depending on the size of the animal and the volume of the chamber ranged from 60 to 150 cm^3/min. Inlet gases (except room air) were made up in Douglas bags to an accuracy of ± 0.4 percent O_2. Pressures in the animal chamber were approximately 740 mm-Hg. Variations in the pressure of oxygen (P_{O_2}), which resulted from barometric and water vapor effects, were less than those allowed in making up the original mixtures. Therefore, the oxygen percentages were considered easier to use in tabulating results. Electrocardiograms (ECG) were taken with a high-gain preamplifier and a polygraph, with lengths of stranded copper wire wrapped around three legs as leads and ground. Breathing records were obtained in some of the experiments with the ECG leads and an impedance pneumograph (*3*) on a second channel. An interval of 1 to 3 hours was allowed to equilibrate the apparatus and quiet the animals. Because turtles have irregular breathing and long periods of apnea, respiration was monitored for as long as several hours.

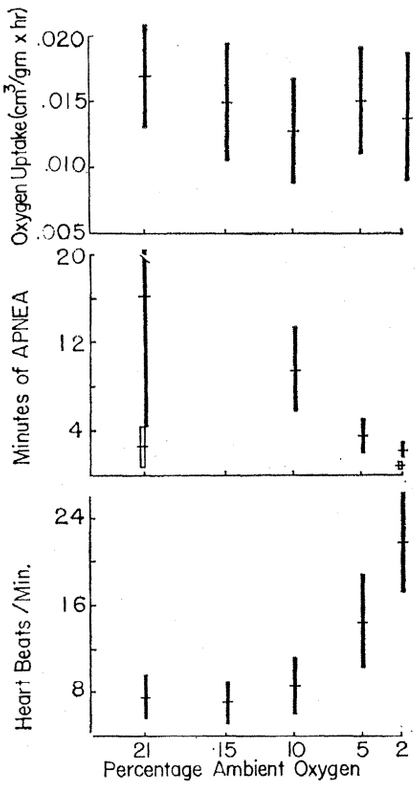

Fig. 1. Effects of decreasing ambient oxygen levels on oxygen uptake, period of apnea between breathing cycles, and heart rate. The vertical bars show 95 percent confidence intervals; the horizontal dashes, the means. Each bar represents 13 animals except in the graph for the period of apnea where the open bars represent the five animals weighing under 200 g, the solid bars the six weighing over 1000 g.

Table 1. Mean oxygen pulse values of 13 turtles at varying oxygen levels.

Oxygen (%)	Oxygen pulse (10^{-5} cm^2/beat × g)
21	3.67
15	3.47
10	2.47
5	1.73
2	1.07

The effects of five decreasing levels of ambient oxygen upon oxygen uptake, period of apnea between breathing cycles, and heart rate are shown in Fig. 1. There were no significant differences in oxygen uptake at the various levels. Comparing the combined data for the five turtles weighing under 200 g with data for those over 1000 g shows that the smaller animals have a significantly higher uptake when all percentages are combined ($P < .001$). These differences were not significant ($P > .05$) when the two lowest oxygen levels were tested separately; in contrast, they were significant for separate tests of the three high levels. The difficulty of showing a clear correlation between respiration and size in turtles has been noted elsewhere (*4*).

At levels of both 21 and 2 percent oxygen the small turtles had much shorter periods of apnea than the large ones. The smaller animals had significantly faster heart rates in room air ($P < .01$), but the rates were not significantly different at other oxygen levels (except at 5 percent).

A regression analysis of oxygen uptake as a dependent variable on heart rate was calculated for the group of 13 animals at each oxygen level by the familiar

$$Y = a_y + b_{yx}(X).$$

The five b_{yx} values were significantly different from zero (that is, regression was actually present) but not from each other. Yet as Table 1 shows, the relation of oxygen uptake to heart rate (oxygen pulse) shows a consistent decrease with decreasing ambient oxygen levels. The oxygen pulse at room air is similar to that given for a lizard, *Eumeces obsoletus* (*5*), despite great dissimilarity in both heart rate and oxygen uptake.

The maintenance of oxygen uptake under hypoxia can be correlated with the decreased period of apnea and the increased heart rate, since these changes would move the available oxygen faster to the tissues. How the turtles can tolerate such a low uptake may possibly be explained by their utilization of anaerobic metabolism (*6*), and by their breathing cycle which has a strong compression phase (*7*) increasing lung P_{O_2}. Comparison of oxygen dissociation curves of the hemoglobin of the snapping turtle (*8*) with those of other reptiles does not suggest any greater loading efficiency for this or other species of turtles.

