Table 1. Effect of treating avirulent *Trichomonas gallinae* with homogenate of virulent strain as evidenced by lesions produced in mice.

Expt.	No. of mice	Treatment of avirulent (YGA) strain	Mean volume of lesions (mm^3)			
			6 days	s*	14 days	s*
I	30	Treated twice with virulent (JB) homogenate	27.82	16.62		
II	16	Cells from lesions of expt. I.	35.64	26.64	46.27	36.59
Control A	16	Untreated	9.28	8.12	10.97	10.01
Control B	21	Treated with JB homogenate and deoxyribonuclease	13.02	10.87	17.02	16.63

*s = sample standard deviation.

in Table 1. The results obtained were compared statistically with the aid of the nonpaired t-test. In all instances the mean volumes of the lesions produced by cells treated with homogenate alone (experiments I and II) were found to be significantly different, on all levels, from the corresponding (6- and 14-day) controls ($P<0.001$). There were, however, no significant differences between controls A and B on the 6th or 14th day after inoculation ($0.1<P<0.2$). Further, no statistically significant differences could be demonstrated between the mean volumes of the 6-day lesions observed in experiments I and II ($0.1<P<0.2$).

The foregoing results suggest strongly a DNA-dependent transformation of the YGA strain, with respect to virulence. It seems probable that virulence is a genetically controlled character among the strains of *T. gallinae*. It must be noted that the mean volume of lesions resulting from inoculations of the transformed YGA strain is very much smaller than the mean volume of lesions observed after inoculation of mice with JB strain. In experiments performed several weeks earlier with the latter strain, the mean volume of 6-day lesions was 158.53 mm^3 ($s = 97.38$).

Two possibilities may be considered in explaining these results. It could be assumed that the conditions for transformation present in the foregoing experiments were far from optimum, and that thus only a relatively small proportion of organisms became transformed. This hypothesis can and will be tested by modification of the conditions under which YGA organisms are exposed to the JB homogenate. On the other hand, we may be dealing with a stepwise transformation. This latter assumption can be proved unequivocally only by the establishment of the homogeneity of the transformed cultures.

It may be of interest to add that recent studies on the mechanisms of pathogenicity of the JB strain in chick cell cultures have not revealed characteristic inclusion bodies, ascribable to the presence of the flagellates. Consequently, if viruses influence the pathogenicity of this strain, they are evidently restricted to the protoplasm of the parasites (*6*).

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Proton Flux during the Great Aurora of 3–4 September 1959

Abstract. Photoelectric measurements of the Hβ intensity show that it continued to increase after a corona formed, and reached a maximum as the corona broke up into rays, decreasing rapidly to nearly zero within the next 10 minutes. The maximum flux of protons incident on the earth during the aurora, deduced from these measures, was at least 1.4×10^8 auroral protons per square centimeter, per second.

On the night of 3–4 September 1959 an extremely bright aurora was visible throughout Canada and the northern United States. At the Pine Bluff Observatory of the University of Wisconsin, a small telescope designed and ordinarily used for photoelectric measurements of diffuse and planetary nebulae was on this occasion used to measure the Hβ radiation from the aurora, and thereby to determine the flux of protons incident on the earth's upper atmosphere.

The telescope is a 5-inch f/5 achromatic refractor, and the Hβ radiation is isolated by an interference filter, made by Baird-Atomic, Inc., with measured peak wavelength 4864 A and nominal band width 30 A. Light transmitted by this filter passes through a circular diaphragm in the focal plane, which was 3.86 mm in diameter and therefore defined a field of 21.7′ in diameter for all the observations reported here. The light is then measured by a conventional astronomical photoelectric photometer, built around a refrigerated 1P21 photomultiplier. The only strong emission line of either the aurora or a gaseous nebula transmitted by the filter is the Hβ λ4861 line, and the measurements were calibrated into energy units by comparison with measurements made with the same equipment of planetary nebulae having known Hβ fluxes (*1*). This calibration was made indirectly; the aurora was compared with the very bright star α Lyrae on 3–4 September, and the star was in turn compared with the planetaries as part of the regular nebular program on nights before and after the aurora.

On the night of 3–4 September the first auroral measurement was made at 2124 C.S.T.; the aurora then had already been visible for over an hour, growing steadily brighter, and was still in the quiet-arc stage. At this time the sky was also measured at a point 58° south of the zenith, far from the bright part of the aurora, in order to determine the sky correction. The sky light is due to the continuous radiation of all the faint stars included within the area of sky measured, as well as to the faint scattered radiation from the lights of the city of Madison, 15 miles distant, and of the nearer but smaller villages of Mazomanie and Cross Plains. A mean sky correction was subtracted from all the measurements to find the residual intensity due to the aurora alone, but since the true sky brightness undoubtedly varies with position and time, this procedure introduces some error. The maximum measured auroral intensity is over seven times larger than the sky correction, and is therefore quite accurate, but the correction is a larger fraction of the fainter auroral intensities, which are therefore less well determined. The measurements were also corrected slightly for atmospheric extinction according to a coefficient derived from observations on previous nights.

