Leaves of cabbage, broccoli, and tomato plants grown in the greenhouse were used as plant material. The tryptophane was supplied to intact leaves through the petioles, which were dipped into the solution. Nicotinic acid was determined by the microbiological method using *Lactobacillus arabinosus* as the test organism. The procedure as outlined in *Methods of vitamin assay* (*1*) was followed. The time allowed for synthesis to take place was usually about 48 hr, though longer and shorter periods were also used. Three days were too long, as the leaves wilted and the plants were not at their best; and usually more vitamin was obtained in two days than in one. Concentrations of DL-tryptophane ranged from 0.025 to 0.10 % L-tryptophane. These concentrations may seem a little high but since the experiments cannot be run very long it has seemed best to have high concentrations and get a high rate of nicotinic acid synthesis. No attempts have been made to study the relation between concentration of tryptophane and concentration of nicotinic acid obtained. Table 1 gives the results of these experiments.

TABLE 1

SYNTHESIS OF NICOTINIC ACID BY GREEN PLANTS FROM TRYPTOPHANE*

Plant	Time in hr	Concentration of tryptophane in %			
		0	0.025	0.05	0.10
Broccoli ..	26	9.22		9.35	9.92
	47	8.18		8.53	
Cabbage ..	70	8.25	9.73	9.92	
	98	7.52	7.98		
	43	6.94		7.49	7.20
	47	6.65	8.25	7.81	7.43
Tomato ...	48	5.14	6.08		
	22	4.44	4.69		
	24	5.81	5.70	6.86	
	47	5.05	6.18	5.99	
	25	5.46	6.35	6.70	
	40	6.36	7.40	8.64	
	48	6.57	6.62	6.80	
	71	6.04			7.10
	48	5.18	6.12	7.60	7.64
	47	4.40	5.70	5.63	
	48	4.75	5.35	5.90	
	48	3.62		4.56	5.10

* The figures denote μg of vitamin/g of fresh plant material.

TABLE 2

SYNTHESIS OF NICOTINIC ACID FROM TRYPTOPHANE BY GREEN PLANTS IN DARK AND IN LIGHT*

Plant	Concentration of tryptophane in %					
	in light			in dark		
	0	0.05	0.10	0	0.05	0.10
Tomato ..	3.64	4.56	5.10	3.26	3.93	4.71
	4.98	5.72	6.72	4.47	4.93	6.32
	6.07	6.67	6.83	4.65	5.06	5.76
Cabbage ..	6.94	7.49	7.20	6.25	6.69	6.96

* Figures denote μg of vitamin/g of fresh material.

While only a few experiments were done with broccoli and cabbage and there is not a constant increase in nicotinic acid assayed with increase in concentration of tryptophane supplied to the plants, there is, nevertheless, no doubt that the three plants used have synthesized nicotinic acid from tryptophane, which is all that the writer is attempting to show. The variation in amount of vitamin in different experiments is due, as has been pointed out (*4*), to differences in age of leaves used.

Another observation, which has nothing to do directly with nicotinic acid, should be recorded. When 4–5-in. tips of tomato plants with their young leaves were put in higher concentrations of tryptophane, the young immature leaves showed unmistakable signs of response to growth hormones. They curled up much as they would if the stem had been supplied with indoleacetic or butyric acid. They had evidently synthesized a growth hormone from tryptophane. This has been shown before but only under special circumstances.

The writer has previously shown (*5*) that light influences the synthesis of thiamin and riboflavin by green plants, and unpublished data indicate this may be true also for nicotinic acid. Experiments were therefore set up in dark and in light. Table 2 presents the findings.

Evidently light is not a factor in this synthesis. Recently Bonner (*3*) has outlined a scheme for the synthesis of nicotinic acid from anthranilic acid. He does not, however, state how anthranilic acid might be formed from the products of photosynthesis.

