● 田近 周 特定助教

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研究課題： 白亜紀末大量絶滅事変における海洋酸性化イベントの復元による頭足類絶滅メカニズムの解明
（Investigating the link between ocean acidification and selective extinction of cephalopods）

専門分野： 古生物学（Paleontology）

受入先部局： 人間・環境学研究科（Graduate School of Human and Environmental Studies）

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私の専門は古生物学という地球史において絶滅した生物に関する研究を行う分野です。私はこれまで海棲無脊椎動物を中心に研究を行ってきました。海棲無脊椎動物は化石記録が豊富であり、化石を用いて進化や絶滅に関する様々な研究をすることが可能です。

私の白眉プロジェクトにおける研究では、白亜紀末に起きた大量絶滅事変に注目し研究を行います。白亜紀の大量絶滅事変では地球上に生息する約 75％の生物種が絶滅したと考えられています。その中で頭足類（イカやタコの仲間）においては、類似した殻形態をもつアンモナイト類は絶滅し、オウムガイ類は絶滅を免れていますが、その絶滅の選択性についての詳細は解明されていません。本研究では、過去の古環境変動復元と殻形態の変化を高解像度で分析することによって白亜紀末における頭足類の絶滅の選択性について解明を目指します。

Why Paleontology?

Paleontology, also known as paleobiology, is the study of the history of life on Earth. It was traditionally focused on “discoveries,” implying that documenting new fossils was a primary objective, which is still the public perspective about paleontology. However, in recent years, the advent of novel techniques as well as the data collected in the past centuries have significantly advanced the field, even though the discovery of new fossils remains crucial. For instance, paleontology provides us with the sole direct evidence of the history of evolution and the diversity of life across geological timescales. It elucidates how life has adapted to Earth's evolving environments and how these environments have been shaped by the existence of life, thereby enhancing our understanding of global biodiversity. Many researchers suggest that we are currently experiencing the “sixth mass extinction event”. By understanding the past mass extinction events, paleontologists can offer insights into what we may anticipate in a similar contemporary scenario. This includes determining which species are at the highest risk, identifying the ecosystems likely to be most profoundly impacted, and estimating the duration of potential recovery. The fossil record can supply data on Environmental changes and resulting species diversity loss have become major issues in the modern world. In order to better understand our current situation, it is necessary to look at Earth history. As a paleobiologist, I have attempted to answer questions regarding environmental changes and their ecological consequences using fossils.

The K-Pg mass extinction event is one of the “Big five” mass extinctions, in which the taxonomic diversity significantly decreased. Studying such a mass extinction event can provide important insights into the ecological and evolutionary impacts caused by rapid environmental changes. In the marine realm, the selective extinction in cephalopods, which include squids and octopuses, is an iconic example of the extinction selectivity at the K-Pg mass extinction; Both ammonoids and nautiloids, despite their similar external shells, experienced drastically different fates during this event. Ammonoids met their end, while nautiloids survived the mass extinction. While several hypotheses have been postulated in previous studies, the definitive cause of this selective extinction remains shrouded in mystery. With the application of advanced geochemical and tomographic techniques, I aim to unearth the mechanisms behind the selective extinction phenomenon among cephalopods.

how ecosystems responded to and recovered from past mass extinctions. This information can steer modern conservation efforts, assisting us in understanding which strategies are likely to be most effective. Moreover, the fossil record can aid in constructing models that predict potential outcomes of the current trends in biodiversity loss.

Cephalopods

Cephalopods are a group of mollusks, which includes squids, octopuses (both mostly lacking external shells), ammonoids and nautiloids (both possessing external shells). The external shells of extinct cephalopods were often fossilized and are therefore frequently found in the field. Due to their worldwide distribution, high abundance, and rapid evolutionary rate, extinct cephalopods serve as significant model organisms for studying various aspects of evolution and paleontology, including paleoecology, biostratigraphy, paleobiogeography, and diversity reconstruction. Ammonoids thrived for approximately 300 million years, survived several mass extinction events and ultimately went extinct at the K-Pg mass extinction event. Consequently, many researchers have investigated ammonoids with respect to mass extinction events.

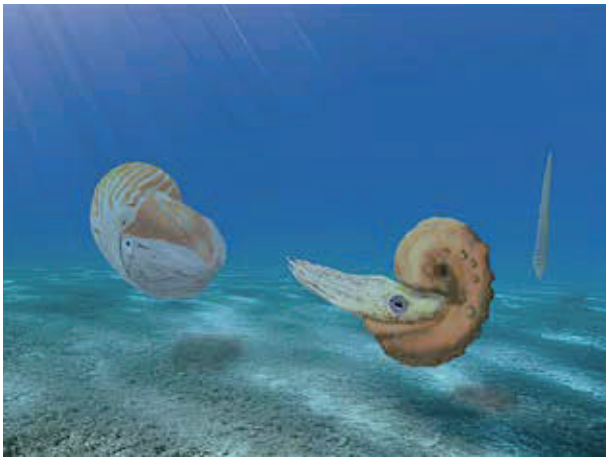

Fig. 1. Reconstruction of ammoinoids (right) and nautiloid (left) at the latest Cretaceous.

K-Pg mass extinction event and selective extinction in cephalopods

The K-Pg (Cretaceous-Paleogene) mass extinction event, which occurred about 66 million years ago, was triggered by an asteroid impact. Although this event, resulting in the extinction of approximately 75% of species, was not the most devastating mass extinction event, it is the most famous mass extinction event for the general public due to the demise of some famous groups including non-avian dinosaurs. The K-Pg mass extinction event holds great interest for scientists because of its selective nature. An iconic example of selective extinction at the K-Pg mass extinction event is cephalopods—ammonioids and nautiloids, both of which possessed an external shell. Although ammonoids were more abundant and diverse in the Cretaceous oceans, ammonoids became extinct and nautiloids survived. Several hypotheses have been proposed to explain the selective extinction and the kill mechanism. Proposed intrinsic (biotic) factors for the selective extinction include the difference in hatching size, geographical distribution and basal metabolic rate (Tajika et al. 2023). Ocean acidification is considered a major extrinsic (abiotic) factor of the selective extinction because it is known that a decrease of pH affects the calcification of marine calcifiers (e.g., planktic gastropod pteropods; Orr et al. 2005). Despite all the hypotheses, it was difficult to test most of the hypotheses to date due to, for example, lack of techniques. With respect to environmental changes at the K-Pg mass extinction event, we have evidence of ocean acidification (Henehan et al. 2019). However, the degree to which ammonoids and nautiloids responded to the change in pH remains uncertain.

Exploring the link between ocean acidification and selective extinction of cephalopods

My research will explore the potential link between ocean acidification and shell calcification in cephalopods at the end of the Cretaceous. As demonstrated in previous studies, the decrease of pH affects the calcification of marine calcifiers. Thus, my research aims to reconstruct the cephalopod shell calcification in response to ocean acidification. The results of this research will serve not only to improve our knowledge of ammonoid paleobiology and reveal the possible cause of their extinction but they will also yield important information to better understand evolutionary processes in cephalopods. This is particularly important in the light of the ongoing ‘sixth mass extinction’. In addition, this method can also be applied to other geological time periods, helping to solve further paleobiological questions such as earlier extinction events and radiations.

References

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