years will see the development of even smaller video-tags and of miniature solid-state video-loggers. Using trained birds, experimental biologists are already paving the way for GPS-based video-tracking and sophisticated, multisensor data collection from wild subjects.

We encourage terrestrial ecologists to incorporate animal-borne imaging into their current projects. Even with existing technology, they will enjoy fresh biological insights into their study systems, and together, the community will become a major force in pushing technological frontiers in wildlife research.

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References

A pragmatic view of animal-borne video technology

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Based on recent applications to wild and trained birds [1–3], Rutz and Bluff highlighted developments in animal-borne video and environmental data collection systems (AVEDs) [4]. We agree that AVEDs can provide novel insights relevant to behavioural ecology and conservation [5]. Their emphasis on video-tracking reinforces our broader recommendations about the utility of combining video with other sensors [5]. However, Rutz and Bluff give ecologists an overly optimistic view of transmission-based AVEDs and video-tracking. In addition, by simply encouraging “terrestrial ecologists to incorporate animal-borne imaging into their current projects,” they unintentionally reinforce our concern that ecologists will focus too much initially on technology-driven objectives when using AVEDs [5]. We encourage a more pragmatic view of terrestrial AVED technology, one that considers tradeoffs and limitations of available AVEDs in the context of underlying research objectives.

The transmission-based AVEDs promoted by Rutz and Bluff provide a good context for discussing the types of tradeoffs that ecologists should consider. Currently, these systems are light enough to deploy on birds such as crows (Corvus spp.) [1]. However, there are several limitations that must be considered. These AVEDs transmit video to an external data storage device which results in severe logistical constraints for most species. A video-transmitter using a small power source cannot transmit energy over a long distance – typically no more than a few hundred yards. Signals from small video-transmitters are attenuated by foliage, moisture, power lines, buildings and other factors, so the researcher must maintain close contact to receive video. Our research demonstrates that when an animal moves out of range or within an area that the signal cannot penetrate, video data are lost and battery power is wasted [6]. Further, manual tracking risks disruption of tagged animals, possibly biasing data or even adversely affecting these animals. Moreover, it is often difficult to maintain close contact with many wild animals given limitations in line-of-sight radio-tracking technology [7] and the elusive nature of animals that range over large areas. Yet, these are the species for which AVEDs are most valuable.

Small, transmission-based AVEDs [1] also are limited by the length of time a tag will transmit video. Many research questions (e.g. valuating predator hunting decisions and mapping social interactions in complex systems [4]), particularly those related to rare behaviours (e.g. feeding events in sharks [8]), require substantial recording time. Animal-borne sensors should weigh <3–5% of the animal’s body mass [5]; for small animals, this means the mass of AVEDs limits the size and battery life of the radio-transmitter used for radio-tracking. A researcher must

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consider whether only 38 min of continuous video [1] is worth losing weeks or months of life from a radio-transmitter that is already weight and time limited. However, if 30–40 min of continuous video is sufficient for addressing the relevant hypotheses [1] and the study animals are trained [2,3], semi-habituated or can be followed easily without disturbance, then small transmission-based AVEDs offer one solution.

Given the disadvantages of transmission systems, the future of terrestrial AVEDs lies in integrated systems that store and compress video data on board and conserves power through duty cycling [5,9]. Similar systems are used in marine environments [10]; when the unit is recovered, the data are off-loaded [9,10]. This approach allows non-intrusive monitoring of elusive wild animals and longer recording times. These systems can be integrated with GPS technology or other sensors [5,9]. Currently, recording systems that are commercially available weigh < 40 g (http://www.pimall.com/nais/capturetek.html), limiting applications to heavier species. Although this technology is rapidly evolving, the integration of multiple sensors and processors increases complexity of the AVED, in contrast to simply adding a radio-transmitter to a transmission-based AVED [4]. Therefore, further development and availability of field-worthy video-recording AVEDs that circumvent limitations of transmission-based systems will take time [5].

As technology advances, ecologists will continually need to consider whether AVEDs are the proper tool for addressing well-defined, important hypotheses [5]. Certainly continued pilot and development studies are necessary, and exploratory AVED studies can produce valuable insights and novel video that has tremendous educational value [5]. However, it is paramount these technologies are evaluated in light of study objectives and logistical constraints. We must consider how ecologists can use AVEDs most effectively instead of assuming rapid technological advancements will solve our problems and lead us to better questions and insight.

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Book Review

Advances in the study of feeding


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Heterotrophic organisms exist solely because they are able to consume other organisms. One would therefore expect that the topic of foraging should have inspired a large literature within each of the fields of ecology, evolution and behavior. It is thus somewhat surprising that most authors, including the editors of the book Foraging: Behavior and Ecology, only trace foraging theory back to the mid-1960s. Relatively little theory existed before that period, and it was not explicitly identified as foraging theory. Seminal theoretical work by Stephen Fretwell, Thomas Schoener, Eric Charnov and others in the 1970s inspired a large body of experimental work designed to test their theories. The first editor of this volume, David Stephens, summarized many of the resulting studies in a book coauthored with John Krebs, which appeared in 1986 [1]. That volume addressed a relatively small number of the decisions made by organisms in their never-ending quest for food, focusing primarily on questions of when a forager should ignore low-quality food sources and when it should leave a feeding area that it is depleting. The 20 years following the publication of the book by Stephens and Krebs have seen a great expansion of the aspects of foraging that have been studied, both theoretically and empirically. Readers of this new volume will get some idea of the new foraging problems that have