light-control means of the two experiments do not differ, both the "conditioning" mean and the O_2 control mean in the Grabowski experiment are significantly lower ($p < .01$) than the corresponding means of our experiment. Although there was no significant difference between the O_2 control and the conditioning mean in the Grabowski experiment, both of these differed significantly ($p < .01$) from the light-control mean.

These comparisons demonstrate clearly that it was not possible to replicate the findings of Grabowski, except with respect to the proportion of time spent by the paramecia in the light in the light-control condition. Contrary to the results of Grabowski, neither conditioning the paramecia nor conditioning the water in our experiment produced any modification in the tendency of the animals to spend roughly equal amounts of time in the dark and light.

Some incidental observations made during the "conditioning" procedure may help to account for the difference in results. When the well was being differentially heated and cooled, a powerful convection current invariably accompanied the gradient in temperature—a current so powerful, in fact, that it often appeared to sweep an animal into the heated side of the well. The presence of the convection current under the conditions of our experiment would seem to rule out the possibility of there being an appreciable difference in oxygen concentration between the two sides of the 17 mm well in either the "conditioning" or the light-control situations. This is consistent with the finding of no significant difference among conditions in our experiment. If it is assumed that Grabowski was somehow able to avoid the presence of the convection current in his smaller 10 mm well (he makes no mention of convection), then the results of our study may be interpreted as supporting Grabowski's interpretation of the response modification of the paramecium in terms of environmental modification.

The results of our study and of those of Grabowski and of Jensen indicate that there has been no unequivocal demonstration of conditioning in paramecia, in either the food-approach or the heat-avoidance situations. Apparently, whenever the "learning" situation has been arranged so as to preclude the possibility of permanent or relatively permanent changes in the environment of the paramecium, then subsequent behavioral modifications have not been observed.

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7 February 1958

Fall of the Sputnik I Rocket

There has been considerable interest in the matter of determining the probable point of impact of artificial satellites (*1*). We are conducting a study of the behavior of satellites as they reenter the atmosphere during the final phase of their lifetimes, and in this connection we have examined the data on satellite 1957 Alpha 1, the carrier rocket which accompanied Sputnik I.

Our calculations lead us to the conclusion that 1957 Alpha 1 fell on 1 December 1957 at 0846 G.M.T., approximately 8 hours after the last radar observation made on it in the United States. We place the probable point of impact at latitude 45°N, longitude 106°E, in Outer Mongolia. The result of our investigation is shown in Fig. 1, which represents the trajectory of 1957 Alpha 1 during its final pass over the Northern Hemisphere. The probable impact point is marked by a circle in Fig. 1, and the uncertainty in the impact point by heavy lines to either side of this circle.

The analysis is based on several observations of the altitude of the satellite during the last five days of its lifetime. These altitudes were deduced from radar observations of 1957 Alpha 1 obtained by: (i) the Lincoln Laboratory (*2*) on 27 November at 2153 G.M.T., 29 November at 2137 G.M.T., and 30 November at 1944 G.M.T. and 2114 G.M.T.; (ii) the Stanford Research Institute (*3*) on 1 December at 0011 G.M.T.; and (iii) the staff of the Royal Radar Establishment (RRE) (*4*) at Malvern, England, on 1 December at 0828 G.M.T.

The altitudes obtained from these radar sightings are indicated in Fig. 2. Figure 2 also shows the calculated altitudes, determined by us from a numerical integration of the satellite equations of motion, starting with orbital data provided by the Smithsonian Astrophysical Observatory for the date of 11 November 1957. The calculated altitudes in Fig. 2 are seen to be in good agreement with the observed altitudes for all passes.

The penultimate measurement shown in Fig. 2 was taken on the Stanford radar during the final pass of the satellite over the United States. The last datum in Fig. 2 is that of the RRE radar at Malvern, obtained, as already noted, at 0828 G.M.T. It is interesting to note that even if both of these data are omitted, the comparison of the remaining observations with our calculated altitudes indicates that the satellite could not have fallen during its last pass over the continental United States, nor in fact for several passes thereafter. For if we assume the last pass in the lifetime of the satellite to be that in which it crossed the western United States, the calculated altitudes then fall on the dashed curve of Fig. 2. The differences between this curve and the data are well outside the probable errors for the observations. In our view, Fig. 2 provides conclusive evidence that the satellite continued on for approximately 8 hours beyond the pass over the west coast of the United States.

The last datum point in Fig. 2 is an altitude of 71 miles, obtained by the RRE radar. This observation is critical for the unambiguous determination of the impact point. An altitude as low as 71 miles indicates that at the time of the passage over Malvern the rocket had entered on the final dive of its reentry into the atmosphere. The detailed numerical integrations then indicate that the rocket continued on past Malvern for 64° in the plane of the orbit before striking the earth. This figure of 64° is subject to an uncertainty of ± 15°, corresponding to the probable error in the altitude of the RRE observations, and

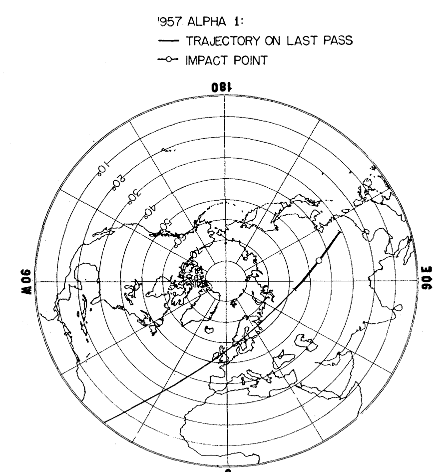

Fig. 1. Polar projection of the Northern Hemisphere showing the trajectory of satellite 1957 Alpha 1 during its final pass. The calculated impact point is indicated by a circle at latitude 45°N, longitude 106°E. The probable error in the impact point due to uncertainties in (i) the altitude over Malvern, England, and (ii) the drag coefficient is indicated with heavy lines to either side of this circle.