References

1. ASSOCIATION OF VITAMIN CHEMISTS, INC. *Methods of vitamin assay.* New York: Interscience, 1947.
2. BEADLE, G. W., MITCHELL, H. K., and NYC, J. F. *Proc. nat. Acad. Sci. Wash.*, 1947, **33**, 155.
3. BONNER, DAVID. *Proc. nat. Acad. Sci. Wash.*, 1948, **34**, 5.
4. GUSTAFSON, F. G. *Plant Physiol.*, 1947, **22**, 620.
5. ———. *Plant Physiol.*, 1948, **23**, 373.
6. LING, C. T., HEGSTED, D. M., and STARE, F. J. *J. biol. Chem.*, 1948, **174**, 803.
7. NASON, ALVIN. *Science*, 1949, **109**, 170.
8. ROSEN, F., HUFF, J. W., and PERLZWEIG, W. A. *J. biol. Chem.*, 1946, **163**, 343.
9. SCHWEIGERT, B. S., and PEARSON, P. B. *J. biol. Chem.*, 1947, **168**, 555.

Relation of Sporadic E Reflection and Meteoric Ionization

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One of the purposes of the radio-meteor research program at the Central Radio Propagation Laboratory of the National Bureau of Standards is to determine to what extent meteoric ionization may be responsible for sporadic E reflections from the ionosphere. Various investigators (*1, 3, 4*) have proposed that sporadic E reflections are caused by ionization produced in the atmosphere by meteors. Observations made up to the present time at this laboratory fail to support this view.

Since radio-meteor observations were begun at this laboratory (*2*) special equipment for the purpose has been constructed and placed in regular operation. It consists of two transmitters and receivers operating on 27.2 and 40.98 mc/s emitting pulses with a peak power of 10 kw. Reflections of the pulses by meteor trails are displayed on a cathode-ray oscilloscope and simultaneously recorded on two recording milliammeters. The emitted pulses are approximately 50 microseconds in width and the pulse repetition rate is 60/sec. Duration of the sweep is adjustable to a maximum of 4 milliseconds. The antennas are half-wave horizontal dipoles spaced a quarter wavelength aboveground, thus directing the radiation predominantly upward in accordance with the well-known pattern of these antennas. Separate but similar antennas are used for emitting and receiving.

Multifrequency ionospheric records are obtained continuously at the Sterling, Virginia, station where the meteor equipment is installed. Sweeps over the frequency range 1–25 mc/s are made regularly every 15 min. The multifrequency transmitter's pulse width, pulse repetition rate, and peak power output to the antenna (but not necessarily its radiation therefrom) are approximately the same as for the meteor equipment. The antenna is a modified rhombic, oriented so that the main lobe is directed upward. Although no direct measurements of the antenna pattern have been made, it is known that the directivity of the antenna and its radiation efficiency change with frequency. At the lower frequencies this effect reduces the power radiated in the desired direction. Strong interference is encountered from other broadcasting stations in the frequency range between 1 and 2 mc/s. Because of this interference and the relatively poor radiation efficiency at these frequencies the receiver, which is not sharply tuned, often does not obtain reflections even from the normal ionosphere layers at the lower frequencies. The time required to sweep over the frequency range 1–25 mc/s was 15 sec during these observations.

On numerous occasions, the operation of the multifrequency ionospheric equipment has been visually observed while meteors were being recorded with the regular radiometeor equipment. In general, no relation was observed between the occurrence of sporadic E reflections on the multifrequency equipment and reflections from meteor trails on the other apparatus. On certain occasions, however, records of reflections from the multifrequency equipment have been obtained coincident in time and range with reflections received on the meteor equipment and also, in some cases, with visually observed meteors. These reflections resemble sporadic E reflections, and could be so interpreted, although distinct differences between the two types of records can be seen.

An excellent illustration of these differences was obtained during the November 1948 Leonid meteor shower. The meteor equipment was in operation on both frequencies.

On the morning of November 15, 1948, at 0056 eastern standard time, a high intensity meteoric reflection was visually observed on the monitor oscilloscope, simultaneously on both frequencies at a distance of 125 km, continuing for 4 min on the lower frequency and for 2 min on the higher frequency. At 0058 eastern standard time, the multifrequency equipment was turned on manually and showed, in addition to the regular F2 reflections, regular sporadic E reflections at a virtual height of 100 km which had been prevalent all night, and also another reflection at a virtual height of 125 km, which extended to a somewhat higher frequency. The appearance of this 125-km reflection, coincident with echoes seen at the same range on the meteor-recording equipment, seems to be sufficient evidence that what appeared as a layer at a height of 125 km was indeed the ionized trail of a meteor. These reflections varied considerably in intensity. It is to be noted that the echoes had already disappeared on 40.98 megacycles and were beginning to fade rapidly on 27.2 megacycles at the time the regular ionosphere recorder was turned on. Approximately 2 min later the ionosphere recorder came on automatically, making two consecutive sweeps, both of which showed sporadic E reflections at 100 km but neither of which showed the 125-km reflection which appeared earlier. A previous sweep, made at 0045 eastern standard time, showed faint sporadic E reflections at 100 km but nothing at 125 km.

