平成２５年度第２次募集

新潟大学大学院自然科学研究科博士前期課程入学者選抜試験問題

外国人留学生特別入試

環境科学専攻

地球科学コース

Ｅ５

専門科目（地球科学）

注意事項

1　この問題冊子は，試験開始の合図があるまで開いてはならない。

2　問題冊子は，表紙を含めて全部で７ページある。

3　解答は，すべて解答用紙の指定された箇所に記入すること。

4　受験番号は，各解答用紙の指定された箇所に必ず記入すること。

5　解答時間は，１８０分である。

6　下書きは，問題冊子の余白を使用すること。

1　あなたが大学院にて実施予定の研究について，次のような章立てで論理的に説明せよ。

（１）研究課題名

（２）研究課題の学術的背景と問題点

（３）研究目的

（４）研究計画

（５）期待される研究成果

2 Read the following article and answer the questions <u>in English</u>.

Dinosaur body temperatures determined from isotopic (^{13}C-^{18}O) ordering in fossil biominerals [Modified from Eagle, R. A. et al. 2011 Science, 333, 443-445]

For the majority of the time since dinosaurs were first named in 1842, it was assumed that their metabolism was similar to ectothermic "cold-blooded" reptiles that derive the heat they need to function from the environment, rather than endothermic "warm-blooded" mammals and birds, which have higher and more stable body temperatures regulated by internal metabolic heat production. However, in the 1960s and 1970s, evidence began emerging that endothermy could be more consistent with observations on the behavior, paleogeographic distribution, and anatomy of dinosaurs. The initial case for dinosaur endothermy was largely made on the basis of interpretations of the inferred physical performance and behavior of dinosaurs, such as estimating running speeds from preserved tracks and predator/prey ratios determined by comparing biomass estimates from the fossil record to those ratios in modern ecosystems. These methods have been extensively debated and have sparked several decades of study on dinosaur thermoregulation by using biophysical and behavioral modeling, bone histology and growth rate analysis, anatomical observations, and oxygen isotope paleothermometry.

Sauropod dinosaurs are the largest terrestrial animals that have ever lived, and therefore understanding their physiology poses a particular challenge. Perhaps the most convincing argument in favor of endothermy in sauropod dinosaurs comes from the analysis of bone histology, which suggests very high growth rates that could not be sustained by a low basal metabolic rate. Conversely, the case for ectothermy in sauropods has been made by modeling heat exchange by animals with the environment, suggesting that endothermic sauropods would have severe problems with overheating. Recently, Gillooly et al. (2006) presented a biophysical model that is based on allometric scaling laws and dinosaur growth rate analysis, predicting that dinosaur body temperatures would increase as their mass increased, reaching over 40°C for the largest Sauropods. Such models imply that dinosaurs were ectotherms, but that some dinosaurs would achieve high body temperatures because of their large mass. This phenomenon has been termed "gigantothermy".

We applied a different approach to this problem, using clumped isotope thermometry to determine the body temperatures of large Jurassic Sauropods by analyzing material from six sites. This technique is founded on the thermodynamic preference of rare heavy isotopes of carbon (^{13}C) and oxygen (^{18}O) to bond with each other (^{13}C-^{18}O), or "clump," in carbonate-containing minerals. Unlike the well-established oxygen isotope thermometer, application of clumped isotope thermometry is not dependent on knowing or assuming the oxygen isotope composition of the water from which a mineral grew. The parameter measured in this approach is the $\Delta 47$ value of CO_2 liberated from the carbonate component of tooth bioapatite. This approach is capable of reconstructing the expected body temperatures of modern and fossil mammals and ectotherms with an accuracy of ~1°C and a precision of 1° to 2°C.

Our data indicate body temperatures of Sauropod dinosaurs were in the range between 36° and 38°C, which are similar to those of most modern mammals (Fig. 1). This temperature range is 4° to 7°C lower than predicted by a model that showed scaling of dinosaur body temperature with mass, which could indicate that sauropods had mechanisms to prevent excessively high body temperatures being reached because of their gigantic size. One possible explanation of this result is that adult Sauropods had mechanisms to prevent excessively high body temperatures being reached and so could regulate their body temperatures to some extent. Overall, our data are most consistent with the hypothesis that Sauropods sustained high metabolic rates during ontogeny to reach their gigantic size so rapidly, but that in maturity a combination of physiological and behavioral adaptations and/or a slowing of metabolic rate prevented problems with overheating and avoided excessively high body temperatures.

