論文の内容の要旨

論文題目　Paleoecological study of the earliest Cambrian biological activity evidenced by the diversification of ichnofossils

（生痕化石の多様化から探るカンブリア紀最前期の動物活動の古生態学的解明）

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In order to better understand the diversification of the animal activities in the earliest Cambrian, ichnofossils were comparatively studied in three different locations (Newfoundland, Canada, Yunnan, China and Gobi-Altai, Mongolia). Special attention was paid for following topics. 1) To understand the development mode of the animal behaviors, the diversification patterns of ichnofossil were studied. 2) To know the adaptation processes to different environments, change of the ichnofossil assemblages in different sedimentary facies were surveyed. 3) To reveal the body sizes of trace maker animals, size distributions of the tube-shaped ichnofossil *Planolites* were investigated. 4) To clarify the activation processes of animal activities, densities of ichnofossils with covering on the bedding plane were measured.

The diversification pattern of ichnofossils in the earliest Cambrian Chapel Island

Formation, Newfoundland shows that the major diversification of the ichnofossils occurred twice; firstly at the almost basal part of the Pc-C boundary, secondary around the boundary of the *Treptichnus pedum* and *Rusophycus avalonensis* zones. The ichnofossil assemblages are relatively common to different depositional facies, suggesting that there was no conspicuous specialization of these assemblages to a particular facies. This result indicates that the animal behavior occurred in a wider environmental spectrum in the earliest Cambrian than those of the later ages. On the other hand, ichnofossil assemblages were considerably differed in the late Early Cambrian Balang and Chintingshan formations in China. One of the possible explanations for this change would be that the animals have started to adapt and to be diversified their behavior corresponding to the environment since the late Early Cambrian.

The size (width) of *Planolites* should represent the size of the trace maker. In Newfoundland, the size distribution of *Planolites* in the *T. pedum* Zone was generally small. However, that of the *R. avalonensis* Zone is greater than the *T. pedum* Zone. Thus, there should be an increase in the size of *Planolites* producers near the boundary of the two zones. On the other hand, the size distribution of *Planolites* in the Zhujiaqing Formation, Yunnan and the Bayan Gol Formation, Gobi-Altai showed that the various sizes animals already appeared in the *T. pedum* Zone. Besides, the densities of ichnofossils on the bedding planes were low in the *T. pedum* Zone in Newfoundland, although these became large in the *R. avalonensis* Zone. The densities in Yunnan and Gobi-Altai,

however, were already high in the *T. pedum* Zone. Therefore, the animal activity firstly became intense in the *R. avalonensis* Zone in Newfoundland, whereas these were already intense in the *T. pedum* Zone in Yunnan and Gobi-Altai. In addition, the occurrences of specific ichnofossils were also different depending on the area. *Gyrolithes* isp. was well observed in Newfoundland, but not observed in Yunnan and Gobi-Altai. *Didymaulichnus miettensis* showed different trend of *Gyrolithes*. *Didymaulichnus* frequently occurred in Yunnan and Gobi-Altai, but not in Newfoundland.

Therefore, there were geographical differences about the animal activity between Newfoundland, Yunnan and Gobi-Altai. The one possible factor of the geographical difference can be based on the difference of the latitudes between these three areas. The earliest Cambrian Newfoundland was located in high-latitude area, whereas Yunnan and Gobi-Altai was in low-latitude area. Thus, various sizes animals and their intense biological activities could firstly occur in low latitude area in the *T. pedum* Zone. These animal activities subsequently reached high latitude area in the *R. avalonensis* Zone.

In spite of the intense biological activity, the Precambrian-typed microbial mats still covered some sediment surfaces in the Early Cambrian. There were no ichnofossils on the surface of the microbial mat structures (wrinkle structure). Thus, the biological activities on the microbial mats were weak. Ichnofossils are directly associated with the wrinkle structures on their surface in the Middle Cambrian, as exemplified in the Wolsey Shale Formation in the northern Bighorn Basin,

Wyoming. The biological activity had intermittently become weak in the Middle Cambrian, but the animal activity was strong enough to penetrate the firm microbial mat grounds and leave ichnofossils on their structures.