frontiers in Ecology and Evolution

EDITORIAL
published: 28 April 2020
doi: 10.3389/fevo.2020.00113

Editorial: Ecology and Behaviour of Free-Ranging Animals Studied by Advanced Data-Logging and Tracking Techniques

Thomas Wassmer[1]*, *Frants Havmand Jensen*[2], *Andreas Fahlman*[3] and *Dennis L. Murray*[4]

[1] Biology Department, Siena Heights University, Adrian, MI, United States, [2] Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA, United States, [3] Global Diving Research Inc., Ottawa, ON, Canada, [4] Department of Biology, Trent University, Peterborough, ON, Canada

Keywords: data logger, eco physiology, activity pattern, foraging, movement ecology

Editorial on the Research Topic

Ecology and Behaviour of Free-Ranging Animals Studied by Advanced Data-Logging and Tracking Techniques

OPEN ACCESS

Edited and reviewed by:
Elise Huchard, UMR5554 Institut des Sciences de l'Evolution de Montpellier (ISEM), France

***Correspondence:**
Thomas Wassmer
twassmer@sienaheights.edu; tom@wassmer.org

Specialty section:
This article was submitted to Behavioral and Evolutionary Ecology, a section of the journal Frontiers in Ecology and Evolution

Received: *15 March 2020*
Accepted: *07 April 2020*
Published: *28 April 2020*

Citation:
Wassmer T, Jensen FH, Fahlman A and Murray DL (2020) Editorial: Ecology and Behaviour of Free-Ranging Animals Studied by Advanced Data-Logging and Tracking Techniques. Front. Ecol. Evol. 8:113. doi: 10.3389/fevo.2020.00113

INTRODUCTION

Many details of the behavior, life history and eco-physiology of animals, even among intensively-studied species, remain unknown. Direct observation is a laborious process only amenable for accessible and non-cryptic species, whereas traditional radio telemetry does not directly provide information on the diversity and complexity of animal physiology and behavior. Further, both methods are laborious and/or expensive, and may lead to biased data when physiology and/or behaviors are altered by marking or tracking (Boyer-Ontl and Pruetz, 2014; Nowak et al., 2014; Welch et al., 2018; see also Le Grand et al.). Ultimately, these methods provide only a fragmentary overview of animal behavior patterns during periods when individuals can be readily detected and surveyed while leaving activities during other times obscured. However, the ongoing miniaturization, sensor development, and increased affordability of data logging and advanced telemetric devices offers the potential for continuous and intensive data collection, thereby potentially allowing researchers to more rigorously investigate both physiology and behavior of animals that are difficult to study using traditional observational methods. Owing to these new technologies, we are at the cusp of a truly revolutionary opportunity to address important and longstanding knowledge gaps in animal eco-physiology. To that end, the special section entitled Ecology and Behaviour of Free-Ranging Animals Studied by Advanced Data-Logging and Tracking Techniques includes 22 papers that report on and quantify otherwise hidden aspects of the biology of a variety of mammals, birds, and even invertebrates, across diverse environments including land, water, and air. The highlighted studies focus on fields ranging from basic animal behavior and ecology to eco-physiology; several papers adopt an integrative approach, providing a rather comprehensive understanding of individual time budgets and their implications. Ultimately and collectively, these contributions serve as testament to the drastic improvement in the level of ecological inference that can be derived from research studies involving the use of data-logging and tracking devices that are currently available.

