博士論文の要約

氏　　名　清古　貴

論文題目　Visual adaptation to the aquatic environment in sea snakes

要旨

Evolutionary transitions from terrestrial to aquatic life history cause drastic changes in sensory systems of amniotes (namely mammals, reptiles, and birds). Indeed, the drastic changes in vision have been reported in many aquatic amniotes, convergently (e.g. lost opsin gene and shifted absorbance spectra between deep divers in cetaceans and pinnipeds). Among amniotes, snakes and mammals share the background about two distinctive features: possessed same number of opsin genes and the presence of fully marine species. Recently, polymorphism in the opsin genes of the full-aquatic sea snakes have been reported. However, those of the amphibious sea snakes have not been examined in detail. Compared with all other aquatic species among the amniotes, only sea snakes have closely related species that are amphibious lifestyle. A comprehensive understanding of vision among sea snakes including amphibious and fully aquatic species is very important for study about adaptation process to the fully aquatic in amniotes.

Here, I investigated opsin genes and visual pigments of sea snakes and terrestrial relatives. I determined the sequences of *SWS1*, *LWS*, and *RH1* genes from one terrestrial, three amphibious and four fully-aquatic elapids. Amino acid replacements at four and one spectra-tuning positions were found in LWS and RH1, respectively. I measured or predicted absorption of LWS and RH1 pigments with A1-derived retinal. During their evolution, blue shifts of LWS pigments had occurred stepwise in amphibious sea snakes and convergently in both amphibious and fully-aquatic species. Considering the ecological characteristics of sea snakes, blue shifted LWS pigments may have adapted to deep water or open water environments dominated by blue light.

The evolution of opsins differs between marine mammals (cetaceans and pinnipeds) and sea snakes in two fundamental ways: 1) pseudogenization of opsins in marine mammals; and 2) large blue shifts of LWS pigments in sea snakes, in spite of the great difference in depth of habitat. It may be possible to explain these two differences at the level of photoreceptor cell composition given that cone and rod cells both exist in mammals whereas only cone cells exist in fully-aquatic sea snakes. I hypothesize that the differences in photoreceptor cell compositions may have differentially affected the evolution of opsins in divergent amniote lineages.