Personal Information for Corresponding Author

First Name:	Antonio
Last Name:	Saraiva
Title:	Doctor
Company/University:	Universidade de São Paulo
Address:	Avenida Prof. Luciano Gualberto, travessa 3, no. 158, room:C2-54
	CEP 05508-900
City:	São Paulo – SP
Country:	Brazil
Fax:	55(11)3091-5294
Email:	amsaraiv@usp.br

Suggested Topic 1(*):	Field Data Acquisition and Recording
Suggested Topic 2 (*):	Instrumentation and Control

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Conference Topics

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EthoLog: a tool for data acquisition on behavioral studies

A.M. Saraiva[1], J.C Nieh[2] and E.A.Cartolano Junior[1]

Abstract

In the Behavioral Sciences, there is demand for data acquisition tools to deal with the problem of event recording during experiments. Handheld computers can be used and customized for this task, offering flexibility, accuracy and speed. This paper describes an application for a PocketPC handheld computer that allows manually operated event datalogging. Among other features, the application software allows customization of the touch-screen buttons and the assignment of events to each button. The data can be exported to a desktop computer for further analysis on spreadsheets. It has been used successfully on field experiments and classes on bee communication and behavior in USA and Brazil. Although other datalogging software is available, none, to our knowledge, currently meet all the criteria of software that is free, user-friendly, compatible with both Mac and PC platforms, and capable of providing direct acoustic feedback during event recording.

Keywords: datalogger, bees, handheld computer, behavioral ecology

Introduction

Recording behavioral event data is a common technique used throughout the Behavioral Sciences (Bakeman and Gottman 1986) in diverse areas such as the applied sciences (medical testing or wildlife conservation) and the basic sciences (Neuroethology, Psychology, and Behavioral Ecology). A common underlying problem is the rapid, accurate, and electronic acquisition of such data. Speed is an issue because human and animal behaviors can change rapidly and may thus not be adequately described by traditional approaches such as pen and paper event scoring in time blocks (Martin and Bateson 1986). Time event data must also be accurately recorded and errors can occur both in recording such data from stopwatches and in entering such data from paper notes into an electronic format for analysis. Thus the direct electronic acquisition of event data can provide significant advantages in speed, accuracy, and efficiency, given the correct configuration of hardware and software. A useful general tool for recording behavioral event data would therefore be useful in a wide range of fields, including as an educational tool for student laboratory exercises.

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[1] Agricultural Automation Laboratory, Department of Computer Engineering and Digital Systems, Escola Politécnica da Universidade de São Paulo, Brazil. amsaraiv@usp.br
2 University of California, San Diego, Section of Ecology, Behavior, & Evolution, jnieh@ucsd.edu

Requirements

To have general utility, such a datalogger should have several characteristics. First, it must be highly flexible and user-configurable because it will be employed in different types of research projects in which very diverse types of data will be gathered. The datalogger should also be portable and capable of withstanding field conditions in institutions and in different ecological settings. Thus robustness and weather-resistance are important. For example, we use our datalogger in the field in the tropical moist forest of Panama (Nieh 1999) and the cerrado-habitat of the state of São Paulo, Brazil (Nieh et al. 2003). In these regions, the unit must be able to withstand rainfall and relatively high heat in additional to being usable in bright sunlight. User-friendliness is also important as errors in data entry and usage will likely increase with the complexity of the interface. Cost is another factor because behavioral research is frequently conducted with relatively small budgets and, in educational settings, institutions may not be able to invest large sums in laboratory equipment for student use. Finally, the datalogger should unit should ideally be compatible with both Mac and PC computer platforms because both operating systems are used by behavioral researchers (Hulsey and Martin 1991, Moraes et al. 1997).

Description

EthoLog allows registering events on a handheld computer in a simple and accurate way. The user can associate each event (such as a behavior) with a button on the touch-screen, and use it to register a time stamp at the beginning and the end of each behavior. The data stored is associated with the name of the user and of the individual or species being studied. The data can be exported in a commonly used file format, such as CSV (Comma Separated Values) that can be easily imported into any other software package, such as a spreadsheet, where macros will then perform behaviorally relevant analyses. These macros are then posted on the software website to which users can freely contribute and download the EthoLog software.