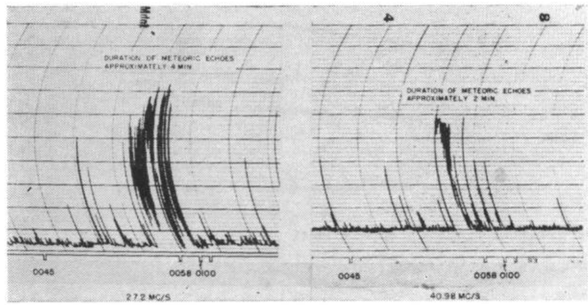

FIG. 1. Meteor record November 15, 1948.

Fig. 1 shows portions of the traces from the recording milliammeters on the two operating frequencies on which the record of the meteor appears. The pips on the lower margins are placed there automatically whenever the multifrequency ionosphere recorder is turned on. Fig. 2 is a reproduction of the photographic record made by the multifrequency equipment, (A) at 0045 eastern standard time, (B) at 0058 eastern standard time, showing the 125-km reflection attributed to the meteor trail just above sporadic E reflections from 100 km, and (C) at 0100 eastern standard time, at which time the 125-km reflection had almost entirely disappeared, although the sporadic E reflections were still present with considerable strength.

The meteoric reflection appearing in the E region of Fig. 2B resembles a sporadic E reflection in that there is no characteristic cusp indicating a critical frequency. However, comparison of this trace with that produced by the true sporadic E reflection shown in Figs. 2B and 2C shows that the meteoric reflections, though weaker, are also more sharply and clearly defined than the sporadic E reflections. The discontinuous character of the reflections, as a function of frequency, from the meteor

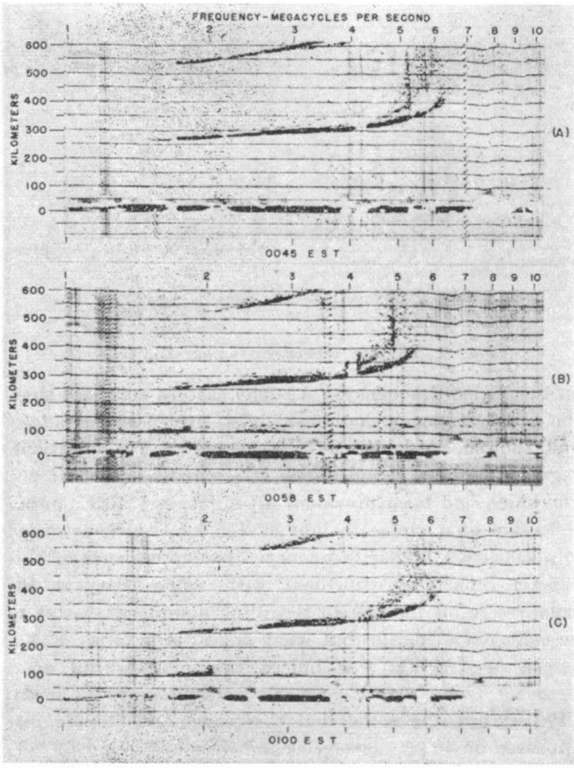

FIG. 2. Ionosphere recordings at Sterling, Virginia, on Nov. 15, 1948, showing sporadic E reflections at 100 km, and reflection from meteor trail (in B) at 125 km.

trail and the absence of reflections at lower frequencies are attributed to variations in antenna radiation with frequency previously described. It is presumed that in the absence of this and similar difficulties inherent in operation of automatic multifrequency equipment, reflections from the meteor trail would have been obtained even at the lowest frequency.

