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The unique biodiversity of Pulau Tioman,
Malaysia

メタデータ	言語: 出版者: 琉球大学21世紀COEプログラム 公開日: 2009-01-07 キーワード (Ja): キーワード (En): 作成者: メールアドレス: 所属:
URL	http://hdl.handle.net/20.500.12000/8748

The Late Pleistocene-Holocene changes in the distribution and body size of amphibians on Okinawajima Island, the Ryukyu Archipelago, Japan

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The fossil study is one of the most effective ways to uncover the past temporal changes of organismal diversity at a given locality and in a given evolutionary lineage. For the Quaternary insular fauna, this approach is known to be particularly fruitful in that it sometimes clarifies various historical biological phenomena in a given clade, such as the evolutionary changes in body size and other morphological characters, and diversification and extinction caused by environmental changes. To take advantage of such paleontological approaches, however, there are at least two strict preconditions as follows: (1) soil of the area in problem should be favorable to fossilization of dead bodies of organisms; and (2) organisms in problem should have hard body parts, such as bony elements, which can be easily fossilized. The southern part of Okinawajima Island, the Ryukyu Archipelago, is one of the major sources of the Quaternary terrestrial animal fossils in Japan, because this area is broadly covered by the Pleistocene limestone, and, therefore, infills of fissures developed in the limestone cliffs and floor deposits of the limestone caves, both usually dated back to the Late Pleistocene, contain numerous fossil remains. However, very few studies have yet been conducted on the fossils from this region, and this situation is particularly true with amphibians despite high abundance of their fossils at some fissures and caves. I have examined morphological features of amphibian fossils collected from two chronologically different fissures in the southern part of the island. Detailed comparisons using skeletal specimens of various extant species revealed that these southern Okinawajima fossils represent no less than eight species that also occur on Okinawajima at present. Of these species, five, *Rana holsti*, *R. ishikawae*, *R. narina*, *R. sp.*, and *Limnonectes namiyei*, do not currently occur in the southern part of the island, where vegetation is relatively open and the surface waters are limited and mostly temporary at present: these five species are currently confined to the northern part on this island, where the deep subtropical broad-leaf forest predominates with a number of constantly running streams on the floor. Because all these five species require the year-round existence of running waters for reproduction and completion of larval growth, discovery of their fossils from the southern part strongly suggests that the Late Pleistocene natural environment of this region was distinctly different from that in the same region, but similar to that in the northern part at present. These frogs seem to have disappeared from the southern part during the last 20,000 years, as a result of deterioration of the natural vegetation, which was caused by the climatic change and, presumably, also by the anthropogenic environmental changes. Moreover, our studies have revealed that in several frog species body size is statistically significantly larger in the fossil individuals than in the extant animals. The body size in some species also differed between the two different fossil sites (see above). Possible factors responsible for such body size variations are discussed.

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Pulau Tioman is the largest island off the East coast of Peninsular Malaysia and is home to many interesting botanical and zoological organisms. Of interest here, the endemic freshwater brachyurans, ichthyological and herpetological examples are highlighted. Recent papers and unpublished results are also incorporated as further evidence of Tioman's uniqueness.