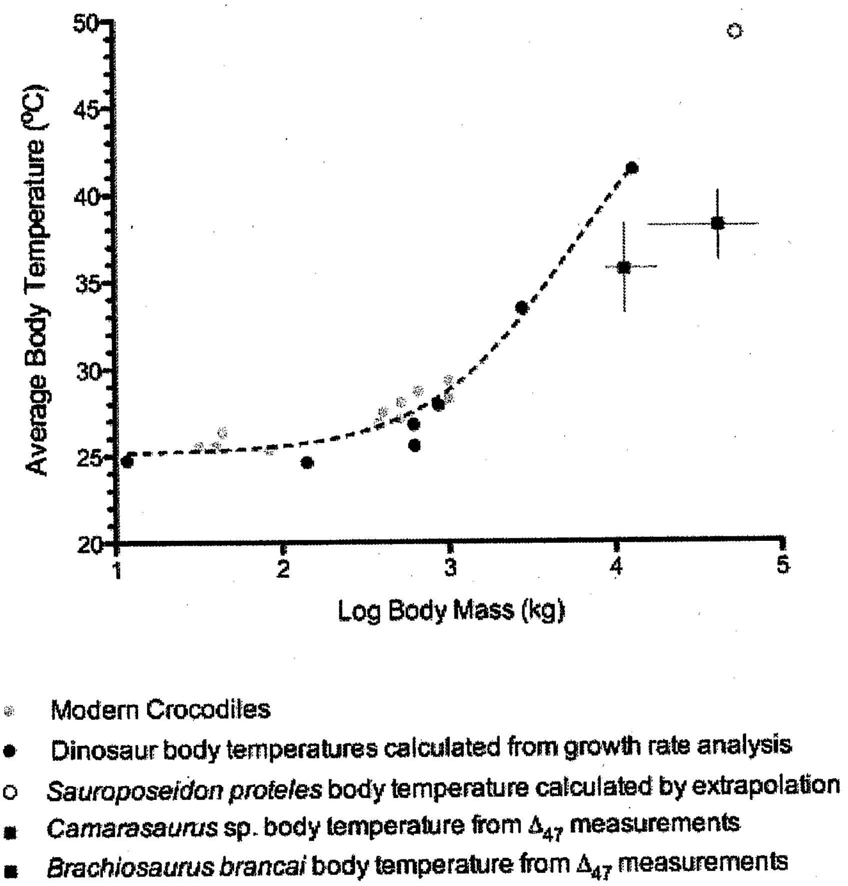

Figure 1: Comparison of measured dinosaur body temperatures to the Gillooly model calling for scaling of body temperatures with body mass. Crocodile data was derived from modern species. We have plotted the average of body mass estimates from the literature versus clumped isotope–derived body temperatures for each Sauropod. Error bars in the horizontal axis represent the range of estimates of body mass reported in the literature. Vertical error bars represent 2 SE of the temperature determinations.

Questions

(1) Explain the reasons for dinosaurs to be considered as endothermic animals.

(2) What kind of methodology was used in this study for estimating the body temperature of Sauropods?

(3) What is the conclusion of this study?

3 地球表面の地形に関する次の文章を読み，下記の設問に答えよ。

The division of the earth's surface into continents and ocean basins is so familiar that it is easy to overlook its significance. With the ocean water removed, it is obvious that the continents are the primary topographic feature of the surface of the solid earth. Furthermore, the continents are not just the parts of the solid earth that happen to protrude above the ocean surface. They are plateau whose tops are remarkably flat, and very close to sea level, apart from restricted areas of mountain ranges. Since much of the seafloor is also very flat, this gives <u>the earth's topography a bimodal distribution of area versus elevation, with peaks near -4 km and 0 km</u> (Figure 1).

The continental crust is known from seismology to be 35-40 km thick and less dense (about 2700 kg/m^3) than the mantle (3300 kg/m^3) or the oceanic crust (2900 kg/m^3). The oceanic crust is only about 6 km thick. The differences in thickness and density between continental and oceanic crust have been long recognized as the explanation for the higher elevation of the continental surfaces: the continents are relatively buoyant and float higher. This was emphasized particularly by Wegener, who used it to argue against the idea of former land bridges between the present continents.

However, buoyancy alone does not explain the bimodality of the earth's topography: why is the continental material piled up usually to near sea level, rather than to a wide range of heights above the deep sea floor? Why aren't the continental margins eroded into broad slope sand fans, like the margins of mountain ranges? The explanation evidently lies in the combined workings of subaerial erosion, submarine erosion and plate tectonics. This was only clearly recognized with the formulation of plate tectonics, but the recognition was early. Both Dietz (1961) and Hess (1962) saw that seafloor spreading (and subduction) provided a sweeping mechanism whereby continental material on the seafloor could be carried to continental margins and piled up there. This would restrict the areal extent of the continental material. The vertical distribution evidently is controlled by rapid subaerial erosion, which reduces the surface to near sea level, and very slow submarine erosion, which allows the relatively steep continental slopes to survive.

訳注：subaerial 陸上の

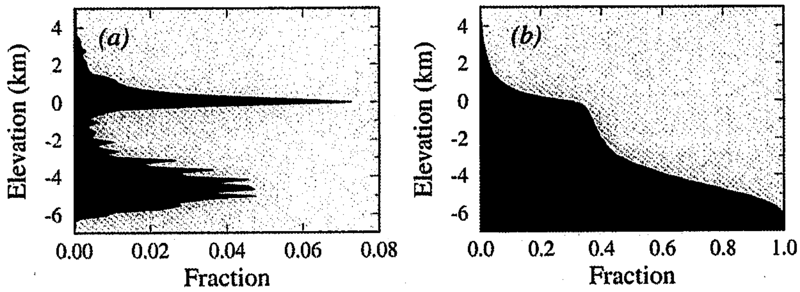

Figure 1. Distribution of elevations of the earth's solid surface. (a) A histogram of elevations, relative to sea level. (b) Cumulative fraction of the earth's surface above a given elevation.

出典：Davies, G. F., 1999, Dynamic Earth. Cambridge University Press, 458 p.

設問 1　第３段落目（However, buoyancy alone から始まる段落）の大意を日本語で説明せよ。

設問 2　下線部に関し，地球表面の高度分布がバイモーダルとなる理由について，文章を参考にして日本語で説明せよ。