From 2124 C.S.T. on, the Hβ intensity at the zenith increased more or less continuously until it reached a maximum at 2142 C.S.T., 7 minutes after it had first been noted that the quiet arc was beginning to form rays and at the time when a well-marked corona was about 10° south of the zenith. The corona then broke up, and the aurora consisted mostly of bright rays, some changing brightness erratically, while the Hβ flux decreased steadily, reaching a level of 0.2 of the maximum only 10 minutes later. Another sky measurement was taken in the south, and by 2200 C.S.T. there was no detectable Hβ radiation from the zenith, though visually the aurora was still extremely bright, being made up in large part by then of rapidly pulsating rays. Faint Hβ radiation could still be measured 60° north of the zenith until 2210, when observations were stopped, but its brightness was only about 0.1 of the maximum flux, and so this measurement is quite uncertain because of the large sky correction and also because some of the flux may have come from the Vegard-Kaplan (2, 15) band of N_2, which is weakly present in auroras (*2*) and is partially transmitted by the filter. The photoelectric measurements therefore show that the primary proton flux occurs not only during the quiet-arc stage, as Fan and Schulte (*3*) have emphasized, but also in this aurora continued and increased into the beginning of the stage of formation of rays, as Bless and Liller (*4*) also found for the aurora of 9–10 April 1957.

The most significant quantitative measurement was the measured Hβ intensity at the zenith, approximately 1.6×10^{-8} erg/cm² sec received at the earth from a circle 21.7′ in diameter. (For 2 minutes just at the maximum the recording pen, which was unattended, went off scale, but from the slope of the graph before and after this time it is safe to say that the maximum flux was only about 15 percent above full scale.) This observed intensity corresponds to a total emission in Hβ (assumed isotropic) of 6.4×10^{-8} erg/sec cm² column of atmosphere, or of 1.5×10^{9} photon/sec cm² column of atmosphere, and since according to the theory worked out by Chamberlain (*5*) each incident fast proton produces about 11 Hβ photons in the course of being slowed down, the maximum flux incident on the earth's upper atmosphere during the aurora was at least 1.4×10^{8} proton/cm² sec. This figure is a lower limit to the maximum flux, because protons incident with energies below about 100 kev produce less than 11 Hβ photons (*6*). The measured maximum flux is similar to the maximum flux of 1.0×10^{8} proton/cm² sec found by Bless and Liller (*4*) from their measurements of the Hβ intensity during the aurora of 9–10 April 1957 and to the maximum flux of 1.6×10^{8} proton/cm² sec measured by Hunten (*7*) as the upper limit for a number of bright auroras, and so a value of this order of magnitude may be characteristic of all very bright auroras (*8*).

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Benzimidazole Enhancement of Ion Uptake by Plant Roots

Abstract. Excised barley roots in the presence of benzimidazole accumulate about twice as much potassium in 6 hours as those in a potassium source only. The enhanced rate of uptake is maintained steadily during this time. Sodium and calcium accumulation are similarly augmented but not at identical levels.

In the course of our studies on the physiology of plant roots, the differential effect of certain antibiotic and antimetabolites on growth, water uptake, and ion accumulation have been examined. Several benzazoles, which might be viewed either as purine or indole analogs, were compared in various systems and found to have some activity in repressing root growth and water uptake. Suggestions to the effect that benzimidazole might form complexes with certain metallic ions and thus interfere with their functioning have been postulated by Hillman (*1*) and by McCorquodale and Duncan (*2, 3*). In fact McCorquodale and Duncan (*3*) made the further suggestion that benzimidazole "pumps" ions out of the cell into the external medium, thus causing growth inhibitions due to ion deficiencies. If such is the case, the usual pattern of ion uptake would not prevail. Unexpectedly, however, cation accumulation by barley roots, either excised or attached, was found to be substantially enhanced by certain concentrations of benzimidazole and to a lesser degree by its 5-chloro derivative. Benzotriazole and benzothiazole, which were more active than benzimidazole in repressing growth and water uptake, did not similarly enhance ion accumulation in the ranges tested.

Most of our experiments have been carried out on excised roots from 7-day Atlas-46 barley seedlings grown in mass culture in an aerated medium containing $7.5 \times 10^{-5}M$ $CaSO_4$ and $2.5 \times 10^{-5}M$ $MgSO_4$. The samples of excised roots, 7.5 gm fresh weight in size, were treated with a 200-ml solution containing the cation and antimetabolite at 25°C. The solutions were continuously aerated through sintered glass aerators during the test period, up to 6 hours. Analyses for K^+, Na^+, and Ca^{++} were made by flame photometry in a Beckman model DU spectrophotometer. The amount of cation taken up by the roots was usually determined by difference between the initial and final content of the ambient solution.

In preliminary experiments, excised roots exposed to $1 \times 10^{-3}M$ benzimidazole accumulated about twice as much potassium from unbuffered $1 \times 10^{-3}M$ K_2SO_4 as roots in the same strength of potassium salt alone. The response curve for enhancement of potassium uptake plotted against benzimidazole concentration passes through a peak in the vicinity of $1 \times 10^{-3}M$; at both higher ($3 \times 10^{-3}M$) and lower ($< 1 \times 10^{-4}M$) concentrations the amount accumulated is not significantly different from that accumulated by the untreated roots.

Rate studies showed that the enhanced rate of potassium uptake in the presence of benzimidazole was maintained steadily for at least 6 hours (Fig. 1). In this typical experiment, excised roots in $1 \times 10^{-3}M$ K_2SO_4 accumulated potassium at a steady rate of 30 μg of K per hour, per gram (fresh wt.) after the first hour, whereas with the added presence of $1 \times 10^{-3}M$ benzimidazole, the steady rate was 124μg of K per hour, per gram (fresh wt.)—almost four times higher. At the termination of the experiment; the benzimidazole-treated roots had accumulated 1.0 mg of K per gram (fresh wt.) while the ambient solution, initially containing 78 μg of K per milliliter, was depleted to 40 μg/ml, whereas in the potassium sulfate alone only 0.387 mg of K per gram (fresh wt.) was accumulated with the ambient solution still containing 63 μg/ml. The effect of benzimidazole, therefore, is to augment the accumulation process.

Enhancement of potassium uptake does not necessarily require the simultaneous presence of benzimidazole and