pollen than in the other treatments. Thus, there was a decrease in pollen fertility associated with the nonexsertion of anthers in the low temperature treatment.

Photoperiod did not affect the degree of pollen fertility at the warmer temperatures. However, at 10°C, pollen fertility decreased as the photoperiod increased. Under continuous light, sterility was essentially complete.

Seasonal sterility in *P. clandestinum* therefore appears to be influenced primarily by low temperature. The interaction of long photoperiod with low temperature to increase sterility is difficult to relate to the natural seasonal sterility.

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References and Notes

1. D. C. Edwards, *Empire J. Exptl. Agr.* **5**, 371 (1937).
2. K. N. Narayan, *Proc. Indian Acad. Sci.* **41**, 196 (1955).
3. Part of a longer paper submitted for publication in another journal.
4. C. A. Suneson, *J. Am. Soc. Agron.* **29**, 247 (1937).
5. J. P. Nitsch, E. B. Kurtz, J. L. Liverman, F. W. Went, *Am. J. Botany* **39**, 32 (1952).
6. D. J. Carr and Ng. Eng Kok, *Australian J. Agri. Research* **7**, 1 (1956).
7. J. W. Lesley and M. M. Lesley, *J. Agr. Research* **58**, 621 (1939).

20 October 1960

Hemoglobin Types of Macaca irus and Macaca mulatta Monkeys

Abstract. Hemoglobin of 30 *Macaca mulatta* monkeys and of 15 *Macaca irus* monkeys consisted of one electrophoretic component similar to human hemoglobin A. Twenty-one *M. irus* monkeys had two types of hemoglobin. In 20 animals the hemoglobin resembled human hemoglobin AJ, and in one animal it resembled human hemoglobin AI.

While studying the hematological effects of irradiation in animals, we examined the blood and bone marrow of 36 adult monkeys of the species *Macaca irus* (cynomolgus) and 30 of the species *Macaca mulatta* (rhesus). Hemoglobin was analyzed by paper electrophoresis at *p*H 8.6 with veronal buffer, 0.05 ionic strength (*1*), and the percentage of alkali-resistant hemoglobin was measured (*2*). Stained smears of blood and bone marrow were examined, and the packed-cell volume and percentage of reticulocytes were determined.

Hemoglobin of all the *M. mulatta* and 15 of the 36 *M. irus* monkeys resembled human hemoglobin A by electrophoretic analysis (Fig. 1). Hemoglobin of 21 (58 percent) *M. irus*

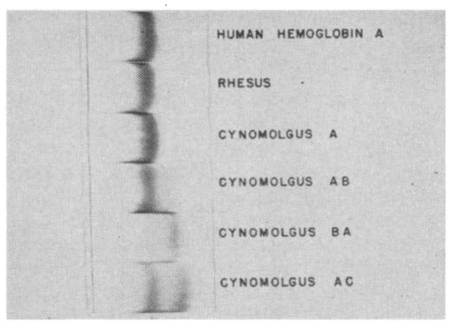

Fig. 1. Relative electrophoretic mobilities of hemoglobins as designated.

monkeys consisted of two components similar to the human hemoglobin combination AJ. The electrophoretically slow component in our monkeys was designated type A, the fast component, type B. The predominant component was type A in some animals (type AB); in others it was type B (type BA), as shown in Fig. 1 and Table 1. The hemoglobin of one animal consisted of type A, and a second component which migrated more rapidly than type B and was designated type C (Fig. 1). The percentage of alkali-resistant hemoglobin ranged from 0.3 to 2.0 with no significant differences among the groups under study, although we did observe significant increments in the alkali-resistant fraction of hemoglobin in *M. mulatta* and *M. irus* animals with types A, AB, and BA hemoglobin after sublethal irradiation (*3*).

We found no evidence that the presence of B or C hemoglobins imposed a hematological handicap upon the carriers (Table 1). An examination of bone marrow aspirates obtained from the anterior iliac crest revealed no abnormality. There were no distinguishing morphological characteristics of erythrocytes in carriers of B or C hemoglobins. The sex of the animals was not correlated with the incidence of hemoglobin type B (Table 1).