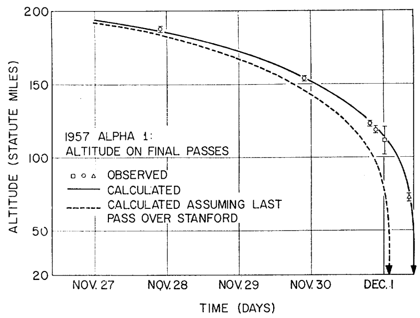

Fig. 2. Comparison of observed and calculated altitudes during the final days of satellite 1957 Alpha 1: ○, Lincoln Laboratory; □, Stanford Research Institute; △, Royal Radar Establishment (Malvern, England). The solid curve indicates the calculated altitudes. The dashed curve represents the calculated altitudes on the assumption that the satellite fell during its last pass over the United States.

to an uncertainty of ±15°, corresponding to an assumed variation in the drag coefficient by a factor of 2. The combined uncertainty is shown by the heavy line in Fig. 1, as mentioned above.

In the final phase of the reentry the rocket probably disintegrated into elements of differing drag coefficient, whose impacts would be strewn over an arc length of the satellite trajectory approximately equal to the uncertainty in impact shown in Fig. 1.

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B-Complex Vitamins in Certain Brown and Red Algae

With the world population continually expanding at a rapid rate, it has been predicted that future generations may have to depend more and more, for food, upon products from the sea (*1*). Such products include the algae, which are found in great abundance in many areas and about the nutritional value of which with respect to B vitamins, except for a small number of reports on some of the water-soluble factors in certain species (*2*) comparatively little is known. In this report (*3*) are presented the results of an investigation of the B-vitamin content of certain red and brown algae.

The plants analyzed were *Fucus spiralis, Ascophyllum nodosum, Laminaria agardhi,* and *Chondrus crispus.* They were taken from the coast line of New Hampshire and of York, Maine, through the months of October and November 1956. The algae were dried in a large, forced-hot-air dryer, at not over 85°C, and were then ground in a Wiley mill before analysis.

Analyses for the various vitamins were carried out by microbiological procedures (*4*); *Lactobacillus arabinosus* 17-5 (ATCC 8014) was used for niacin, pantothenic acid, and biotin; *Lactobacillus casei* (ATCC 7469), for riboflavin; *Streptococcus fecalis* (ATCC 8043), for folic acid; *Lactobacillus fermenti* 36 (ATCC 9833), for thiamine; and *Lactobacillus leichmannii* (ATCC 7830), for vitamin B_{12}.

The average results of the vitamin-content analyses are presented in Table 1. The four algae gave rather high results for niacin content when compared to many vegetables, fruits, and animal feeds. However, even the species containing the greatest amount of niacin, *Chondrus crispus,* contains considerably less than the 60 or more micrograms per gram found in barley and wheat. It can be concluded that these algae are a moderately good source of niacin. While all four of the algae studied are rich sources of pantothenic acid, the red alga *C. crispus* contains much more of the vitamin than do the three brown algae. This same relationship holds also for riboflavin and, to a lesser extent, for thiamine and vitamin B_{12}, indicating perhaps that in general the red algae are superior to the brown as a source of B vitamins.

In addition to being a good source of niacin and pantothenic acid, the algae are apparently a relatively good source of riboflavin and folic acid and a fair source of biotin and vitamin B_{12}. They are comparable with many fruits and vegetables as a source of thiamine.

It may be concluded, therefore, that the algae constitute an important potential source of certain water-soluble vitamins for animal, or human, consumption. Of the species studied, this is particularly true for the red alga *Chondrus crispus.*

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10 February 1958

Table 1. Average vitamin content (in micrograms per gram) of various species of algae. The average results were figured from three to seven determinations.

Vitamin	*Fucus spiralis*	*Ascophyllum nodosum*	*Laminaria agardhi*	*Chondrus crispus*
Niacin	22.8	14.6	30.2	31.8
Pantothenic acid	23.0	49.4	33.0	150.0
Biotin	0.063	0.021	0.042	0.032
Riboflavin	10.0	3.50	12.6	25.0
Folic acid	1.91	1.50	10.00	9.50
Thiamine	0.40	0.23	0.46	0.83
Vitamin B_{12}	0.080	0.096	0.052	0.312

Chemical Induction of Male Sterility in Inbred Maize by Use of Gibberellins

The effects of gibberellin on flowering of inbred maize were studied during the winter of 1957. Unexpectedly, plants sprayed with relatively high concentrations (500 to 1000 parts per million) of gibberellic acid developed sterile or partially sterile tassels. Possibilities of chemical induction of male sterility in maize by means of gibberellin were thus suggested.

The following summer this phenomenon was further investigated under field conditions. A relatively early-flowering inbred line, R53, was planted on 1 June and 1 July, and a relatively late-flowering inbred line, OH51, was planted on 1 June and 8 July. Potassium gibberellate (*1*) in concentrations of 100, 1000, 2000, and 2500 parts per million, and a wetting agent (Tween 20 at 0.1 percent) were used as a foliar spray. The estimated amount of gibberellin per plant ranged from 1.0 to 10 mg for the 1 June plantings and from 12 to 35 mg for the two later plantings. Approximately 40, 55, and 90 plants per treatment were sprayed and scored for the 1 June, 8 July, and 1 July plantings, respectively.

The critical stage of plant development for the most effective chemical induction of male sterility appeared to be when the immature male inflorescence (immature tassel) was approximately 1 in. in length. Plants were defoliated (with