Since turtles show changing blood values of CO_2 and *p*H with changing temperature, their control of breathing may not depend on these factors (*9*), and since they respond to rapidly increasing or decreasing ambient oxygen levels with changes in heart rate and period of apnea in as little as 1 minute, the oxygen tension of the blood may be a factor in the control of breathing, especially when the other factors depend on temperature (*10*).

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25 February 1963

Repeatability of Jupiter's Decametric Radio Emission

Dynamic spectra of Jupiter's decametric emission show that the planet has a permanent dynamic spectrum. This report discusses a recent outstanding series of events where this feature is particularly clear.

Jupiter's sporadic emission at low frequencies is notable for the stability with which events occur in definite longitude ranges [near 100°, 200°, and 300° in the radio longitude system (*1*)]. This directivity was recognized very soon after the discovery of the emission, and has been discussed widely in the literature (*2*).

The first dynamic spectra (*3*) of Jupiter's low-frequency emission ex-

hibited correspondingly a pronounced association between spectral character, especially the drifting of emission up or down the spectrum as a function of time, and longitude. The early longitude range appeared to emit radiation drifting positively, toward higher frequencies as time increased, while the two later longitude ranges drifted negatively, toward lower frequencies.

These first dynamic spectra, largely from late winter and spring of 1960, were of limited frequency range and relatively low time resolution. Later spectra, obtained on many occasions during 1961 (*4*), confirmed and extended the result on the association of the sign of frequency drifts with longitude. In addition, the 1961 data exhibit a remarkable stability of the dynamic spectrum from one event to the next, especially for the central peak of emission following 200° longitude.

This stability of the dynamic spectrum appears in the as yet unpublished data for 1962, and includes the early source at 100°. An especially interesting case of persistent occurrence in a narrow range of early longitude for three major events in September and October 1962 is shown in Fig. 1, along with activity observed 28 months earlier, in May 1960. The longitude scale is shown below the time scales for each record in the figure. If the positively-drifting strong branch of emission is identified as beginning near 20 Mcy/sec, these beginnings cover the very limited longitude range from 107° to 130°. Other equally striking and similar features recur. For example, very-narrow-band emission at about 38 to 39 Mcy/sec at the end of the positive-drift branch continues with a gradually decreasing frequency for nearly 1 hour on 24 September 1962 and again over a month later on 26 October 1962. Also, the general contours of positively-drifting emission preceding the most intense features appear to be somewhat similar.

Not only are there narrow-band features in Jupiter's spectrum, but these features appear repeatedly at the same frequency when the planet presents a particular and narrow range of longitudes toward the earth. Further-

