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Full-length MHC class II alleles in three New World monkey species

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Thirty newly identified full-length MHC class II alleles in three New World monkey species.

KEYWORDS

common marmoset, cotton-top tamarin, gray-bellied night monkey, nonhuman primates

New World monkeys (NWM) are primates that are found in the tropical regions of Central and South America and Mexico. Five families are known: *Callitrichidae*, *Cebidae*, *Aotidae*, *Pitheciidae* and *Atelidae*, and they are ranked together as the *Cebidea*, the only superfamily in the parvorder *Platyrrhini*. NWMs are small- to mid-sized primates, and differ from Old World monkeys in several aspects. A prominent feature of NWM is the flatter nose with side-facing nostrils, which gave them the name *Platyrrhini* (flat nosed).

One species of NWM used in this study was the common marmoset (*Callithrix jacchus*). Marmosets are small monkeys, with an average weight of 250 g and a relatively long tail. They are native to east-central Brazil, and live in different habitats, varying from Atlantic coastal forest to dry secondary forests farther inland. The common-marmoset is widely used in biomedical research

as an animal model for human degenerative and immune-related diseases, which dictates the investigation of their immune system.^{1,2} Extensive sequencing has already been performed on the class I and class II DRB genes in different cohorts of animals, and many alleles are archived in the nonhuman primate section of the IPD-MHC database (<https://www.ebi.ac.uk/ipd/mhc/>).³ Here we present a first investigation of the polymorphism of the other class II genes: DPA, DPB, DQA and DQB in 24 marmosets. In addition, we studied these genes in nine gray-bellied night monkeys (*Aotus lemurinus*) as well as 13 cotton-top tamarins, for both of which B-cell lines are available at the BPRC. The gray-bellied night monkey is a nocturnal species. Its small round head is dominated by two large, brown eyes, which give it an owl-like appearance. The monkeys are found in (sub) tropical forests in Colombia and neighboring countries.

The cotton-top tamarin (*Saguinus oedipus*) is a small monkey (< 0.5 kg), with white hair that spans its head and neck. Cotton-top tamarins, native to a small area of northwest Colombia, are endangered as a result of deforestation of their habitat.

The PCR primer sets that we used were originally developed for the full-length class II genes in macaques.⁴ The primers have also proven to be effective for the amplification of these genes in great apes.^{5,6} Direct sequencing was performed on the PCR products, and samples were run on a Genetic Analyzer 3500. The peak-patterns were analyzed using MacVector software, version 16.0.10. Based on animals homozygous for a

particular MHC class II gene and on pedigree analysis, the two alleles in heterozygous samples could be determined. A cloning step was needed for only five marmoset DQA samples. In the marmosets all four class II genes were successfully amplified and sequenced. The DPA and DPB genes seem to be invariant in these animals, whereas both DQA and DQB show polymorphism. In the night monkeys and tamarins, only the DQA and DPB primers led to successful amplifications, although *Aole-DQB1*23:01* was amplified in cDNA samples of three monkeys. For further analyses of class II genes in NWM, the design of more species-specific primers is required.

TABLE 1 Novel alleles observed in this study, together with accession-numbers

Species	Allele	Accession	Animal
Common marmoset	<i>Caja-DQA1*28:01:01</i>	LR596537	38R, 75 N
	<i>Caja-DQA1*28:01:02</i>	LR596538	38R, 67R
	<i>Caja-DQA1*28:02</i>	LR596539	41R, 91 V
	<i>Caja-DQA1*29:01:01</i>	LR596540	Avon, Earth
	<i>Caja-DQA1*29:01:02</i>	LR596541	Earth, Errant
	<i>Caja-DQA1*28:03</i>	LR596542	Annabelle, Anorak
	<i>Caja-DQA1*27:01</i>	LR596543	Errant
	<i>Caja-DQA1*29:02</i>	LR596544	Avon
	<i>Caja-DQB1*23:01</i>	LR596545	Annabelle, Anorak
	<i>Caja-DQB1*23:03</i>	LR596546	Annabelle
	<i>Caja-DQB1*23:04</i>	LR596547	Enwor, Ergo
	<i>Caja-DPA1*19:01</i>	LR596548	24 monkeys
	<i>Caja-DPB1*27:01</i>	LR596549	24 monkeys
	<i>Caja-DPB1*27:02</i>	LR596550	Earth, Errant
Gray-bellied night monkey	<i>Aole-DQA1*27:01</i>	LR699076	A50, A0103
	<i>Aole-DQA1*27:02</i>	LR699077	A0005, A58
	<i>Aole-DQA1*27:03</i>	LR699078	A0204
	<i>Aole-DQB1*23:01</i>	LR699079	A0005, A58
	<i>Aole-DPB1*29:01</i>	LR699080	A50, A0204
	<i>Aole-DPB1*28:01</i>	LR699081	A0005
	<i>Aole-DPB1*28:02:01</i>	LR699082	A58, A0105
	<i>Aole-DPB1*28:02:02</i>	LR699083	A50, A0103
Cotton-top tamarin	<i>Saoe-DQA1*27:01</i>	LR699084	95-07, R187
	<i>Saoe-DQA1*27:04</i>	LR699085	T00-06, T00-07
	<i>Saoe-DQA1*29:01</i>	LR699086	95-07, R187
	<i>Saoe-DQA1*29:02</i>	LR699087	B224, T00-03
	<i>Saoe-DQA1*29:03</i>	LR699088	B224, T00-03
	<i>Saoe-DPB1*30:01:01</i>	LR699089	95-07, 95-50
	<i>Saoe-DPB1*30:01:02</i>	LR699090	96-02, B224
	<i>Saoe-DPB1*30:02</i>	LR699091	96-02, R187

Note: For each allele, one or two reference animals are listed. *Caja-DPA1*19:01* and *-DPB1*27:01* were detected in all 24 marmosets.

All alleles found in this study were submitted to the European Nucleotide Archive, and to the nonhuman primate section of the IPD-MHC database (Table 1). The alleles were given designations in accordance with the rules described in the latest nomenclature report on non-human primate MHC.⁵

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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