DNA Polymorphisms in the $\psi$β₁- and β-Globin Gene Regions in Asian Macaques

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DNA polymorphisms in the $\psi$β₁-β-globin gene region in nine Asian macaques (Macaca fuscata, M. mulatta, M. nemestrina, M. cyclopis, M. fascicularis, M. arctoides, M. radiata, M. maura, and M. assamensis) were examined using several restriction endonucleases and the human $\psi$β₁, δIVS2, and βIVS2 probes. The BamHI site 3' to the β-globin gene was polymorphic in M. fuscata and M. mulatta, while the HincII site and the EcoRI site in the δβ₁-globin gene region was highly polymorphic in M. fuscata and M. mulatta, respectively. These polymorphic sites also seem to be present in other Asian macaques. The present study of the polymorphism at the BamHI site 3' to the β-globin gene in Asian macaques supports, at the nuclear DNA level, the idea that the fascicularis group including M. fuscata, M. mulatta, M. cyclopis, and M. fascicularis is different from other Asian macaque groups.

KEY WORDS: DNA polymorphisms; $\psi$β₁-globin gene; δ-globin gene; β-globin gene; macaques.

INTRODUCTION

In the human (Homo sapiens), the β-globin gene cluster on chromosome 11 includes six loci arranged 5'-ε-Gγ-Aγ-ε$\psi$β₁-δ-β-3' within a stretch of DNA about 60 kilobases (kb) long (Collins and Weissman, 1984). The ε-globin gene is active in embryos; the Gγ- and Aγ-globin genes, in fetuses; and the δ-
and β-globin genes, in adults (Bunn and Forget, 1986). The ψβ₃(ψη)-globin gene (Harris et al., 1984) is a pseudogene, and the activity of the δ-globin gene is very low in humans (Bunn and Forget, 1986). The δ- and β-globin genes in higher primates are supposed to have arisen from a common ancestral gene through gene duplications (Collins and Weissman, 1984).

The presence of the δ-globin gene has been demonstrated in Old World monkeys such as *Macaca mulatta* (rhesus monkeys) and *Papio papio* (baboons), although the gene is silent (Martin et al., 1980, 1983). It was thought that the δ-globin gene arose before the divergence of Old World monkeys, apes, and humans from New World monkeys, and it then became silent after the divergence of old world monkeys from apes and humans (Martin et al., 1983). Evolution of the β-globin gene cluster in primates has been studied using restriction site differences (Barrie et al., 1981).

In order to understand the genetical relationships between macaques, the genomic restriction fragment length polymorphisms (RFLPs) in the ψβ₃-β-globin gene region of nine Asian macaques were analyzed. We have made restriction endonuclease cleavage site maps for macaques, compared RFLPs among macaques, and found that the *BamHI* site polymorphism 3′ to the β-globin gene is a good DNA marker for discussing genetical relationships among macaques.

MATERIALS AND METHODS

Peripheral blood samples (10 ml) from adult macaques were collected at the Primate Research Institute, Kyoto University, Inuyama, Aichi. Macaques used in the present study were 48 Japanese macaques (*M. fuscata*) from eight different regions in Japan, 20 rhesus (*M. mulatta*) from China (10) and India (10), 2 pig-tailed (*M. nemestrina*) from Malaysia, 2 Taiwan (*M. cyclopis*) from Taiwan, 2 crab-eating (*M. fascicularis*) from Indonesia, 2 stump-tailed (*M. arctoides*) from Thailand, 2 bonnet (*M. radiata*) from India, 2 Moor (*M. maura*) from Indonesia, and 2 Assam (*M. assamensis*) from India.

DNA preparation, restriction endonuclease digestion, agarose gel electrophoresis, Southern transfer of DNA, preparation of a ⁴³P-labeled DNA probe by nick translation, hybridization and washing nitrocellulose filters, and autoradiography were carried out according to the methods of Old and Higgs (1983). Probes used in the present study were the human ψβ₃ (1.7-kb *EcoRI/XbaI* DNA fragment), δIVS2 (1.0-kb *BamHI/EcoRI* fragment), and βIVS2 (1.2-kb *BamHI/EcoRI* fragment).