THRIVING, NOT JUST SURVIVING, AT HIGH ALTITUDE

TO THE EDITOR: We would like to thank the scientists who commented on this Point:Counterpoint. We originally argued that high altitude is for the birds because of several unique features that should improve their ability to exercise at extremely high altitudes (4). Many authors agreed with our Point, but several others highlighted the impressive ability of other vertebrates to tolerate hypoxia. These animals are indeed exceptional [Casey (1) in fact cites work by one of us (Meir) on these animals!], and we do not dispute the striking tolerance of acute, transient hypoxia by diving mammals (or by some birds, like penguins) or of chronic hypoxia/anoxia by carp, turtles, or hibernators. However, these animals use entirely different strategies in hypoxia, such as metabolic suppression, and they cannot compare with flying birds in their ability to sustain high rates of aerobic metabolism during prolonged exercise in hypoxia.

High altitudes pose many additional challenges, such as freezing temperatures and low humidity [Gunga and Tedjasaputra’s and Hopkin’s points (1)], but to the best of our knowledge mammals and birds cannot be distinguished by their abilities to tolerate these stressors. Low temperatures may even be favorable under some conditions—for high altitude birds, cooler air is denser, requiring less power for efficient flight while increasing the oxygen tension (2) and possibly the ability of hemoglobin to bind oxygen.

It is clear from this debate that species of both birds and mammals have evolved interesting and unique strategies for living and breeding at elevation, and it may be that these groups are difficult to distinguish based on these criteria. High-altitude species in both classes are well known to possess features that should improve their ability to exercise at high altitudes, such as a lung that is unrivalled in its ability to extract oxygen and a cerebral circulation that is insensitive to hypocapnia. These are not true evolutionary adaptations to high altitude and may have arisen for other purposes in the archosaurian ancestors of birds [Birchard (1)], but the available evidence does suggest that they distinguish birds from other present-day vertebrates. The select species of birds that are capable of performing at extreme altitudes appear to have evolved additional features over many generations of high-altitude adaptation and/or ancestry [Flouris and Carrillo (1)].

Is high altitude for the birds? The answer to this question undoubtedly depends on one’s point of view, as demonstrated by the exceptional contributions from all sides of this debate. We may be a few decisive experiments away from a resolution, but birds still appear to be the favorite for thriving, not just surviving, at high altitudes!

GRANTS

Our contributions in this Point:Counterpoint debate were supported by the Natural Sciences and Engineering Research Council (NSERC) of Canada and the Biotechnology and Biological Sciences Research Council (BBSRC) of the United Kingdom.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS


REFERENCES