Hemoglobin Polymorphism in Chimpanzees and Gibbons

Abstract. *Hemoglobin polymorphism has been observed in the chimpanzee and two subspecies of gibbons. In chimpanzees, hemoglobins J and B were found in addition to hemoglobin A; J and B differed from A in their alpha and beta chains, respectively. Hemoglobins A and B were observed in different subspecies of gibbons; B differed from A in its beta chain.*

Variation in electrophoretic mobility of hemoglobin has been reported for several species of new- and old-world monkeys (*1*), for orangutans (*2*), and for gibbons (*3*). We found that hemoglobin polymorphism exists in the chimpanzee and two subspecies of gibbons.

Hemoglobin samples were obtained from 109 chimpanzees, comprising four subspecies (*4*)—54 *Pan troglodytes versus*, 31 *Pan troglodytes schweinfurthi*, 23 *Pan troglodytes troglodytes*, and one *Pan troglodytes koolo-kamba* — maintained at the 6571st Aeromedical Research Laboratory, Holloman Air Force Base; 14 gibbons (12 *Hylobates lar lar* and 2 *Hylobates lar pileatus*) from the Delta Regional Primate Center of Tulane University; and eight gibbons (*Hylobates lar lar*) from the primate colony of J. Moor-Jankowski, Department of Forensic Medicine of New York University Medical School. Erythrocytes were thoroughly washed with physiologic saline, *p*H 7.0, and were lysed with two volumes of cold, distilled water. The stroma was removed by centrifugation at 60,000*g* for 30 minutes, and the clear hemoglobin solution was converted to carbonmonoxyhemoglobin. Horizontal starch-gel electrophoresis (*5*) was performed in a 13.2 percent starch gel with a tris-EDTA-borate gel buffer, *p*H 9.1, and a borate buffer, *p*H 8.6, in the electrode chambers. A voltage gradient of 15 volt/cm was maintained for 75 minutes. After electrophoresis, hemoglobin zones were stained with a benzidine-peroxide mixture. Column chromatography with Amberlite IRC-50 (CG-50) was used for purification of hemoglobin (*6*). Aberrant hemoglobin chains were identified by recombination with canine hemoglobin, as suggested by Robinson and Itano (*7*).

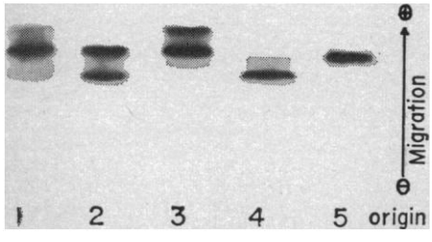

Fig. 1. Starch-gel electrophoresis, *p*H 9.1, of carbonmonoxyhemoglobin stained with benzidine-peroxide: (1) human hemoglobin (Hb) J/A/S; (2) chimpanzee Hb A/B; (3) chimpanzee Hb J/A; (4) gibbon Hb B; and (5) gibbon Hb A.

The single major component of chimpanzee and gibbon hemoglobin—chimpanzee hemoglobin A (Hb A^{Ch}) (*8*) and gibbon hemoglobin A (Hb A^{Gi})—has been shown to be electrophoretically similar to human hemoglobin A. In our study the hemoglobins of 107 of 109 chimpanzees examined electrophoretically had a single major component indistinguishable from human hemoglobin A at *p*H 9.1. A second minor component having the mobility of hemoglobin A_2 was also present in each case. One chimpanzee showed a second fast major component hemoglobin J (Hb J^{Ch}), similar in electrophoretic mobility to human hemoglobin J (Fig. 1). This component was found by column chromatography to constitute about 30 percent of the total hemoglobin. A second chimpanzee exhibited, in addition to Hb A^{Ch}, a slow major component hemoglobin B (Hb B^{Ch}), similar in electrophoretic mobility to that of human hemoglobin S (Fig. 1). The slow component constituted about 40 percent of the total hemoglobin; Hb $A_2{}^{Ch}$ was also present.

Recombination of Hb J^{Ch} and Hb B^{Ch} with canine hemoglobin indicated that Hb J^{Ch} differs from Hb A^{Ch} by a substitution in the α-chain, and that Hb B^{Ch} differs from Hb A^{Ch} by a substitution in the β-chain. The two chimpanzees with Hb J^{Ch} and Hb B^{Ch} thus represent heterozygosity for genes of the α-chain and β-chain, respectively (*6*). In view of the fact that the Holloman colony was not a breeding colony until recently, it is not surprising that additional heterozygotes or Hb J and Hb B homozygotes were not found. The J/A and A/B heterozygotes have been classified as *P. t. schweinfurthi*. At this time, it is premature to speculate on the degree of hemoglobin variation of one subspecies as compared to another. However, the transferrin data of Goodman *et al.* (*9*) and the blood-group data of Moor-Jankowski *et al.* (*4*) suggest that *P. t. schweinfurthi* is more heterogeneous than the other three chimpanzee subspecies.

Twenty gibbons (*H. l. lar*) exhibited Hb A^{Gi} (Fig. 1), while the two gibbons of the *H. l. pileatus* subspecies had Hb B^{Gi} (Fig. 1). Recombination of Hb A^{Gi} and Hb B^{Gi} with canine hemoglobin indicates that the two hemoglobins differ in their β-chains. Evidence obtained from peptide-map analysis of the β-chains indicates that the difference is confined to a single peptide (*10*). Although our sample of the two subspecies is small, the occurrence of only homozygous hemoglobin types is significant in view of the blood-group data of Wiener *et al.* (*11*). Our data indicate that *H. l. lar* and *H. l. pileatus*, being interfertile, could be allopatric species. An examination of a larger number of hemoglobin phenotypes from the two subspecies, as well as more information concerning their exact geographic habitat, is necessary before the presumed allopatry can be confirmed.

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References and Notes

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