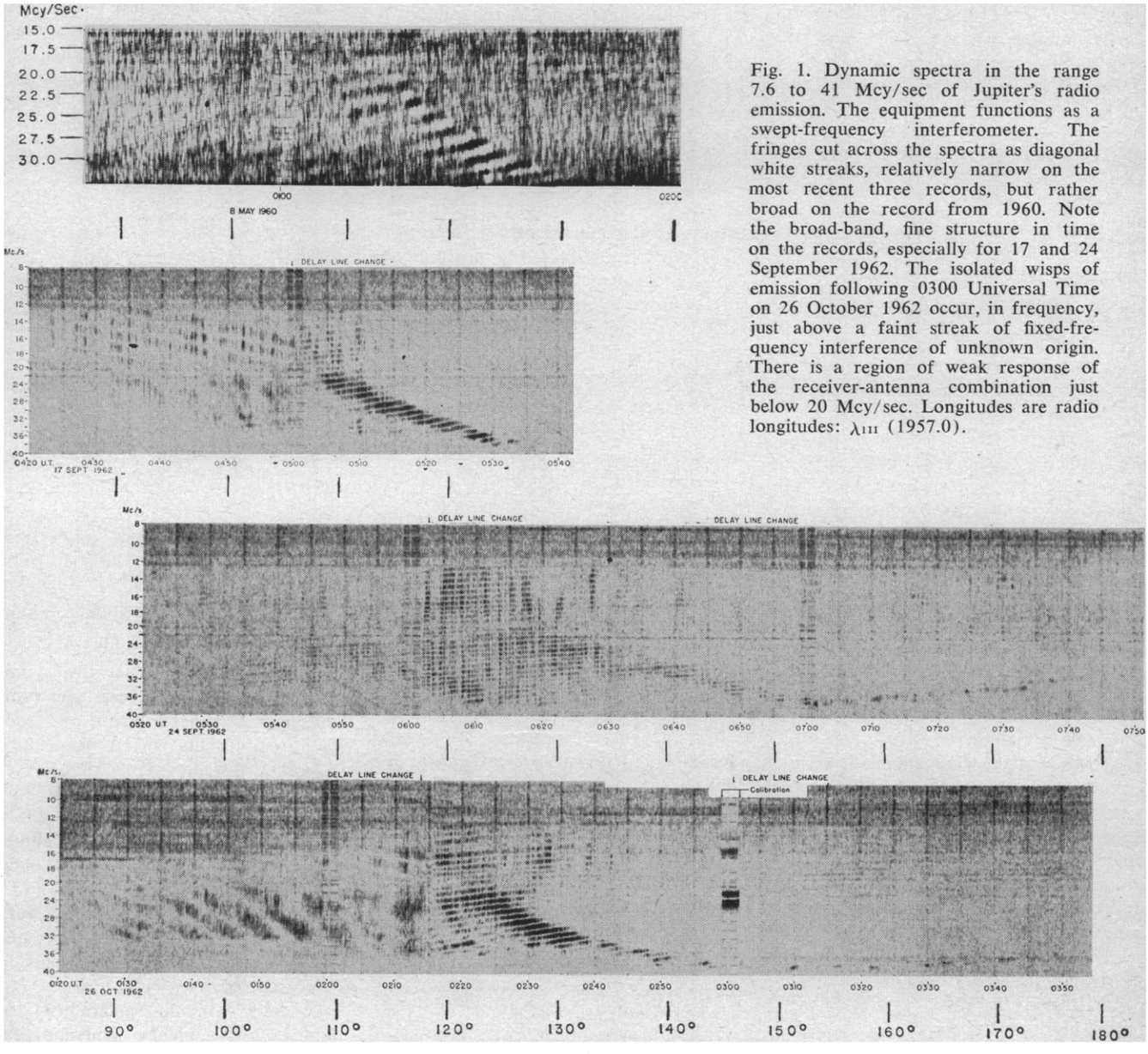

Fig. 1. Dynamic spectra in the range 7.6 to 41 Mcy/sec of Jupiter's radio emission. The equipment functions as a swept-frequency interferometer. The fringes cut across the spectra as diagonal white streaks, relatively narrow on the most recent three records, but rather broad on the record from 1960. Note the broad-band, fine structure in time on the records, especially for 17 and 24 September 1962. The isolated wisps of emission following 0300 Universal Time on 26 October 1962 occur, in frequency, just above a faint streak of fixed-frequency interference of unknown origin. There is a region of weak response of the receiver-antenna combination just below 20 Mcy/sec. Longitudes are radio longitudes: λ_{III} (1957.0).

more, the time changes in the spectrum also repeat, with virtually identical slopes in the time frequency domain. Jupiter's dynamic spectrum represents a kind of permanent map of the surface of the planet, where radio frequency and time act as latitude and longitude, respectively. Possible physical implications of the existence of this permanent dynamic spectrum are discussed in the references below.

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25 March 1963

Catalase Abnormality in a Caucasian Family in the United States

Abstract. *An erythrocyte catalase with atypical electromigration velocity was discovered in three generations of a family of Scandinavian-British extraction. Six members are heterozygous for the hereditary autosomal character; no abnormal homozygotes were found. The condition is associated with normal erythrocyte catalase activity and with no clinical or subclinical disease.*

Acatalasemia is the only known catalase disorder. This rare hereditary abnormality represents the homozygous phenotype for a mutant catalase gene. Acatalasemia and its heterozygous analogue, hypocatalasemia, were both discovered in Japan and described by Takahara and the Okayama University group (*1*, *2*). Later, two familial cases were reported from Switzerland (*3*). Recent efforts to obtain evidence of other catalase disorders or to reveal multiple molecular forms of catalase have failed (*4*). Nevertheless, heterogeneity of this enzyme occurs, though rarely.

