How-To-Do-It

Motion Picture and Videotape Analysis of Behavior

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Film and videotape are useful tools in the analysis of animal behavior. A camera can capture actions that evade an observer's eye; films taken at high speeds can be viewed at slow rates to capture actions too fast to be viewed at a normal pace. Single-frame analysis can be employed stop-motion in order to permit detailed analysis of rapid behavior patterns. Time-lapse photography and videotape are useful in recording behaviors and interactions that take place infrequently or over prolonged periods. Finally, film and videotape can be viewed repeatedly, allowing the observer to concentrate on the behavior of several animals or separate events at a particular time, or on different body parts of a single animal during any particular behavior. An observer unaided by the camera may have difficulty concentrating on more than a single animal or body part at one time.

Films and videotapes can be used to determine behavior patterns via a method known as single-frame analysis. This does not necessarily involve the viewing of every single frame as the name implies, but merely recording the position of particular body parts, entire animals, or even the behavior of an animal at constant intervals. This technique has been exploited in the study of the species-specific display action patterns (DAP) of iguanid lizards (Carpenter and Ferguson 1977; cf. Carpenter this volume) (fig. 1). The species-specific DAP of a lizard is employed as a social signal during encounters with conspecifics and may involve fighting, territoriality, or courtship. The DAP involves specific sequences of "head-bobs" and "push-ups" that occur over specific time intervals. These are of paramount importance in many kinds of lizards in the recognition of species, sex and probably individuals. Sophisticated equipment is available for time-motion analysis, for example, the Vanguard Motion Analyzer (Vanguard Instrument Corporation, Long Island, NY). Although easy and convenient to use, this equipment is costly. A simple, less expensive, laboratory set-up for time-motion analysis can be constructed (fig. 2). A projection screen should have a grid drawn on it for the analysis of behavior. For videotape analysis a transparent

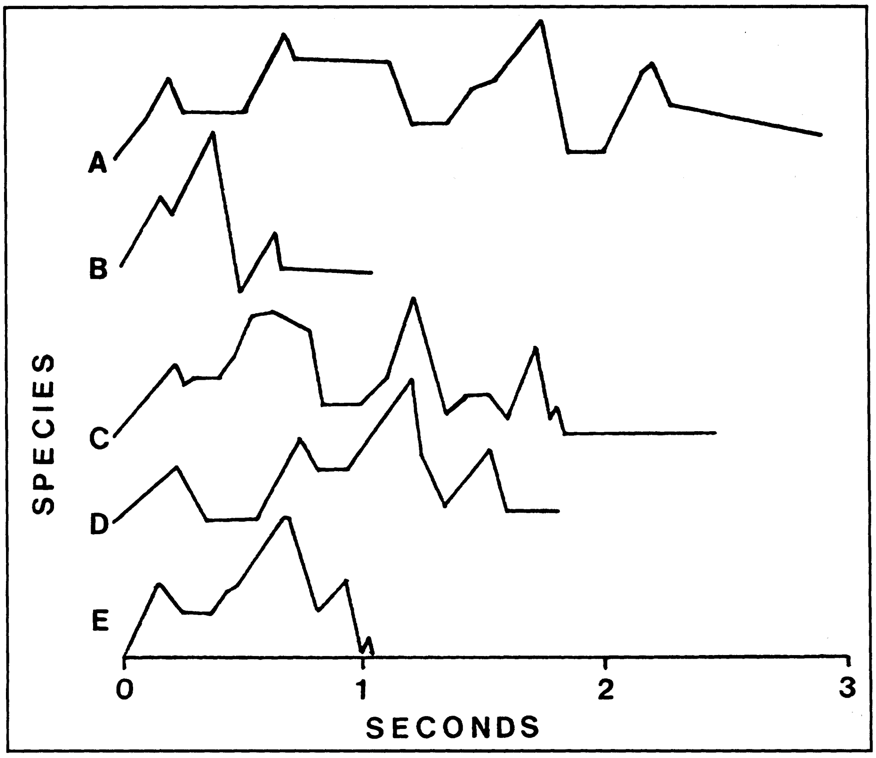

FIGURE 1. The display action patterns (DAP) of five species of lizards from the *Sceloporus variabilis* group. These graphs represent the time-motion sequences of front leg push-ups performed by displaying males of (A) *S. cozumelae,* (B) *S. teapensis,* (C) *S. variabilis,* (D) *S. parvus,* and (E) *S. couchi.* Modified from Carpenter (1978), with permission.