After analyzing the requirements and the market alternatives, we have chosen the PocketPC as the portable device to be used as the platform for EthoLog. It has now fallen in price to a level nearly comparable to Palm handhelds, is more widely used, and is compatible with both Mac and PC operating systems. In addition, free software tools are available for application development on PocketPC, thus facilitating modifications by end users. EthoLog was developed with VB.net language. It runs on a handheld with Pocket PC operating system and SQLCE2.0 database management system.

The software allows the user to register events using buttons that can be assigned to specific behaviors. In addition, the user can specify the total number of buttons that appear, thereby showing only the minimum necessary number of buttons for a given application, eliminating clutter, and reducing data entry errors. When beginning, the user must use the software configuration screen to identify the data collection run, to indicate the events that will be observed by assigning names to the buttons, to specify comments associated with the file, and to associate unique sounds with each button (Fig. 1).

After configuring the identification and event boxes, the user may begin registering the data with the event buttons. To help the user operate the device without having to deviate his or attention from the event, audio confirmation is provided through a unique sound is assigned to each button every time it is pressed. In the event of an error (such as the wrong button being pressed) the user can tap an "error" button that will indicate that the previous action should be disregarded.

After data collection is competed, the device can be connected to a desktop computer in order to transfer the data collected. Data transfer can occur in several ways, including wireless, infrared, wire, and card transfer (such as a SD card). These files can then be analyzed with other software (Microsoft Excel®, Microsoft Word®, etc). A version of Excel is also provided with most PocketPC's, thus allowing some direct manipulation of the data on the PocketPC.

Results and discussion

We used the EthoLog software with a Dell Axim PocketPC in Brazil during August 2004 with excellent results in two experiments. We had two primary goals. First, we wished to test the efficacy of the EthoLog software and its ease of use with students in the field. Second, we wanted to collect data on bee behavior that would be highly time consuming and difficult to accurately record through non-electronic means. In both experiments, EthoLog collected key descriptive data for our overall analysis, a description of how stingless bee foragers (*T. hyalinata*) deposit odor marks. In this paper, we present only the results collected with the datalogging software. Our application called for the datalogging of foraging bee departures and arrivals at a feeder in order to document the temporal pattern of foraging and recruitment (the increase in the number of nestmates visiting a rewarding food source). The overall goal of this study was to determine how bee foragers communicate food location to nestmates. Students had no problem learning the interface and configuring the data entry buttons. The hardware was robust at temperatures up to 50°C (the highest obtained in direct sun exposure). Data was downloaded to a PC computer using the USB cradle provided with the hardware and also to a Macintosh laptop computer through the PocketPC's external's memory card slot. The text file generated by the EthoLog software was easily converted using Microsoft Excel software on both computers and Excel macros then streamlined the data analysis process.

Foraging ethogram. In the first experiment, our goal was to measure the time ethogram of foraging behaviors on a feeder, how individual foragers allocated their time during feeding at a rich food source. Following a focal individual, students recorded the times that bees spent landing, feeding, and then away from the feeder (departing). Departure times correspond to the amount of time that bees spent away from the feeder. Fig. 2 shows the results. Not surprisingly, bees spent the majority of time away from the feeder. At the feeder, they spent approximately twice as much time feeding at the 2.5 M sucrose solution than either walking or in landing. This ethogram provides basic data describing the time allocation of foraging that can then be compared with future data on foraging under different spatial and food quality conditions.

