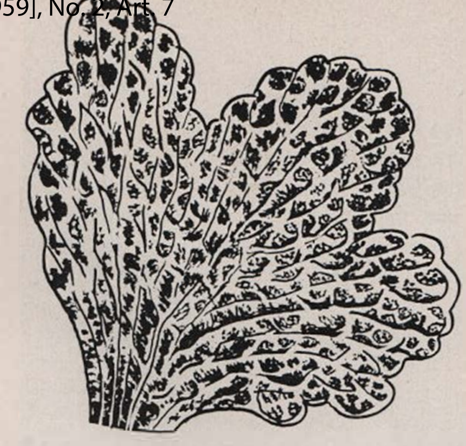
If water within the ship is not recycled, there appears to be no advantage of any kind in choosing dehydrated foods as any significant part of the Space crew menu. Since the water requirement of a man is practically the same whether he drinks his water or takes it in combination with one or another food, the absence of water in his dehydrated food would only dictate the presence of an equivalent amount in liquid form. Result: the net gain in weight conservation would be almost nothing.

The simplest recycling process is designed for the reuse of water through the activity of an ion-exchanger or by means of distillation processes. Operated efficiently this cycle would reduce water requirements to that amount needed by the Space man during the time necessary for recycling a roughly equal amount. With this change, the use of dehydrated foods becomes a much more prominent possibility. Apart from this advantage however, the burden of equipment for dehydration of dehydrated foods remains.

Closed-cycle feeding of crewmen in Space trips is usually constructed from two important components: a Space crewman and a microbiological regeneration system. The Space crewman is usually visualized as a less-than-average size man weighing between 100 and 140 pounds. A small man is chosen for the obvious reason that economy of both space and weight are, at least for the present, highly essential in the design and operation of Space craft. Only as soon as fuel-weight ratios are reduced will it be possible to contemplate large Space crews either individually or collectively.

The reasons for including a man at all in the Space craft have been critically reviewed by many authors. For our purposes, it is sufficient to conclude that he is most needed for control, through human judgement, of Space voyage situations which cannot be reliably predicted and therefore cannot be fully mechanized. Also, he weighs less than most computers of roughly equal ability.

But he must have daily about 1 ½ pounds of oxygen, five pounds of water, and a pound of food (dry weight). However, in the course of a small number of hours he returns to the system all of the water taken in—about five pounds—plus 11 ounces (330 grams) of metabolic water. And, too, all of the oxygen is returned as carbon dioxide along with four ounces (125 grams) of carbon dioxide pro-

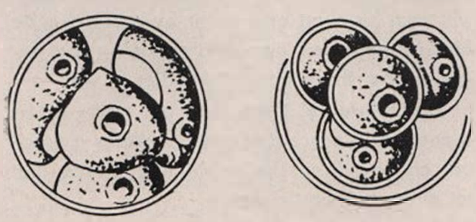


Lichens would require less water . . .

duced from the breakdown of foods. This leaves a remainder of approximately 1 ½ ounces (45 grams) of dry solids which are returned to the system each day.

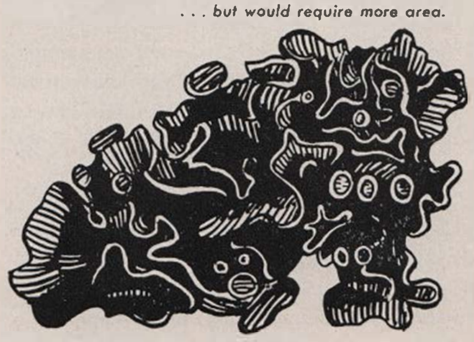
While this gives the overall picture on a short term basis, it is clear that the growth of hair, nails, and skin would have to be taken into account at least in excursions of very long duration.

The microbiological regeneration system has already received many names and many identities, but all descriptions contain a plant which functions to produce oxygen from human wastes. The algae are usually preferred for this task since they are, by comparison with higher plants, of uncomplicated structure. Essentially, the alga functions entirely photosynthetically while higher plants have roots, stalks, blossoms, bark, and a complicated vascular system which may play no part at all in photosynthesis. This complication in structure seems, in some way, to be related to their possible use as human food. Observe, for instance, that we eat leaves, roots, stalks, blossoms, and even the bark of some of the higher plants while, with a few exceptions, the algae and other lower green plants are not as often used for food.



One of 40,000 kinds of Algae.

. . . but would require more area.



The advantage of photosynthetic efficiency of the algae is partly reversed by their requirements for large amounts of water to grow in and their lack of direct acceptability as human food. And it is these attributes which lead the designer of a closed-cycle feeding system to consider any one of a number of combinations of plants and animals to perform the combined functions of supplying oxygen, water, and food while existing entirely on a diet of human wastes.

The closed-cycle concept is almost invariably applied to long Space excursions which will take months or years. This is the direct result of a host of known and expected inefficiencies in the cycling operation. Ultimately, however, we should look forward to a closed-cycle system of high enough efficiency to compete with conventional feeding methods, even during short Space excursions.

What might be the requirements of such an idea system? How would it look and how would it function under the stresses of actual Space flight?

To house the system we should construct a cabin with a total volume of less than 50 cubic feet. The cabin will have a cylindrical shape in early models to maximize the efficient use of space in a vehicle of similar design.

The cabin will be completely sealed 48 hours prior to launching and rigorously checked and adjusted. Twelve hours later the Space man will be placed in a cabin simulator where the oxygen level built up to 50 percent to match that of the vehicle. Simultaneously the pressure will be reduced to half an atmosphere. Then, two hours before launching, the crewman and his immediate gear will be transferred through a pressure-lock to the cabin of the vehicle.

Lying prone on a contour bed he will have in his field of vision all of the instruments and controls with which he will work throughout the trip. He will also be in television contact with control operations informing him of the progress of preparations.

Finally the count down will start, the vehicle will rise slowly at first and then the traveler will zoom off into space.

After a brief blackout the crewman will regain consciousness and begin monitoring the vehicle's progress.

The oxygen he has consumed will be replaced by more supplied by an efficient light-weight bio-converter. This converter should weigh about 40 pounds and be built of light-weight plastic containing a radioactive isotope and a luminescent chemical which causes the inside of the converter tubes to glow brightly. Inside the tubes will be a dark-green mixture containing approximately 50 percent algal cells in water, under two atmospheres of pressure, being circulated very turbulently through the lighted tubes. At the intake end will be a regulating device which raises or lowers the oxygen output of the system to match the needs of the crewman while he is resting or working.

Solid and liquid human wastes will go directly to an incinerator-still combination which will first boil off the water through a condenser and an ion-exchange column to maintain a constant supply of pure water. The remaining dry substance will be automatically heated to higher temperatures and broken down into carbon dioxide, nitrogen, and water—all of which will be fed directly to the bio-converter. Under pressure, the carbon dioxide will dissolve in the converter fluid where it will be reconverted to oxygen.

The mineral salts remaining after the destructive distillation of the human wastes will be dissolved in water and metered into the bio-converter to complete the carbon dioxide-mineral salts diet of the oxygen exchange algae.

At another place in the converter a portion of the converter fluid will be drawn off, cooked thoroughly at a high temperature and pressure and partly dewatered. To this concentrate there will be automatically added a minute amount of flavoring material to make the algal soup palatable to the crewman.

Following a timed schedule, the crewman will take his food and water by a mouth-tube and in measured amounts, changing the flavor but not the texture of his diet at will.

The return to Earth will be followed by a debriefing procedure which includes a gradual change from the semi-liquid Space diet to a normal Earth diet.

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