ACTIVITY, MOVEMENT, AND ENERGETICS IN THE WATER

Estimating activity and field metabolic rates (FMR) in wild animals, with the accuracy and precision necessary for development of robust bioenergetic models, is an increasingly high priority in ecology. Because FMR can vary with environmental or life history features, measuring variability in behavior or energetics through space or time is often exceedingly challenging. Further, aquatic systems pose especially vexing problems for the deployment of bio-logging tools and measurement of energy expenditure because of water resistance against externally deployed units. A variety of bio-logging tools have become available for such investigations, for example, monitors can help understand heart rate and lung function (Cauture et al.), or establish a correlation between movement and energy use (Arranz et al.) in marine mammals; such investigations can elucidate the physiological limitations associated with living in an aquatic environment. Further, high-resolution multi-sensor tags (e.g. Johnson and Tyack, 2003) can be used to reveal variation in feeding strategies and dive depths (Isojunno and Miller; Irvine et al.), as well as serve to establish broader-scale assessments of regional variability in food availability (Heerah et al.). Multi-sensor data from different populations can be used to model physiological variation across a species' range (Fahlman et al.), and similar approaches may broadly hold promise for understanding how physiology can vary across changing environments. It is important to note that the increasing popularity of bio-logging tags for investigating physiology, behavior and energetics in marine systems should be accompanied by appropriate validation studies assessing potential energetic impacts of tag placement and design. To this end, van der Hoop et al. showed that swimming behavior of bottlenose dolphins was affected by increasing size of tags through increased metabolic cost due to drag, and we highlight the need for similar studies across a range of species, tag types, and environmental conditions before data derived from bio-logging tags be widely used in bioenergetics models. It follows that bio-logging tools can also be used to inform on animal welfare issues by addressing behavioral changes owing to injury or sickness (Arkwright et al.).

ACTIVITY, MOVEMENT, AND ENERGETICS ON THE GROUND

Bio-logging tools are useful for measuring a variety of behaviors in terrestrial systems and are becoming increasingly important as basis for understanding animal responses to stressors or environmental variability. For example, Le Grand et al. used several different logger types to infer the variability in brown bear physiology and behavior relative to several types of anthropogenic disturbance. Temperature sensors are becoming increasingly popular for studying seasonal activity and energetics in terrestrial mammals. For example, Wassmer and Refinetti used temperature data loggers to describe the variability in daily and seasonal activity patterns among individual fox squirrels. Likewise, temperature sensors in hamsters helped reveal whether dietary supplements could induce changes to the intensity of hibernation and associated metabolic rate (Siutz et al.). Along the same lines, temperature sensors attached to GPS transmitters allowed Thaker et al. to infer elephant movement speeds according to ambient temperature. In another study using telemetry in elephants, Wato et al. interpreted the observed directionality in movements to water sources as evidence of animal memory and spatial cognition. Finally, one aspect of bio-logging that is often overlooked concerns the objective classification of behavioral data derived from these devices, and Studd et al. provide a novel template for the robust classification of snowshoe hare behavior derived from accelerometers.

ACTIVITY, MOVEMENT, AND ENERGETICS IN THE AIR

Flying organisms present a unique set of challenges in terms of assessing behavior and energy expenditure, and several developments in this area have helped establish a better understanding of related costs and consequences. O'Mara et al. used GPS loggers and accelerometers to infer the importance of tailwinds on fruit bat energy expenditure, with the important caveat that it remains difficult to infer how simple measures such as overall dynamic body acceleration (ODBA) can be used to assess energetic costs of flight. This is an important point that highlights the need for additional studies relating measurements derived from bio-logging tools to animal behavior or physiology. However, some novel developments hold promise in the interpretation of behavior of aerial organisms, such as those reported by Dreelin et al. that illustrate how altitudinal dataloggers can help understand differences in flight behavior across bird species. Similarly, Eisaguirre et al. applied a sophisticated modeling approach to telemetry data to assess patterns of variation in golden eagle movement and migration. Likewise, telemetry-based tracking of guillemots and razorbills provided novel insight into their distribution and movement patterns compared to traditional boat-based surveys (Carroll et al., 2019). In an interesting methodological investigation, Bridge et al. showed how the deployment of a new open-source RFID data-logging system could be useful for measuring a variety of behavioral responses in several bird species. Finally, an important point regarding the use of bio-logging tools especially for monitoring small aerial organisms concerns the need for miniaturization to avoid deleterious effects of marking on performance. To this end, Minahan and Brunet show how miniaturized loggers can be used to track foraging activity and movements of a variety of bee species.

