which students will go abroad for much shorter periods than previously and will receive their graduate degrees from a Chinese, rather than a Western, institution. It is expected that if such programs are successfully established, students will be less tempted to stay abroad and will also be much less marketable since they will not have a Western doctoral degree.

The reasons for nonreturn or delayed-return are complex. Many students who have become used to pursuing independent research find that, upon return to the PRC, they are slotted into organizations and used as research assistants carrying out plans formulated by their seniors (who in many cases, often because of the educational gaps caused by the Cultural Revolution, are not nearly as knowledgeable as they). Along with the deterrent and coercive measures, the Chinese scientific establishment might do well to consider some positive incentives for their scholars to come home.

The appropriate role of Western educational institutions in arguable. Western governments clearly have the option of denying extended visas or permanent resident status to students from the PRC. Attempts to enlist the universities in enforcing prompt return are something else again. From the academic point of view, there appears to be no valid reason for Chinese students to be treated any differently from others: that is, students with appropriate levels of academic performance should be permitted to continue their work through graduate school and postdoctoral appointments, without the academic decision being influenced by political concerns.

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Estimates of Species Duration

In an interesting and provocative article, David Jablonski (Reports, 16 Oct. 1987, p. 360) argues that the geographic ranges of fossil mollusks provide evidence for the macroevolutionary phenomenon of species selection. He proposes that geographic range satisfies the three basic requirements for species selection: (i) it is an emergent property of species that exhibits variation, (ii) this variation is heritable, and (iii) this variation results in differential survival of species. Evidence presented to demonstrate differential survival includes plots of geologic duration versus geographic range for 421 species of bivalves and 540 species of gastropods from the Late Cretaceous of North America. However, sampling bias can influence studies of species richness, origination, duration, and biogeographic patterns (*1*). When species distributions are examined in space and time, sampling bias can yield patterns that may not actually differ from those expected by chance alone.

Before the positive correlation between geologic duration and geographic range can be adduced as evidence for species selection, an appropriate test is necessary. Taxa having long geographic ranges are more likely to be preserved in the fossil record because they occur at a greater number of fossilization sites. Therefore, long-ranging species have higher probabilities of displaying longer geologic durations than do taxa with short geographic ranges, even if there is no difference in geologic duration.

Testing for a statistically significant positive relation between duration and range is not sufficient evidence for assuming geographically long-ranging species survive through evolutionary time longer than do short-ranging species. The null hypothesis in such a test assumes a zero slope. Until the sampling bias associated with short-ranging species can be quantified, the species selection hypothesis for the Cretaceous molluscan fauna remains untested.

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REFERENCES

1. C. F. Koch, *Paleobiology* **13**, 100 (1987); R. Lewin, *Science* **236**, 521 (1987).

Response: The role of sampling bias in generating spurious correlations in paleontological data has long been a concern. As Russell and Lindberg point out, an independent test (which they do not provide) is needed to assess the role of sampling in determining the relation between geographic range and stratigraphic duration, and the null hypothesis of a zero slope for that relation must be rejected. Here I provide a test that may be applicable to most paleontological situations, apply it to the Late Cretaceous bivalves and gastropods that provided the basis of my report of a significant positive relation between range and duration and reject the null hypothesis of zero slope.

If sampling bias alone generates the relation between geographic range and stratigraphic duration, then that (spurious) relation should vary systematically among taxa having different preservation potential. Linear regressions for the best preserved—and thus best sampled—taxa should more closely approximate the slope of zero than linear regressions for poorly preserved taxa (*1*). For example, oysters (Ostreacea) are particularly well sampled in the Late Cretaceous of the North American Gulf and Atlantic Coastal Plain: they are abundant, are absent from few marine facies, are biostratigraphically useful, and have thick, robust shells of dissolution-resistant calcite (*2*). In contrast, the tellinacean bivalves and such gastropod families as Buccinidae, Fasciolariidae, and Turridae contain much scarcer, small, thin, fragile shells composed of dissolution-prone aragonite. The venerid bivalves and the naticid and turritellid gastropods are also aragonitic, but shells are more robust and common than those of the other gastropods and thus should be intermediate in preservation and collection potential. The prediction of steeper regression slopes for the most poorly sampled taxa, intermediate values for the venerids, naticids, and turritellids, and shallowest slope for the oysters is not met for the Late Cretaceous mollusks (*3*). Thus, the null hypothesis based on sampling bias is rejected in this instance, corroborating my original interpretation.

Comparisons of patterns among taxa having disparate preservation potential may provide a general approach for assessing the effects of sampling bias. Although sampling is by no means perfect in the Late Cretaceous of the Coastal Plain and incompleteness of the record there precludes many kinds of analyses, rejection of the Russell-Lindberg hypothesis suggests that sampling biases are not the principal determinant of the observed relation between geographic range and stratigraphic duration in this instance.

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REFERENCES AND NOTES

1. Biogeographic and biostratigraphic data sets rarely conform to bivariate normality, and regressions are used here for comparative purposes only. Although I provided a bivariate plot in my report, my original analyses emphasized more robust nonparametric statistical methods.
2. K. E. Chave, in *Approaches to Paleoecology*, J. Imbrie and N. D. Newell, Eds. (Wiley, New York, 1964), p. 377; C. F. Koch and N. F. Sohl, *Paleobiology* **9**, 26 (1983).
3. Slopes (±95% confidence limits) for simple linear regressions of species duration on geographic range [for equation, duration (in 10^6 years) = slope × range (in 10^3 kilometers) + intercept]. All regressions are significant at $P < 0.01$ or better. Taxa are listed in approximate order of decreasing preservation and collection potential; the sampling bias hypothesis is rejected because the slopes do not systematically increase in this sequence. Ostreacea ($n = 28$), 2.1 ± 0.6; Veneridae ($n = 22$), 1.6 ± 0.9; Turritellidae ($n = 15$), 1.9 ± 0.7; Naticidae ($n = 15$), 2.2 ± 1.2; Buccinidae ($n = 16$), 2.7 ± 1.3; Tellinacea ($n = 23$), 1.8 ± 1.1; Turridae ($n = 25$), 1.5 ± 0.5; and Fasciolariidae ($n = 43$), 1.1 ± 0.5).
4. I thank S. M. Kidwell, D. M. Raup, and J. J. Sepkoski, Jr., for helpful comments.