Since November 15, reflections on the multifrequency equipment produced by meteors have been frequently observed, often at times when true sporadic E reflections were entirely absent, as evidenced by continuous sweeps of the multifrequency recorder covering the period prior to the appearance of reflections on the meteor equipment and carried on through until their disappearance. Records obtained on the night of December 12, 1948, are shown in Fig. 3. In this case true sporadic E reflections were obtained from a height of 100 km and a meteoric reflection shown in Fig. 3B at approximately 80 km. The records of Fig. 4 were made on December 13, 1948, at a time when no sporadic E was present. In both cases the multifrequency equipment was turned on by the operator at the appearance of strong reflections on the meteor equipment. In both cases the reflections attributed to the meteors were from an apparent height agreeing with the range observed for the meteors.

An examination of the photographs of Fig. 3 reveals several interesting characteristics of meteoric reflections in comparison with those from sporadic E. The sharp definition of the meteor trace previously mentioned is again demonstrated. Also noticeable is the fact that the sporadic E reflections begin to appear at a lower frequency than those from the meteor. This effect is probably due to the radiation pattern of the antenna used with the multifrequency equipment previously described and the comparatively small target area presented by the meteor trail. Another feature of Fig. 3B is the appearance of two M reflections. At the frequency of 3 mc/s, used as a convenient reference abscissa, one sees a reflection at 375 km, which corresponds to the M reflection involving the sporadic E reflection as seen in Fig. 3A at about 100 km, and another at 415 km, which is attributed to the meteor.

In this second case the simple relationship, 2F minus height of meteor, would indicate a height of only 55 km for a meteor directly overhead. The implication is that the meteor was to one side of the observing location at a slant range equal to the 80-km direct reflection but at a somewhat lower true height. In this case the simple relationship, 2F minus height of meteor, does not yield the apparent height of the M reflection involving the meteor trail, indicating that the meteor reflections were not from a point directly overhead, and that the true height of the meteor was somewhat less than indicated by the direct reflection.

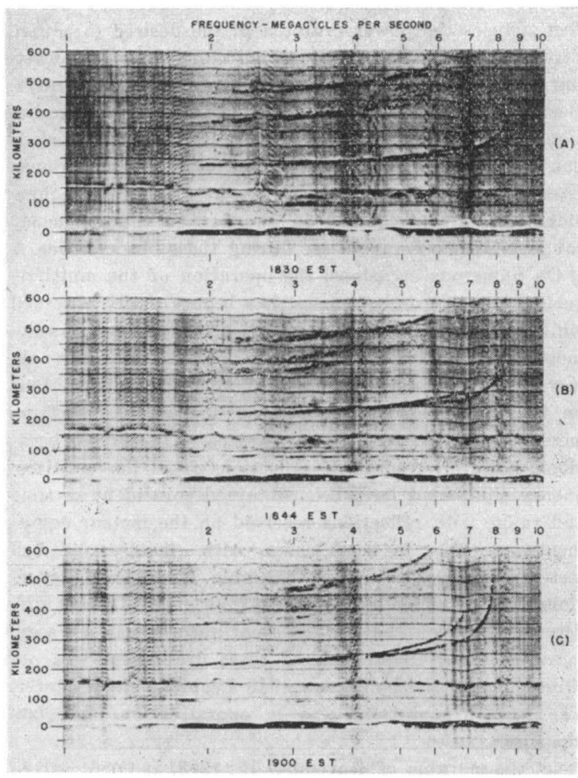

FIG. 3. Ionosphere recordings at Sterling, Virginia, Dec. 12, 1948, showing sporadic E reflections at 100 km, and reflection from meteor trail (in B) at 80 km. (Simulated reflections at 150 km caused by synchronous interference.)