The differences in hemoglobin types among different species of monkeys and among members of the same species have been described recently by others (*4–7*). The hemoglobin of six *M. irus* animals studied by Kunkel (*5*) by starch block electrophoresis had two electrophoretic components, one of which resembled human hemoglobin A. A fast component was present in concentrations ranging from 25 to 65 percent of the total hemoglobin. Lie *et al.* (*4*) performed paper electrophoretic analysis of the hemoglobins of a total of 116 *M. irus* animals obtained from different areas of Indonesia. Forty-three percent of monkeys from one area and 73 percent of those from a second area had two types of hemoglobin. The electrophoretic mobility of the hemoglobin from animals with a single component was similar to human hemoglobin A. The second component migrated more rapidly than type A. The predominant fraction of hemoglobin in some cases was the fast component; in others, the slow component predominated. Although different methods of paper electrophoretic analysis were employed, we believe that the hemoglobin types A and B described by Lie and her co-workers (*4*) are, respectively, the same as the types A and B which we have found.

The occurrence of type B hemoglobin in the absence of type A hemoglobin in *M. irus* has not been reported, despite the relatively high incidence of hemoglobin AB in the series of Lie *et al.* (*4*) and in our series. These findings suggest the following possibilities: (i) Synthesis of hemoglobins A and B is controlled by allelic genes and the combination of BB is lethal in the early life of the affected animal. (ii) Prevalence of hemoglobin B results from a state of balanced polymorphism, analogous to the high incidence of hemoglobin AS and the low incidence of hemoglobin SS disease in adults in some areas of Africa (*8*). (iii) Genes responsible for synthesis of hemoglobins A and B are nonallelic, similar to the nonallelism of genes controlling hemoglobins A and G in the human being (*9*).

Hemoglobin type C appears to be quite rare in *M. irus* since it was encountered only once in our series and in none of the animals studied by Lie *et al.* (*4*). The type C variant is similar to the fast component found by Jacob and Tappen (*6*), in a monkey of the species *Cercopithecus mitis*, which

Table 1. Hemoglobin types of *M. irus* and *M. mulatta* monkeys.

Hemoglobin type	Animals (No.)	Sex M	Sex F	Range and mean (%) Packed cell volume	Range and mean (%) Reticulocytes
	M. irus				
A	15	9	6	34–47 (40.6)	0.1–4.3 (0.8)
AB	11	7	4	35–45 (40.3)	0.2–1.1 (0.7)
BA	9	4	5	39–45 (42)	0.3–1.3 (0.7)
AC	1	1	0	42	1.0
	M. mulatta				
A	30	19	11	36–47 (40.9)	0.2–2.3 (0.87)

is electrophoretically similar to human hemoglobin I.

Since we have not yet compared our two-component hemoglobins with those reported by Kunkel, and because of the differences in electrophoretic methods employed, it is not possible to definitively relate his findings to ours (*10*).

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References and Notes

1. "Spinco model R paper electrophoresis system operating instructions," OIR-1, Spinco Division, Beckman Instruments Company, Belmont, California.
2. K. Singer, A. I. Chernoff, L. Singer, *Blood* **6**, 413 (1951).
3. Unpublished observations by the authors.
4. L. E. Lie-Injo, M. Mansjoer, H. W. A. Donhuysen, *Communs. Vet.* **4**, 59 (1960).
5. H. G. Kunkel, R. Ceppellini, U. Muller-Eberhard, J. Wolf, *J. Clin. Invest.* **36**, 1615 (1957).
6. G. F. Jacob and N. C. Tappen, *Nature* **180**, 241 (1957).
7. ——, *ibid.* **181**, 197 (1958).
8. J. V. Neel, *New England J. Med.* **256**, 161 (1957).
9. H. C. Schwartz, T. H. Spaet, W. W. Zuelzer, J. V. Neel, A. R. Robinson, S. F. Kaufman, *Blood* **12**, 238 (1957).
10. This study was supported jointly by research funds from the Atomic Energy Commission, contract AT (40-1) 1642, the U.S. Public Health Service, grant No. H-1380, and U.S. Army contract No. DA-49-007-MD-967.

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Loss of Mass in Echo Satellite

We wish to make a correction to our report, "Perturbations of the orbit of the Echo balloon" [*Science* **132**, 1484 (1960)]. In preparing a detailed description of our theoretical method we discovered an error in sign in our expression for the third (and higher) harmonics of the earth's gravitational potential. (We used the coefficients provided by an astronomer, but with the physicists' definition of gravitational potential which, as we now know, is precisely the negative of that used by astronomers.)