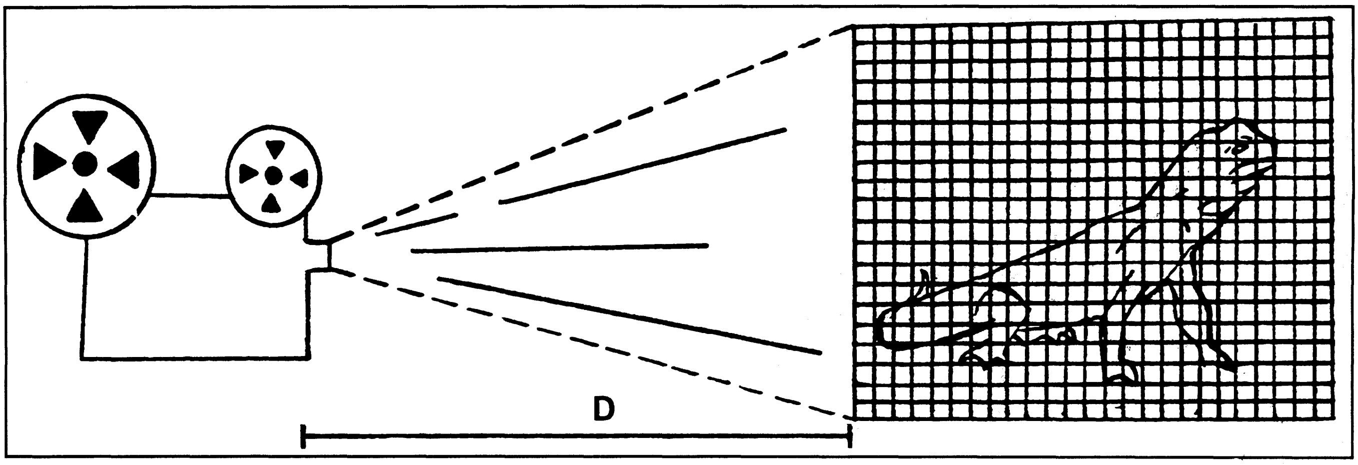

FIGURE 2. A simple laboratory set up for a single-frame analysis of behavior. Motion picture film is projected onto a gridded screen or a grid placed over the screen of a videotape monitor. If using motion picture film, a standard distance (D) should be used between screen and projector. Motions of whole animals or anatomical parts (of the lizard in this example) can be observed in detail by measuring the position of the animal or body part on the grid over constant intervals of film or videotape. This procedure can be used to construct a DAP (see figs. 1, 3).

grid can be constructed and placed on a monitor. The film or videotape ideally is taken at a constant distance from the subject. With film, a standardized distance should be used between the projector and screen. It is important that the projected image of the anatomical part in question be of standard size also. If subjects of unequal size are used, for example (although it is desirable that they are of equal size), the distance of the projector from the screen can be varied.

Let us use the head-bob of lizards as an example. In order to analyze head-bob behavior, the observers watch the recorded behavior of a lizard on a videotape monitor or a projection onto a gridded screen. Select a period of behavior that includes some head-bobs, and note the context (i.e., social situation, season of activity, breeding condition, etc.) in which this behavior is exhibited. After assigning numerical coordinates to the grid, record the position of the anterio-ventral extremity of the lizard's chin at the time selected to initiate the time-motion analysis. Next, proceed to record the position of the chin on the grid over constant time intervals (every three frames of film or every 0.02 feet/meters of videotape, for example). For these particular behavioral actions, the primary concern is with vertical movement of the chin, so perhaps for simplicity it may be easiest to record ordinal coordinates only. If the grid is too coarse to provide the accuracy desired, a finely marked ruler can be used to make more accurate measurements. Once enough measurements have been taken to include a complete sequence of actions, the DAP can be constructed by graphing the recorded ordinal coordinates of the behavior against time. Temporal duration can be calculated from the amount of film or videotape used(fig. 3).