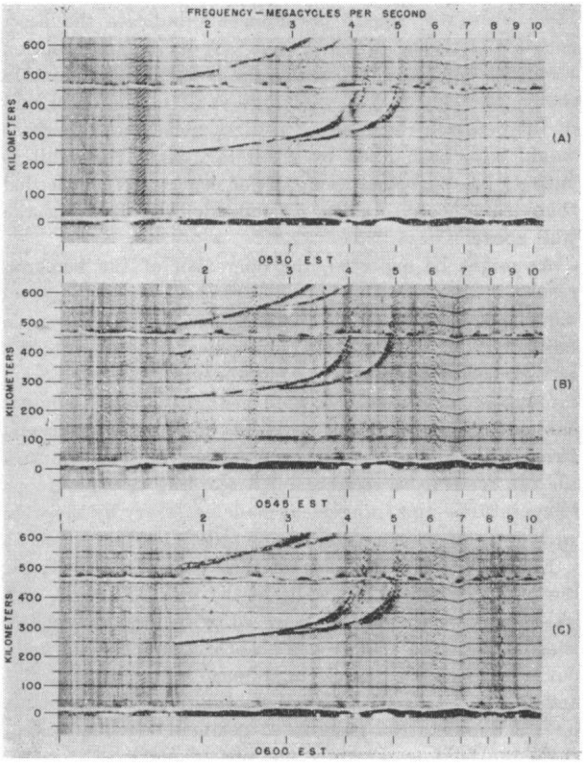

FIG. 4. Ionosphere recordings at Sterling, Virginia, Dec. 13, 1948, showing no sporadic E reflection but reflection from meteor trail (in B) at 105 km. (Simulated reflections at 470 km caused by synchronous interference.)

Fig. 4 is similar to Fig. 3 except that the records shown were made at a time when sporadic E was not present, and the meteoric reflection could be erroneously interpreted as a sporadic E reflection.

It has been found that the relative polarization of the antenna used with the ionosphere set and those used with the meteor equipment makes little or no difference at these frequencies. Coincidences of the type described occur when the orientation is such that the electric vectors are mutually perpendicular as often as when they are parallel.

Although it is beyond the scope of this note to go into an involved discussion of the relation of sporadic E reflections and meteoric ionization, it has been shown that reflections are obtained from meteoric ionization which can be distinguished from sporadic E reflections. A preliminary statistical examination, now under way, of a large quantity of data obtained over several months of nearly continuous observation does not appear to show that variations in meteoric activity are associated with corresponding variations in occurrence of sporadic E reflections. Continued observation of meteoric activity and perhaps a new line of approach in the technique of obtaining and evaluating the data are necessary before more extended conclusions can be drawn.

References

1. APPLETON, E. V. and NAISMITH, R. *Proc. phys. Soc. Lond.*, 1947, **59**, 461.
2. BATEMAN, R., MCNISH, A. G., and PINEO, V. C. *Science*, 1946, **104**, 304.
3. PIERCE, J. A. *Proc. IRE*, 1938, **26**, 892.
4. SKELLET, A. M. *Proc. IRE*, 1935, **25A**, 132.

Comments and Communications

The Betatron Building and Installation at the University of Saskatchewan

About two years ago the authors, all members of the staff of the Department of Physics at the University of Saskatchewan, felt that in order to carry out a significant research in nuclear physics they should act together as a team for the purpose of obtaining and using a 25-Mev betatron. The group was interested in investigating also its possible therapeutic uses in the treatment of cancer. Because of their wide interests they were able to enlist the generous support of the Atomic Energy Control Board of Canada in the purchase of the instrument and of the Provincial Government of Saskatchewan in the erection of the building to house it. Auxiliary equipment has been obtained through the support of the university, the National Research Council of Canada, the National Cancer Institute, and local cancer societies. The machine will be used both as an X-ray machine and as an electron beam machine. It is available to other groups in the university who may wish to investigate the biological and the chemical effects of high energy radiations.

The betatron building was built in one angle of the T of the main building but separated from it by 11 ft. It has the same floor level and is connected to the main building. The principal research rooms and instrument shop facilities of the main building are thereby made directly accessible to the betatron building, yet the betatron itself, a source of highly penetrating radiation, is well removed from persons in the main building. Its beam is directed away from the main building and is well below ground level.

The general plan of the betatron building, presented in Fig. 1, shows that the betatron room is surrounded by heavy concrete walls. The wall in the direct path of the X-ray beam is seven feet thick. In place of having a direct opening and a necessarily massive door between this room and the control room, entrance is made through a corridor long enough to reduce scattered radiation to a tolerable level. This corridor is entered from the control room through a doorway which is closed by a light, soundproof and airtight door. In spite of the greater walking