According to our published results, the third harmonic caused a decrease in eccentricity of about -3×10^{5} per day during the first 12 days after launch. The magnitude of this decrease is approximately one tenth as large as the increase due to solar radiation pressure. However, despite its being so small, it affected significantly our attempt to estimate the reflection properties of the balloon and the rate of its loss in mass due to gas escaping from puncture holes. In order to reconcile the theoretical with the observational changes in eccentricity, we had assumed that the value of KA/M (the product of a scattering constant and the area-to-mass ratio of the balloon, defined in our report) increased substantially from its nominal initial value of 102 cm^2/g.

After correcting the sign in the third (and higher) harmonics, we now find that for the first 12 days the values of KA/M which lead to reasonable agreement with the observed changes in eccentricity are quite close to 102 cm^2/g. For example, by assuming specular reflection ($K = 1$) and a decrease in mass of 0.6 lb/day, our theoretical predictions of the changes in the eccentricity from its initial value agree with changes deduced from observations to within 2 percent at all points. (The corresponding probable errors associated with the data range from 1 to 2 percent, except for the first two days after launch when the absolute changes were quite small.) On the other hand, by assuming specular reflection and no loss in mass, we find that after 12 days the predicted change in eccentricity is 4 percent below the observed change. (With respect to the argument of perigee, close agreement with the data is obtained in both cases.)

These differences between eccentricity changes estimated with an assumed loss in mass of 0.6 lb/day and changes estimated with no loss in mass do not conclusively establish that a detectable amount of gas escaped from Echo during this short period. Other physical phenomena about which little is known (such as variations in the solar constant) could also account for these differences.

Of course, since Echo was launched more than 3 months ago, many more data on its orbit have now accumulated. We find that the assumptions that K equals 1 and that loss in mass is 0 lead to changes in eccentricity which are 10 percent below those observed at the end of this extended period. Hence, it appears reasonably certain that by now Echo has lost a measurable portion of its gas. Preliminary attempts at adjusting the changes in KA/M to obtain close agreement with the data indicate that the rate of loss in mass decreased after Echo entered the earth's shadow.

The rather slow escape of gas from the balloon (slow as compared with the rate predicted by many before launch) may provide valuable information on the micrometeorite environment in the vicinity of Echo's orbit.

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Chromosomal Control of Preferential Pairing in Nicotiana

Abstract. A stock of tobacco with 23 pairs of tobacco chromosomes and one substituted pair from *Nicotiana glutinosa* was available. An amphiploid of this tobacco with *N. tomentosiformis* was synthesized in order to test whether preferential pairing is determined by the homologies of the chromosomes or whether it is under genic control. Characteristically, segregates for duplex loci in *N. tabacum* × *N. tomentosiformis* amphiploids give a gametic output of about 3:1, but for a factor on the substituted chromosome that output was found to be 59:1. The result suggests that preferential pairing in this material is not genically determined.

My co-workers and I (*1*) have used genetical segregation of synthetic amphiploids to measure differential affinity (*2*) of chromosomes. Since in any particular amphiploid the segregation ratios for independent factors were often found to be of similar magnitude, it became desirable to ascertain whether preferential pairing is determined, in our material, by individual chromosome homologies or whether it is under genic control. In the latter case, all chromosome sets of four would exhibit a similar degree of differential affinity, and would give similar genetic ratios, while under the former condition loci on different sets of chromosomes might give very different ratios.

Holmes Samsoun tobacco is an appropriate stock for such a test. In this variety Holmes (*3*) had substituted a pair of chromosomes from taxonomically distant *Nicotiana glutinosa,* which carried a dominant gene for resistance to mosaic disease, for a pair of tobacco chromosomes. The stock has been maintained over the years by selfing, and a recent test proved that it still contained 23 pairs of tobacco chromosomes and one pair from *N. glutinosa* (*4*).

The other parent for the synthetic amphiploid was *N. tomentosiformis.* This species is related to *N. tabacum* and is perhaps the closest living relative of that cultigen (*5*). Amphiploids *N. tabacum* × *N. tomentosiformis* have given consistently very small segregation ratios, indicating a close homology of the chromosomes of the two species and absence of differential affinity.

In general, an amphiploid which has obtained the recessive allele from one of its parent species and the dominant allele from the other may be symbolized as being of the genetic constitution *ZZzz*. If there is no differential affinity, the testcross of such an amphiploid will produce phenotypic ratios lying between 5:1 and 3.7:1, depending on the extent to which double reduction occurs. In *N. tabacum* × *N. tomentosiformis*