selected for study at Lake Itasca, Minnesota. A total of 2283 songs were recorded with a tape recorder (Nagra III) and omnidirectional microphone (Sennheiser 104) at 7.5 inches per second (19 cm per second) during the period from 20 June to 5 July 1970. We analyzed the tapes, using a sonagraph (Kay 6061B) with wide band setting. The lengths of all songs and intervals were measured from the end of one song to the beginning of the next. The data were coded for computer analysis in such a way that the entire temporal patterning of acoustic signals could be represented; we plan a later extensive analysis of these temporal patterns for both species, using additional data when each species is singing in the absence of the other. Our purpose in the analysis presented here was to determine if either species was influencing the timing of song by the other.

Let v be the total amount of time during which the vireo is producing sound, and let $\bar{v}$ be the vireo's total quiet time in the recorded sample. Then the probability of a vireo's singing is

$$p(v) = v/(v + \bar{v}) \qquad (1)$$

and its probability of being silent is

$$p(\bar{v}) = \bar{v}/(v + \bar{v})$$

Suppose during the same total time $(v + \bar{v})$ the least flycatcher sings f total songs. If these songs are begun regardless of whether the vireo is singing or not, then the predicted number of flycatcher (F_v) songs begun during vireo song should be

$$F_v = p(v) \cdot f \qquad (2)$$

and, analogously, the predicted number of flycatcher songs begun during vireo silences should be

$$F_{\bar{v}} = p(\bar{v}) \cdot f$$

These predicted values were calculated and compared with the actual values (f_v and $f_{\bar{v}}$) by means of the χ^2 test:

$$\chi^2 = \frac{(F_v - f_v)^2}{F_v} + \frac{(F_{\bar{v}} - f_{\bar{v}})^2}{F_{\bar{v}}} \qquad (3)$$

with one degree of freedom. A parallel analysis was made of the beginning of vireo songs relative to the periods of singing and silence of the flycatcher.

The results of the analysis of the timing of flycatcher songs are shown in Table 1, and the parallel analysis of vireo songs is given in Table 2. Table 1 shows that all the flycatchers avoid beginning a song while a vireo is singing to a degree highly significantly different from chance. On the other other hand, Table 2 shows a somewhat smaller unwillingness of the vireo to begin a song when a flycatcher is already singing. Despite the large sample sizes, only three of the five vireos can be shown to avoid beginning a song while a flycatcher sings, and the differences are not as pronounced as those in Table 1. In fact, vireo 4 actually began singing during flycatcher songs *more* often than predicted by chance, although the departure from prediction is not significant.

The two species are matched by individual numbers in Tables 1 and 2 for comparison. The total number of songs uttered during the recorded period is strikingly similar in each pair. The difference in duration between the relatively long vireo song (9 to 83 csec, usually 20 to 40 csec) and the short flycatcher song (10 to 14 csec, usually 11 csec) is accounted for in the analysis by Eq. 1; however, this difference may be of value in the interpretation of the results. Although there is some mutual avoidance of acoustic interference, the flycatcher tends more strongly to insert its short songs in between the longer songs of the vireo, rather than vice versa. Indeed, most of the overlap recorded (f_v of Table 1) occurred when the flycatcher began singing just after the vireo had begun, suggesting that the flycatcher had not heard the vireo begin singing. In some cases, with the recording microphone nearer the vireo, the onset of vireo sound may not even have reached the flycatcher's ears by the time the flycatcher commenced singing. In terms of selective advantage, it seems less important for the vireo to avoid interference, since a portion of its longer song will be transmitted without interference regardless of when during the vireo song the flycatcher sings. However, the song of the flycatcher can suffer total interference by the long vireo song, so that the burden of avoiding interference falls more heavily upon the flycatcher.

There are, of course, many ways in which two species can avoid acoustic interference, for example, by singing on different daily rhythms (*1*), in different frequency bands (*2*), at different heights (*2*), and so on. The results presented here clearly demonstrate avoidance by adjustment in the temporal patterning of singing. We have no evidence that the vireo and flycatcher discussed here are in any sort of direct ecological competition or are communicating with one another in any sense other than avoiding mutual acoustic interference. The results demonstrate the importance of assessing influences of unrelated species when attempting to study the temporal structure of acoustic communication in a given species.

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20 September 1973

Martian Climate: An Empirical Test of Possible Gross Variations

In the wake of the discovery of sinuous channels on Mars, a number of authors have speculated about the possibility that the average climate on Mars may once have been more clement by terrestrial standards than it is at present (*1*). Indeed, there appears to be evidence for cyclic behavior in which the surface pressure periodically reaches values compatible with the flow of water in equatorial regions on the planet (*2*, *3*). It is the purpose of this note to call attention to a relatively simple test of such hypotheses—a test that may be carried out as early as February 1974.

The premise on which cyclic models are based is that a substantial reservoir of volatiles exists in frozen form at one or both poles. Warming of the polar regions by one or more processes leads to the release of the trapped volatiles and a subsequent increase in surface pressure, an enhanced greenhouse effect, and so forth. Estimates of the amount of material in these reservoirs varies; for this discussion I adopt the estimate of CO_2 equivalent to ~ 1 bar favored by Sagan *et al.* (*2*). This estimate is based on the well-grounded assumption that the atmospheres of both Venus and Mars have developed through outgassing processes similar to those which produced our own atmosphere (*4*). I also adopt this assumption. If we then attempt to assess the total terrestrial volatile inventory, allowing for biological and hydrological effects, the resulting abundance ratios for the various gaseous constituents should be applicable in a general way to the other two planets. This estimate cannot be made with great precision, but we are only interested in orders of magnitude and the pioneering work by Rubey (*5*) is well suited for this purpose.