Time-lapse analysis is useful for observing behaviors that occur infrequently or over prolonged periods of time. This technique is functionally the converse of single-frame analysis of films taken at high speeds. Instead of slowing down action that occurs too rapidly to be observed, time-lapse techniques speed up action which normally takes place too slowly or too infrequently to be efficiently studied. This involves taking motion pictures at very slow speeds or taking videotapes at much slower than normal speeds. Using this technique, activities normally occurring over hours or days can be condensed into a few mintues or seconds.

As an example, consider the motion of the hour hand of a clock. Human observers are ordinarily unable to detect the slow movement of the hour hand. However, if the clock is filmed with time-lapse photography at one frame per minute, and later viewed at a film speed of 30 frames per second, the motion ("behavior") of the hour hand can be readily observed. Wiley and Kohler (1980) have used this technique to observe the interactions of small aquatic invertebrates in an epilithic stream community. This provides a convenient method for quantifying the infrequent encounters between these small, slow-moving organisms. As a sidelight, another field which has made a great deal of use of time-lapse photography is embryology. The development of a frog or a fish for example, which normally takes several days, can be viewed in a matter of minutes or seconds when recorded via time-lapse photography. This is a handy tool for the embryologist in the laboratory as well as for teachers in the classroom.

Behaviors recorded on film or videotape can be viewed repeatedly and thus provide much more information than is available in a single viewing. The observer's confidence in what he or she has seen is also greater in that the behavior can easily be viewed again and

