

3. Frakes, L. A. *Climates Throughout Geologic Time* (Elsevier, Amsterdam, 1979).
4. Williams, G. E. *Megacycles: Long-Term Episodicity in Earth and Planetary History* (Dowden, Hutchinson & Ross, Stroudsburg, in the press).
5. Williams, G. E. *Geol. Mag.* **112**, 441–465 (1975).
6. Young, G. M. *Am. J. Sci.* **276**, 366–370 (1976); *Precambrian Res.* **3**, 137–158 (1976).
7. Kröner, A. *J. Geol.* **85**, 289–300 (1977).
8. McWilliams, M. O. (thesis, Australian National Univ. (1977); *Trans. Am. geophys. Un.* **59**, 1061 (1978).
9. Morris, W. A. *Geology* **5**, 85–88 (1977).

HUNT REPLIES—Current knowledge regarding climatic conditions during the Precambrian is fragmentary and subject to differing interpretations. However, there is considerably more information available than I was aware of, mainly in the geological literature, and I thank Dr Williams for providing very interesting data. Frakes¹ suggests that glacial conditions prevailed 2,300 Myr ago, followed by a warm period extending to 950 Myr when an interval of episodic ice ages commenced, terminating at about 600 Myr (ref. 2). If, as I suggested³, 1,500 Myr ago the Earth was rotating 2–2.5 times faster than now with a somewhat smaller obliquity, climatic conditions should have been most conducive to an ice age. Thus the warm period which apparently then existed implies some very marked difference between the model and the actual atmosphere. What this difference was remains a mystery! With regard to the late Precambrian (600–1,000 Myr ago) when the Earth's rotation was closer to its present rate, Williams² suggests that glaciation was confined to low and middle latitudes, attributable to the Earth's obliquity then exceeding 54°. Clearly any such obliquity variations would create climatic conditions completely different from those of my model regardless of rotation rate effects.

The concept of climatic changes induced by obliquity variations has considerable attractions, but also unresolved problems. Williams² has suggested an obliquity cycle with a period of over 1,000 Myr and a total amplitude exceeding 54°. Wolfe⁴, from Tertiary palaeobotanical data, has deduced obliquity variations of up to 25° in ~25 Myr. No mechanism is advanced to account for these obliquity changes. The absence of an identifiable mechanism, however, should not preclude them from consideration; rather it should stimulate a search for the cause. If such obliquity changes did occur this implies that current understanding of the Earth–Moon dynamical interaction over the ages as presented by MacDonald⁵, for example, is deficient. The rotational period and obliquity variations with time shown in my Fig. 1 (ref. 3) were taken from MacDonald's⁵ calculations, and had the great attraction of being dynamically based and mutually consistent.

One positive way to investigate the hypothesis of obliquity-induced climatic

variations is to resort to numerical modeling; as noted by Williams this approach has considerable potential. In 1980 I intend to run the same model as used in my study³, with an obliquity of 0° and a value near 60° as an initial contribution to this fascinating area of science. It is hoped this will throw light on the combined climatic effects of an increased rotation rate and extreme values of obliquity.

B. G. HUNT

Australian Numerical Meteorology Research Centre, PO Box 5089AA, Melbourne, Australia 3001

1. Frakes, L. A. *Climates Throughout Geologic Time* (Elsevier, Amsterdam, 1979).
2. Williams, G. E. *Geol. Mag.* **112**, 441–465 (1975).
3. Hunt, B. G. *Nature* **281**, 188–191 (1979).
4. Wolfe, J. A. *Am. Scient.* **66**, 694–703 (1978).
5. MacDonald, G. J. F. *Rev. Geophys.* **2**, 467–540 (1964).

Analysis of host specificity of temperate and tropical animals

IN the contingency-table analysis of the host specificity of temperate and tropical ambrosia beetles, Beaver¹ erred in using the percentages of species showing various grades of host specificity rather than the actual frequencies². Depending on the sample size and the distribution of frequencies among cells, this procedure may either inflate or deflate the values of χ^2 and thus invalidate a test of independence of rows and columns. Also, Beaver¹ implied that a test of host specificity for xylomycetophagous beetles was carried out with a 2 × 4 table but no xylomycetophagous species was restricted to a single species of host plant. Thus, the data for this group should have been tested in a 2 × 3 design.

Corrected values of χ^2 for Beaver's¹ data are given in Table 1. Considering all species of both families of beetle, the evidence for increasing specialization with increasing latitude is considerably

stronger than Beaver's analysis indicated. For phloeophagous species, the evidence is weaker than Beaver suggested but, for the most part, his hypothesis is strongly supported by data from this group of species. However, the data for the xylomycetophagous species are equivocal (4/6 country pairs show independence of rows and columns) and thus provide no evidence in support of Beaver's hypothesis. It is not clear whether this failure results from the small sample sizes for this group or from a fundamentally different pattern of resource utilization.

STEPHEN SMITH

Faculty of Science, Department of Biology, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1

1. Beaver, R. A. *Nature* **281**, 139–141 (1979).
2. Zar, J. H. *Biostatistical Analysis* (Prentice-Hall, Englewood Cliffs, 1974).

BEAVER REPLIES—The point concerning the use of percentages in χ^2 tables is accepted. I had not intended to suggest that the xylomycetophagous species followed the pattern of the phloeophagous species and were less host specific in the tropics. As I noted¹, they show "a similar low specificity in both temperate and tropical regions". I think it probable that this difference from the phloeophagous species is related to the different methods of resource utilization. If the ambrosia fungi can grow in the dying or dead wood of a high proportion of the tree species present in a tropical forest, this forest may not appear more heterogeneous to an ambrosia beetle than a temperate forest.

R. A. BEAVER

Department of Biology, The University of Zambia, PO Box 2379, Lusaka, Zambia

1. Beaver, R. A. *Nature* **281**, 139–141 (1979).

Table 1 Comparison* of the degree of specialization of feeding habits of Scolytidae and Platypodidae

Species group	Countries compared					
	Fr/Ca	Fr/Ma	Fr/Fi	Ca/Ma	Ca/Fi	Ma/Fi
All	15.085	165.121	70.169	245.781	100.747	20.505
Phloeophagous	13.058	37.753	40.718	55.899	40.905	12.110
Xylomycetophagous	1.640	19.339	2.148	9.583	4.161	5.126

*The null hypothesis states that there is no relationship between the degree of specialization and latitude. Data were tested in 2 × 4 (all species and phloeophagous species) or 2 × 3 (xylomycetophagous species) contingency tables. For 2 × 4 tables, critical values are 7.815, 11.345 and 16.266 for $\alpha = 0.05$, 0.01 and 0.001, respectively; corresponding critical values for 2 × 3 tables are 5.991, 9.210 and 13.816. The values of χ^2 comparisons among all pairs of countries are given. Ca, California; Fi, Fiji; Fr, France; Ma, West Malaysia.