The constituents of greatest significance are carbon dioxide, argon, and neon, which are present in the earth's volatile inventory in the approximate ratio $3 \times 10^6 : 1.1 \times 10^3 : 2.2$. Nitrogen could be useful, but it is susceptible to chemical deposition and escape, while neon and argon, once in the atmosphere, will remain there. This helpful property is retained even with a cold trap temperature of 145°K, the present estimate for the lowest temperature at the polar caps on Mars. In other words, when large amounts of H_2O and CO_2 are deposited at the martian poles during putative ice ages, the neon and argon will become relatively more abundant in the atmosphere.

It is well established that more than 99 percent of the argon in our own atmosphere is ^{40}Ar produced by the decay of ^{40}K in rocks and subsequently released in the various outgassing processes that have produced the other constituents (*6*). In contrast, terrestrial neon and ^{36}Ar appear to be primordial in the sense that they have been released from the materials that originally accreted to form the earth. Whatever mechanism was responsible for the fractionation of the noble gases observed in the earth's atmosphere seems to have produced identical results in the planetary component of trapped meteoritic gases (*7*). We thus expect ^{20}Ne : ^{32}Ne : ^{36}Ar to be similar on Mars and the earth, since Mars presumably accreted from material that had a similar history in this respect.

Using this information on terrestrial rare gas abundances, I calculate that 1 bar of CO_2 trapped at the martian poles implies that the present atmosphere (surface pressure ~ 5.5 mbar) should contain approximately 0.33 mbar of ^{40}Ar. On the other hand, if most of the outgassed CO_2 is still in the gas phase, so the surface pressure is now as high as it ever was, we should expect only 2×10^{-3} mbar of ^{40}Ar to be present, or 0.04 percent of the present atmosphere. This range in argon abundance is encompassed by the dynamic range of the mass spectrometer presently under development for the Viking mission of the National Aeronautics and Space Administration in 1976 (*8*). We have every reason to expect that our colleagues in the Soviet Union have developed similar instrumentation, which means that the required measurements may be made after the soft landing next February of Soviet spacecraft presently en route to the planet (*9*).

In other words, a simple, terrestrial analog model for the origin of the martian atmosphere requires the release of enough ^{40}Ar to serve as a sensitive tracer for the total amount of CO_2 outgassed by the planet and thus provides an index by which to judge the credibility of cyclic models for martian climatology. In fact, this test may be used to determine whether the atmosphere was ever more massive than it is at present, even if this stage occurred only once in the planet's history. A check on the applicability of terrestrial analogy will be provided by a determination of the relative abundance of ^{40}Ar compared to ^{36}Ar, ^{20}Ne, and ^{22}Ne, for the reasons described above. For example, if the present atmosphere is actually a relic from a time of early, massive, accretional outgassing (*10*), we would expect an anomalously high concentration of neon and relatively little ^{40}Ar.

Some qualifications of this argument must be added. It is possible that the distribution of ^{40}K in the upper layers of Mars and the earth is not identical and hence the outgassing of ^{40}Ar and CO_2 may not have maintained the same ratio on Mars as on the earth. But this will be a small effect compared with the factor of 200 that separates the relative abundances of argon expected in the models under consideration. It must also be recognized that the argon-neon test cannot prove that polar reservoirs exist because an anomalously high ^{40}Ar concentration does not guarantee that the missing CO_2 is all trapped at the poles. Some may have formed carbonate rocks, and dissociation and escape cannot be completely ruled out (*11*). On the other hand, it is difficult to imagine the presence of a large reservoir of CO_2 without some anomaly in the argon and neon abundances. It should therefore be easier to dismiss cyclic theories than to prove their validity, but it will also be possible to provide a good test of whether or not the martian atmosphere was ever much more massive than it is today. These analyses will gain in acuity from whatever additional information can be obtained on the chemical and elemental composition of the crust and the escape processes that have operated in the upper atmosphere. Experiments that should produce information in both of these categories are included on the Soviet and American spacecraft.

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9 October 1973; revised 8 November 1973 ■

Galactosemia and Galactonolactone: Further Biochemical Observations

A rapid method of detecting a galactosemic fetus using only a few cells biopsied from amniotic fluid was recently proposed by Hill and Puck (*1*). In this procedure γ-D-galactonolactone, a presumed inhibitor of one of the alternate pathways for galactose utilization, was used. Incorporation of [1-^{3}H]galactose into trichloroacetic acid (TCA) precipitable material was monitored by radioautography (*1*). Approximately 23 silver grains per galactosemic cell were detected in comparison to over 400 grains per nongalactosemic cell when both were grown for 16 hours in the presence of 0.05*M* γ-D-galactonolactone and [1-^{3}H]galactose (*1*). This procedure allowed a small number of galactosemic cells to be more readily distinguished from nongalactosemic cells. Hill and Puck reported that without galactonolactone