INTRODUCTION

Primates originated once, long ago, in an unknown place, without leaving a fossil record of the event. At face value, learning anything about primate origins seems implausible. Can our curiosity about such a singular, unobservable, historical event be investigated within the realm of science?

The evolutionary history of any biological lineage is like a single experimental lab trial in one important way—both are unique events unfolding along a particular sequence of causes and effects. Once the sequence is over, it is history. Much has been made of the problem that unique historical events are inexplicable to science (e.g., Cartmill, 1990; Popper, 1957). This is why lab scientists never rely on a single experimental trial—they make several parallel runs and analyze the various outcomes comparatively. Lab scientists have learned to control as many variables as possible before launching a trial, so that the diverse outcomes of a set of trials can be interpreted more easily as a consequence of one theoretically interesting factor that is allowed to vary. The lab scientist is not attempting to explain a single experimental run *per se*, but rather to explain which variables influence the outcome of a set of runs.

The evolution of a single lineage is like a single lab trial in this way. Despite the philosophical similarities between a single experimental run and an evolutionary
run, there are fundamental practical differences between the two. Evolutionary
time exceeds the lifetime of the scientist, evolutionary lineages have much
more complex cause-and-effect sequences, and parallel evolutionary runs were
not designed with controls to highlight the effect of a single interesting vari-
able. The evolutionist is in the position of a chemist who walks into a lab after
several poorly controlled trials are over, with no lab notes, and maybe without
even knowing what the question was.

But these problems are not insurmountable. First, an evolutionary biolo-
gist interested in processes of adaptation has the advantage of knowing what
the questions are. Evolutionary theory is robust enough that many meaning-
ful questions can be generated about the variable outcomes of a set of evolution-
ary runs, including questions about how organisms are morphologically
adapted to their ways of life. Second, the evolutionist has no shortage of
evolutionary runs—there are literally millions of them. Even within mammalogy
there are thousands, and within primatology there are over 200 trials still liv-
ing and many more extinct (but represented in the fossil record). The biggest
problem confronting the biologist is that the evolutionary runs cannot be
controlled in advance. Instead, the challenge is to identify after the fact
which outcomes are relevant to a given question and then to control for
confounding variables through proper comparisons.

To understand the singular origin of the order Primates, one must look for
other animal lineages with parallel outcomes. By definition, no other evolu-
tionary run yielded a primate, so the questions really center around the
origin of key primate-like attributes that occur in other animals, either in
combination or dismantled piece by piece. Which experimental runs on Earth
have yielded grasping hands and feet? Which have yielded large brains?
Primate-like visual systems? This kind of approach to primate origins is epit-
omized by Cartmill’s (1972, 1974a) landmark studies on the mammalian
visual system and the grasping extremities, which highlighted how the com-
parative study of completed evolutionary experiments could be used to test
hypotheses about primate adaptations.

This comparative approach to primate origins requires that we find and
examine as many parallel independent evolutionary runs as possible. The pha-
langeroid marsupials of Australia and New Guinea are one such mammalian
group that shows parallel development of primate-like traits. Smith (1984a)
wrote that the phalangeroid diversification “has led to some remarkable
convergences of form, function and behavior with the arboreal lemurs, bush