Effect of spatial position on substrate temperature. In the second experiment, our goal was to determine whether the spatial location of the substrates on which bee deposited odor marks varied in temperature, as this would affect the evaporation rates of odor. We measured temperatures on leaves placed on ropes 1, 1.5, or 2 m above the ground with an IR thermometer. Measurements were recorded using the datalogger comment function, exporting the data to a Macintosh Powerbook G4 and running statistical analyses with JMP software. In the two-factor Fit Least Squares ANOVA model with interaction, there was no significant interaction, thus we used the simplified model. The overall model was significant ($F_{2,283}$=79.4, P<0.0001) but only the factor height above ground ($F_{1,283}$=158.2, P<0.0001) was significant, not distance from the feeder ($F_{1,283}$=0.72, P=0.40). A detailed analysis reveals that the ground was significantly hotter (by approximately 15°C) than the leaves (pairwise Tukey-Kramer tests, q^*=2.58, P<0.05), but that there was no significant difference between the leaf temperatures (P>0.05). Thus, there was no significant effect of height or distance from the feeder on *leaf* temperatures alone . Because foragers did not deposit odor marks on the ground, we now know that temperature effects associated with leaf height and distance can be excluded from our analysis of where foragers stopped to deposit odor marks on the leaves.

Conclusions

EthoLog proved to be very helpful and met the requirements posed by the users. Using EthoLog, we met our two goals of proving the software's field efficacy and ability to collect useful behavioral data. It demonstrates that relatively simple developments can be of much importance to improve basic research. Handheld computers are very suitable for such field experiments and have much potential to be explored.

It is anticipated that due to its characteristics and low cost it can be used by many other researchers and students, especially those belonging to the bee research community. It will be offered to the participants of an international research project on pollinators funded by the Food and Agriculture Organization of the United Nations, FAO-UN. Other features will be developed for the tool which will enhance its flexibility and allow its usage in a wider range of experiments on animal (especially bee) behavior and also in other situations.

References

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Figures

Fig. 1. Screens for configuring user name and event definition (left), for configuring buttons name (center) and for datalogging (right).

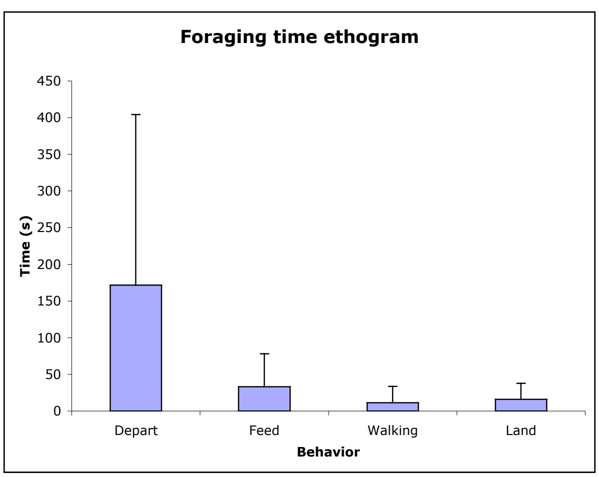

Fig. 2. Foraging time ethogram. Data from 896 events shown.

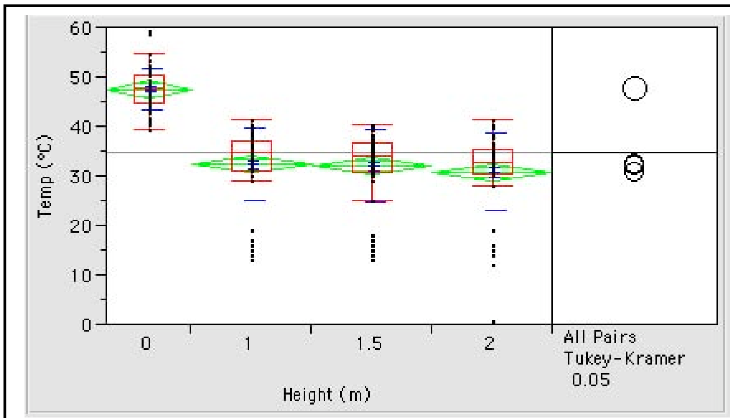

Fig. 3. Results of the one-way analysis of substrate temperature by height above ground. The elevated leaves were substantially cooler than the ground.