EFFECTS OF GAMMA RADIATION ON LICHENS
AND LICHEN-FORMING FUNGI AND ALGAE

Progress Report -

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Summary

Xanthoria polycarpa apothecia have been collected from Site 1 of the Enterprise Radiation Forest, fixed, sectioned, and stained for a study of ascus and ascospore development. The study will be completed later this year.

Four years of data compiled on the effects of chronic gamma radiation on two species of Parmelia are now being analyzed and correlated. Up to this time most of the analysis has been with P. sulcata.

Evidence from Cladonia sylvatica acute radiation studies indicated that radiation damage (macro- and microscopic and physiological) was not manifested until the lichens passed through a period suitable for growth. An experiment has been set up to determine if the growth period is responsible for the change observed. Irradiated (1000krad) and non-irradiated podetia were placed in the field and others placed in a growth chamber. Those podetia in the growth chamber will not go through a growth period while those in the field will. Comparisons of these podetia is going on monthly in regard to: photosynthesis-¹⁴CO₂ uptake, respiration, usnic acid concentrations, podetial strength, and cytological changes. Although several months data have been collected no conclusion can be drawn yet.

During the past year the principal investigator spent 100% of the summer and 10% of the academic year on the project. Two graduate students have spent 75% of their time on the project through June, 1974.

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During the past year three different areas of research were carried out. These research areas include: (1) ascus and ascospore development of Xanthoria polycarpa irradiated at Site 1 in the Enterprise Radiation Forest; (2) effects of gamma radiation on two species of Parmelia, P. sulcata and P. olivacea; (3) effects of gamma radiation on Cladonia sylvatica. Each of these studies will be discussed below.

Xanthoria. Apothecia of X. polycarpa was collected, fixed, paraffin embedded and sectioned (Erbisch, 1969) during the past year. The material was obtained from that irradiated in Site 1 of the Enterprise Radiation Forest. The sectioned apothecia have not been examined as yet, but will be in the near future.

Originally it had been purposed to study lichens at Site 2 in the Forest; however, since Site 2 was not irradiated, it was impossible to carry out the original plan. The materials from Site 1 still should show some evidence of radiation damage.

Parmelia. Study of the Parmelia species at Site 1 of the Enterprise Radiation Forest has continued (Erbisch, 1974). Bark temperature readings from three years have been transferred to computer cards and this temperature data will be correlated with radiation damage. Growth analysis has also continued and four years of growth data has been placed on computer cards for further analysis.

Growth patterns noted during the past year correlate with that of previous years. However, this fall some lichens which had not grown for two years, but had retained their natural color, had numerous, small thalline outgrowths. This spring, 1975, materials will be collected and analyzed to see if these outgrowths have the potential to re-establish the lichens.

Data from two species of Parmelia, P. sulcata and P. olivacea, will be compared (Thus far the study has concentrated on P. sulcata) to determine if radiation tolerance varies between species.

Cladonia. Two master's theses were completed this past spring that dealt with effects of acute gamma radiation on usnic acid content (Funky, 1974) and photosynthesis (Barstow, 1974). As stated in an earlier report (Erbisch, 1974) gamma radiation has no direct effect on usnic acid, but that the usnic acid level did change when irradiated lichens passed through a period suitable for growth. Radiation did have a direct effect on photosynthesis because it decreased markedly after radiation. It was also shown that photosynthesis could go on at decreased levels under deep snow. In both studies, lichens manifested macroscopic damage after the lichens went through a period suitable for growth.

It appeared that lichens which were irradiated and kept in conditions not suitable for growth would not manifest radiation damage, usnic acid levels would remain normal, and respiration would continue at a steady state (Erbisch & Kalosis, 1973) but, if the irradiated lichens were subjected to a suitable environment, changes in all these areas would be evidenced. In order to see if this were true, an experiment was set-up in which irradiated lichens (1000krad) were either placed in a growth chamber (conditions not suitable for growth) or in the field. Field and growth chamber, irradiated and non-irradiated podetia are collected each month and examined macroscopically; and for usnic acid content, respiration rate, photosynthesis rate, and cytological changes. Four months of measurements have been made in each of these areas; however, no analysis of the data has been attempted at this point. At least six months additional data will be collected before the data is analyzed.

Many times when handling irradiated Cladonia podetia it was noted that they broke easier than non-irradiated ones. However, there was no way to obtain accurate quantitative measurements of podetial strength to determine if there was a significant difference between irradiated and control lichen. Dr. John Ligon of the Mechanical Engineering Department at Michigan Technological University was consulted and he was

able to design and build a simple machine for podetial strength measurement. The device, which was completed approximately two months ago, consists of an open magnesium ring with two opposing strain gauges attached to the ring. The strain gauges must be connected to a strain indicator which then indicates any electrical change between the two gauges. To use the device first two small hooks are glued, one to each end, of a podetium; then the lichen is attached with the upper hook to one end of the magnesium ring and a thread attached to the lower hook; the thread is pulled until the podetium breaks, but while pulling on the podetium the magnesium ring is opening causing the strain indicator needle to be deflected. The deflected needle is read at the moment the podetium breaks and later this value is converted to grams. Eventually the data obtained will be converted into tensile strength units, but more data in regard to podetial cross sectional area, etc. must be obtained. Several hundred non-irradiated podetia were broken on the device before it was decided that reproducible results were obtainable. The preliminary results of a comparison of irradiated versus non-irradiated podetia are given in Table I. It is felt that this device will become an important tool in helping to evaluate the radiation damage of irradiated lichens; because strength differences are apparent before macroscopic differences. This test has been incorporated into the experiment which was described earlier and the data will be used in correlation with that obtained with the other tests, i.e., photosynthesis, respiration, usnic acid concentration, etc.

TABLE 1. Preliminary strain data from irradiated and non-irradiated Cladonia sylvatica podetia. Data given as grams needed to break a podetium.

A = non-irradiated podetia, obtained from the field

B = irradiated podetia, obtained from the field

C = non-irradiated podetia, kept in growth chamber for three months

D = irradiated podetia, kept in growth chamber for three months

	A	B	C	D
	53.8	13.5	22.8	13.5
	54.9	14.8	28.2	28.2
	50.3	16.0	23.9	19.3
	64.0	14.2	30.5	12.5
	67.1	18.1	12.5	29.0
	65.0	30.1	26.1	44.7
		14.2	25.3	22.0
			33.4	21.1
				39.0
mean	59.2	17.3	25.3	25.5

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