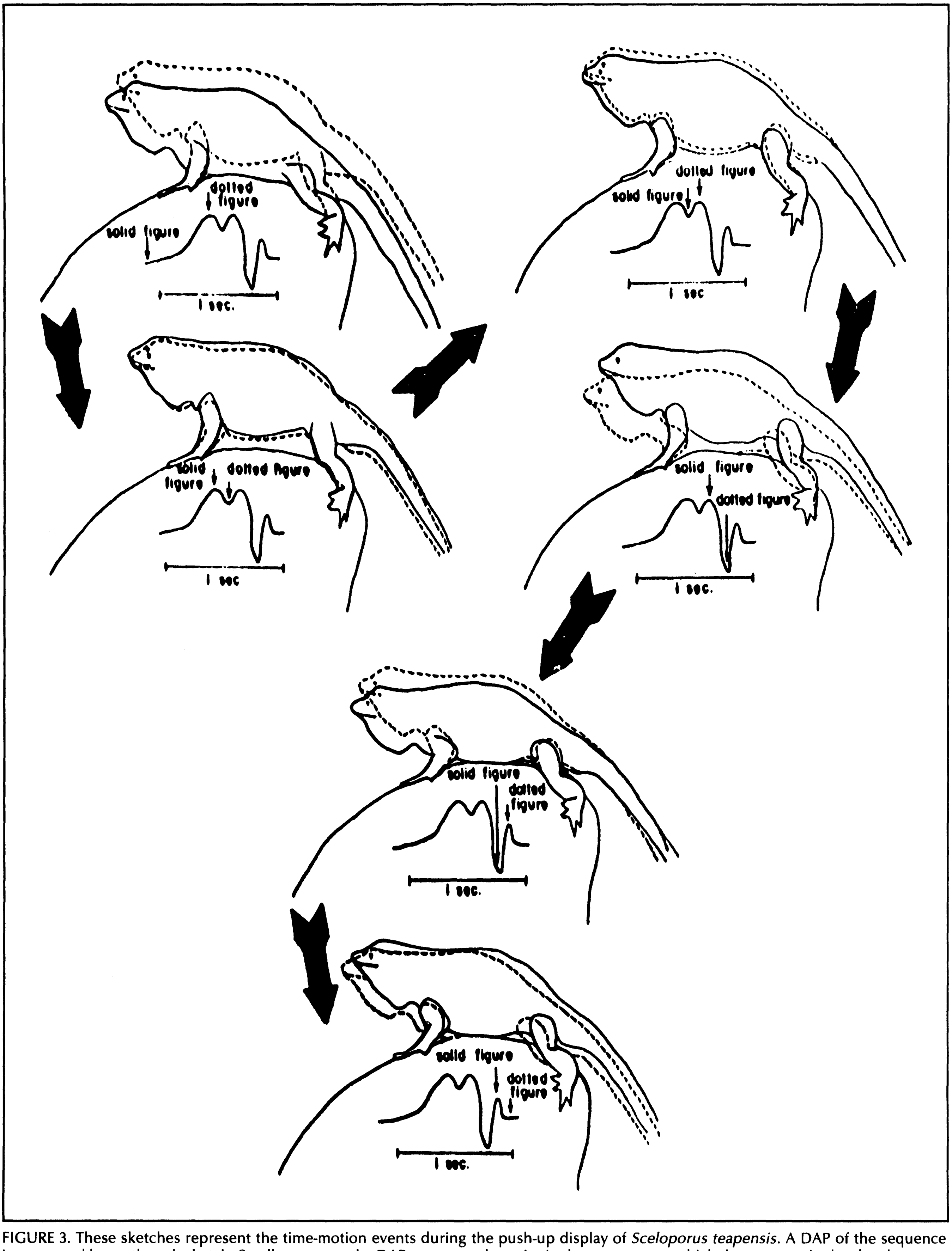

FIGURE 3. These sketches represent the time-motion events during the push-up display of *Sceloporus teapensis*. A DAP of the sequence is presented beneath each sketch. Small arrows on the DAP represent the point in the sequence to which the postures in the sketch correspond. Where the bold line represents the initial posture in the sketch, the dotted line represents the latter posture (indicated by the second small arrow on the DAP). Large arrows indicate the overall direction of the behavioral sequence. Reprinted from Carpenter (1978), with permission.

again "just to be sure." For example, single-frame analysis has been employed to study the complex displays of certain agamid lizards. Some of these displays involve simultaneous tail-twitching, leg-waving, push-ups, and head-bobs. The patterns of all of these behaviors are specific and they are synchronized in a coordinated manner as well. By repeated viewing of the film on which this behavior was recorded, each individual display pattern has been described and then assembled into a sequence of behavior patterns in a study of the lizard *Amphibolurus muricatus* (Carpenter 1979). These observations would be extremely difficult if not impossible to make by simply watching the behavior without the aid of the camera. Simultaneous behaviors of more than one individual also can be observed separately and then synchronized by repeatedly viewing a film or videotape of the behavioral interaction. Combat rituals of male crotaline snakes, such as that of the rock rattlesnake (*Crotalus lepidus*), have been analyzed effectively this way (Carpenter, Gillingham, and Murphy 1976).

Infrared film can be used to record events that occur under low light conditions. It can also be used in studies of the heat characteristics of organisms (Kodak 1980). Recorded behaviors can be played back to animals to determine what aspect of a display is necessary to elicit a response. For example, Jenssen (1970) found that projected behaviors of male *Anolis nebulosis* would elicit an "approach" response in female lizards of that species.

In conclusion, the use of motion picture film and videotape in the study of animal behavior can greatly increase the accuracy as well as the amount of available data. Behaviors can be sped up or slowed down to provide the observer with a temporal perception similar to the animal being studied. The simultaneous behaviors of different animals or body parts can be recorded and later analyzed. Ultimately, in the teaching laboratory, the intricacies of a behavior can be determined via repeated viewing of the recorded behavior. The value of these tools to the animal behavior researcher, biology student, or teacher are immense.

For further information on the use of film and videotape for data collection (or teaching applications) refer to Lehner (1979) for an excellent compilation of behavioral methods and techniques.

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