An atypical erythrocyte catalase, demonstrated by electrophoresis, was found in six members of a Caucasian family (hereafter designated as S), all six of whom are heterozygous for this inherited character. In contrast to the abnormality in hypocatalasemia, their erythrocyte catalase activity is normal. Electrophoresis with thin-layer starch gel and the staining and plasticizing methods for catalase, peroxidase, and proteins were used as described previously (*5*). The catalase stain is a modification of the staining method of Thorup *et al.* (*6*). Catalase activity was determined with potassium permanganate by the titrimetric method of von Euler and Bonnichsen (*7*) at 60, 120, and 180 seconds. The reaction velocity constants (K_t) were calculated according to the equation (*7*)

$$K_t = \frac{2.3 \times 10^3}{t} \log \frac{X_o}{X_t}$$

where X_o is the initial amount of potassium permanganate and X_t the amount at t seconds. Values for K_t were extrapolated to time zero (K_o). Hemolyzates were prepared at 4°C from red blood cells that had been washed four times in normal saline, lysed by the toluene method (*8*), and used within 24 hours for titration and electrophoresis (*9*). Although electrophoretic artifacts of catalase are rarely observed with fresh hemolyzates, the possibility of such incidence caused us to examine at least three blood samples of each member of family S. Consistent results were obtained with all samples.

When a buffer system of tris-citrate and borate at *p*H 8.6 is used, the location of the common human erythrocyte catalase after electrophoresis is indicated by a single white zone on the iodine-stained blue background at the anodic side of the gel. Catalase moves slightly more slowly than hemoglobin A_2 (Fig. 1). The atypical catalase also exhibits a single white zone but has a relative rate of electromigration (R_u) of .89 (*10*). Its zonal length exceeds the normal by an average of one-tenth. The fastest and the slowest moving components of the abnormal catalase band show signs of low enzyme concentration, as indicated by the clouded appearance and by unsharp borders. Clouding of the entire zone of normal catalase occurs when hemolyzate concentrations of below ½ percent are used.

Efforts were made to fractionate the atypical catalase band through electrophoresis with different buffer systems (phosphate, borate, acetate, tris-borate-ethylenediamine-tetraacetate) at *p*H 8.9 to 5.5. Although a mobility difference between normal and variant catalase remained, no separation into more than one zone could be obtained, even when electrophoresis was prolonged to 64 hours; moreover, catalase did not subfractionate with the highest practical dilutions (⅛ percent) of normal, abnormal, and mixed hemolyzates.

In a mixture of normal and abnormal hemolyzates, catalase migrates as a sin-

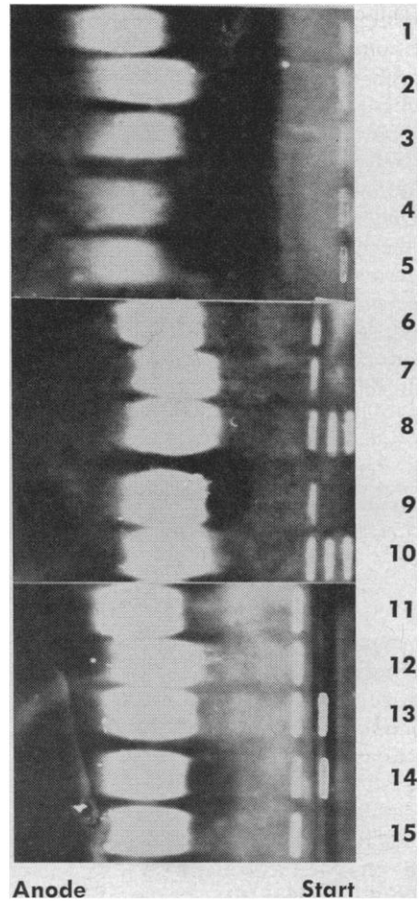

Fig. 1. Electrophoresis of hemolyzates with thin-layer starch gel; catalase stain. Samples 1–5 developed in inverted-J type, 6–10 and 11–15 in inverted-V type electrophoresis cells. For each application strip 10 μl of hemolyzate were applied. Multiple application strips are listed from anode toward cathode. Hemolyzate concentrations in percentages follow (where *A* is from a normal homozygote; *AB*, from a heterozygote of family S).

	%		%
1.	*A* 2	9.	*A* 2
2.	*AB* 2		*AB* 2*
3.	*AB* 1	10.	*A* 1.33
4.	*AB* 0.5		*A* 0.33
5.	*A* 0.5		*A* 0.33
	AB 0.5*	11.	*A* 2
6.	*A* 2	12.	*AB* 2
7.	*AB* 2	13.	*A* 1
8.	*A* 0.67		*A* 1
	A 0.67	14.	*A* 1.5
	A 0.67		*A* 0.5
		15.	*A* 2
			AB 2*

* 1:1 volume