polare, which is presumed to have grown on the land (*9*). If it had been washed or blown onto T-3 in 1935, it would have lived 19 years to the time when a piece of it was revived in the laboratory (early in 1954; the next year the remainder could not be revived). This is precisely the longest period of which a record could be found of a moss tussock remaining viable in a herbarium (*10*).

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References and Notes

1. A. P. Crary, J. L. Kulp, E. W. Marshall, *Science* 122, 1171 (1955).
2. L. S. Koenig *et al.*, *Arctic* 5, 67 (1952).
3. A. P. Crary, R. D. Cotell, T. F. Sexton, *ibid.* 5, 211 (1952); A. P. Crary, *Trans. Am. Geophys. Union* 35, 293 (1954).
4. J. L. Kulp, unpublished quarterly progress reports and letters to the Air Force Cambridge Research Center.
5. N. Polunin, unpublished report on plant materials from ice island T-3, collected mainly in the vicinity of the North Pole; *Huitième Congr. Intern. Botan. Paris* (1954), Rapp. et Communs. aux Sect. 7 et 8, p. 170.
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7. E. Fritz and J. L. Averill, *J. Forestry* 22, 31 (1924); J. M. Harris, *Forest Products Research Notes New Zealand* 1 (4), 1 (1952).
8. B. Bannister and W. S. Glock, *in litt.* See W. S. Stallings, Jr., "Dating prehistoric ruins by tree-rings" (Tree-Ring Society with the cooperation of the Laboratory of Tree-Ring Research, University of Arizona, rev. ed., 1949); also *Botan. Rev.* 21, 73 (1955).
9. N. Polunin, *Nature* 176, 22 (1955).
10. N. Malta, Latvijas Augstskolas Raksti Acta Univ. Latviensis 1, 125 (1921).

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Electrophoretic Separation of Hemoglobins from the Chicken

Investigations of the dissociation of oxyhemoglobin in birds (*1, 2*) have led to the suggestion that there are two hemoglobins, one embryonic and one adult. Such differences exist in various mammalian species; these have been summarized by Lecks and Wolman (*3*). Recently, electrophoretic methods have been successfully used in separating mammalian hemoglobins (*4*). It appeared that the nature of avian hemoglobins could profitably be examined by a similar technique (*5*).

Hemoglobin was obtained from embryos and adults of White-Olympian-New Hampshire cross chickens. Blood samples were drawn from the vitelline artery, the heart, or from the radial veins, depending on the age of the chicken. Embryonic bloods from several individuals in a single age group were pooled to form a single sample for analysis. Heparin was employed as the anticoagulant. The cells were separated from the plasma by centrifugation and washed three times with 0.85-percent sodium chloride. The hemoglobin solution for analysis was prepared by adding 2 vol of distilled water to 1 vol of packed erythrocytes. The supernatant fluid, after centrifuging, was stored at −10°C, then thawed at room temperature for use. Electrophoretic patterns were obtained by applying 5 μl of this hemoglobin solution to the filter paper strips (S. and S. No. 204-313, 20 mm wide) in a thin line. A controlled voltage (300 v) was applied to the strips for 6 hours; the current increased from 6 to 12 ma. The strips were moistened with Veronal buffer (*p*H 8.8, ionic strength 0.05) prior to application of the sample. Boundary diagrams were prepared by direct readings of paper strips in a spectrophotometer (*6*). The results are plotted in Fig. 1.

The samples tested were from embryos (13, 15, 18, and 20 days), hatched chicks (up to 6 hours and 1, 2, 4, 6, 8, 11, and 18 days), and 6-month-old and 2-year-old chickens.

Two hemoglobins were observed in each age group tested. No marked differences were apparent among specimens. The faster moving component, designated as α-hemoglobin, appeared to be in lower concentration. The slower moving component was β-hemoglobin. Migration was toward the anode; the rate of migration was uniform in all samples (Fig. 1). Percentage composition of the hemoglobins, as determined by planimetry of boundary diagrams, appeared to vary with age. There was an approximate 30-percent reduction of the α component in the 2-year-old chicken as compared with the 18-day embryo—that is, 30 percent α and 70 percent β in the embryo, and 20 percent α and 80 percent β in the adult. Determinations on a limited number of samples indicated that the major portion of the change occurred within a few days after hatching.

As early as the 13th day of incubation, two hemoglobins are present. If one were essentially an embryonic hemoglobin and the other an adult hemoglobin (*1*), the replacement of the former by the latter would be expected. It appears that no such major replacement occurs. The average life-span of an avian erythrocyte has been reported to be approximately 32 days (*7*); yet the hemoglobin of both 6-month and 2-year chickens exhibits α and β components in relatively the same proportions as is found in young (18-day) chickens. A logical explanation of hemoglobin types is readily available in mammals; however, in birds, where no placental transfer of oxygen occurs, this explanation does not directly apply.

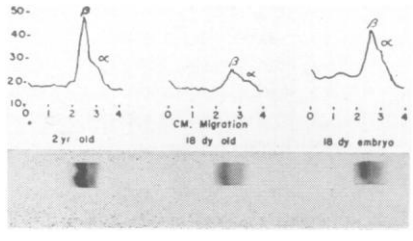

Fig. 1. Electrophoretic analysis of chicken hemoglobin.

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References and Notes

1. F. G. Hall, *J. Physiol. London* 83, 222 (1934).
2. H. H. Rostorfer and R. H. Rigdon, *Am. J. Physiol.* 146, 222 (1946).
3. H. Lecks and I. J. Wolman, *Am. J. Med. Sci.* 219, 684 (1950).
4. M. A. Andersch, D. A. Wilson, M. L. Menter, *J. Biol. Chem.* 153, 301 (1944); G. H. Beaven, H. Hoch, E. R. Holliday, *Biochem. J. London* 49, 374 (1951); A. I. Chernoff, V. Minnich, S. Chongchareonsuh, *Science* 120, 605 (1954); Karl Singer, *Yearbook of Pathology and Clinical Pathology 1953–1954.* (Yearbook Publishing Co., Chicago), p. 382.
5. Scientific paper No. 1408, Washington Agricultural Experiment Stations, Pullman; supported in part by Project No. 1056.
6. D. M. Schulz, R. L. Dryer, M. A. Holdcraft, *Tech. Bull. Register Med. Technol.* 24, 200 (1954).
7. J. Ottesen, *Nature* 162, 730 (1948).

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Production of Fungistatic Substances by Plant Tissue after Inoculation

Among the various attempts to learn how plants are able to resist invasion by pathogens, the most successful is the work of Link *et al.* (*1–3*), Angell, Walker, and Link (*4*), and Walker and Link (*5*), who showed that protocatechuic acid and catechol in the outer scales of colored onions were responsible for resistance to smudge and neck rot. Other instances of specific resistance owing to the presence of biochemical entities have been suggested but not proved. Johnson and Schaal (*6*) suggest that chlorogenic acid in the potato peel participates in resistance to scab. Müller and Behr (*7*) point out that tanninlike substances in the potato may be associated with resistance to late blight. The possibility that a pathogen-inhibiting substance might be produced by plant tissue in response to the presence of a pathogen has been conceived by some workers in the field. However, experimental proof has been lacking heretofore.

Helminthosporium carbonum race I, the incitant of a leaf-spot disease of corn, has an exceedingly narrow host range (*8*).