

# **Age-related changes in the skulls of Japanese macaques**

**By Nguyen Van Minh**

I investigated age-related changes in the skull and mandible of Japanese macaque (*Macaca fuscata*), using dried skulls. In chapter 1, I studied age-related skull morphometric changes of Japanese macaque. Some skull dimensions increased from young adulthood (7.0 years) and peaked at 13.3–19.0 years in males and at 19.7–22.6 years in females. Some dimensions remained at the level of peak to very old age, and others continued increasing through very old age. The continuous increase of cranial size in adulthood has also been observed in humans but the smaller magnitude of change. Facial and mandibular dimensions showed larger and more significant increases than neurocranial dimensions in macaques, as in humans. The face and mandible are greatly influenced by tooth loss and/or dental disorders, and I found large changes were also found in skulls with the loss of several teeth. Intertemporal distance and biorbital breadths after 16.0 years of age decreased significantly in males, and cranial and posterior basicranial lengths increased only in males. I suggest that these craniometric changes are associated with the development of insertion area onto which muscles attach. In chapter 2, I investigated age-related changes in the craniofacial thickness of Japanese macaques, using computed tomography scans. The cranial thickness at many sites in neurocranium showed a pattern of increasing from young adulthood (7.0–9.0 years) to mid-adulthood (15.0–19.5 years in males and 19.7–22.2 years in females) and decreasing to very old age (26.9 years or older). However, the thickness at the two facial sites (maxilla and at the bone of zygomatic bone) showed an exceptionally distinctive pattern of decreasing from young adulthood to very old age in both sexes. The thickness at crown sites on the mid-sagittal plane significantly increased in males from young adulthood to mid-adulthood that did not in females. This sex difference may be associated with the differences in the size of projecting face and canines. The cranial thickness at other sites in macaques showed a significant decrease from mid-adulthood to very old age in both sexes, however, females revealed more sites with decreasing thickness than males. In chapter 3, I investigated age-related changes in the definitions of the sulcus imprint on the endocranium of Japanese macaques from juveniles to old age, using virtual endocasts generated by computed tomography scans. The definitions of the sulcal imprints showed a slight decrease from the juvenile period (age group 2–4 years) to the adolescent period (group 4–6 years), and then, remained unchanged to mid-adulthood (age group 15–16 years). After that, the definiteness significantly decreased to old age (age group >20 years). The decrease in the definiteness of the sulcal imprints between the younger age classes and the older age class may be associated both with the shrinkage of the brain and an increase of the endocranial volume with age.

Bone minerals of postcranial skeletons are absorbed more than deposited with advancing age in general. In present study, the cranial thickness in macaques showed a significant decrease from mid-adulthood to very old age in both sexes, however, females revealed more sites with decreasing thickness than males. This sex difference may be associated postmenopausal estrogen depletion in female macaques. Age-related changes in the skull are associated with the development of insertion area on which muscles attach accumulating physical stress.