NAVIGATING A CHANGING ENVIRONMENT

Bio-logging tools can be used to answer basic ecological questions but perhaps their greatest promise relates to establishing important baseline values for behavior and physiology. These baseline values will be critical to understand how animals may respond to future environmental change and can help provide

means for mitigation. Indeed, in their mini review, Chmura et al. highlight the potential use of such technology for detecting, understanding, and forecasting species responses to climate change. Finally, in a general overview Judge et al. reviewed how recent advances in temperature logging reveal thermal stress in a variety of organisms inhabiting the intertidal zone and likely facing dire threats from climate change.

CONCLUSION AND FUTURE CHALLENGES

The variety and novelty of contributions presented in this Research Topic provides an important overview of the many opportunities offered by new technologies in bio-logging. We anticipate that in the next decades existing devices will be refined and further miniaturized, new devices will be developed with added opportunities for understanding animal behavior and physiology, and new tools will become available for analysis of the large amount of data that are collected by these devices. Doubtless, these developments present tremendous opportunities for advancing our understanding of animal performance and responses to environmental change. However, we conclude by offering the important caution that successful application of these devices for addressing basic and applied questions in ecology relies on their proper validation. Indeed, the success of bio-logging tools in providing robust ecological inference depends on the implementation of systematic companion studies that validate their use, as well as additional studies focusing on the proper interpretation of the data that they yield. We consider it as crucial for researchers to resist applying new technologies and analytical tools without the requisite validation studies and system stress tests in controlled settings. How might bio-logging devices affect animal behavior or physiology? What are the best size, shape and attachment methods to minimize impacts? Do all individuals respond similarly to such devices? How well can data from bio-loggers serve as proxies for animal features of interest such as behavior, physiology or energetics? How can we best analyze data derived from a particular type of device? These are important questions that will serve as the foundation for successful application of bio-logging tools in the future, and they can best be answered through close interaction and collaboration between researchers, device manufacturers, and data analysts. Ultimately, we are optimistic that with this proper foundation bio-logging will continue to revolutionize our understanding of animal ecology and how individuals, populations, and species respond to a changing environment.

AUTHOR CONTRIBUTIONS

TW initiated the Research Topic and recruited the other authors as editors, along with Stan Boutin, who is not listed as author on the present paper. TW wrote the first draft of this editorial, with contributions from coauthors. All 5 editors helped develop the Research Topic and contributed to its editorial process.

ACKNOWLEDGMENTS

We wish to thank all authors and reviewers of this Research Topic for their contributions.

REFERENCES

Boyer-Ontl, K. M., and Pruetz, J. D. (2014). Giving the forest eyes: the benefits of using camera traps to study unhabituated chimpanzees (*Pan troglodytes* verus) in Southeastern Senegal. *Int. J. Primatol.* 35, 881–894. doi: 10.1007/s10764-014-9783-3

Carroll, M. J., Wakefield, E. D., Scragg, E. S., Owen, E., Pinder, S., Bolton, M., et al. (2019). Matches and mismatches between seabird distributions estimated from at-sea surveys and concurrent individual-level tracking. *Front. Ecol. Evol.* 7:333. doi: 10.3389/fevo.2019.00333

Johnson, M. P., and Tyack, P. L. (2003). A digital acoustic recording tag for measuring the response of wild marine mammals to sound. *IEEE J. Oceanic Eng.* 28, 3–12. doi: 10.1109/JOE.2002.808212

Nowak, K., le Roux, A., Richards, S. A., Scheijen, C. P. J., and Hill, R. A. (2014). Human observers impact habituated samango monkeys' perceived landscape of fear. *Behav. Ecol.* 25, 1199–1204. doi: 10.1093/beheco/aru110

Welch, R. J., le Roux, A., Petelle, M. B., and Périquet, S. (2018). The influence of environmental and social factors on high- and low-cost vigilance in bat-eared foxes. *Behav. Ecol. Sociobiol.* 72:29. doi: 10.1007/s00265-017-2433-y

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.