University of Florida Book of Insect Records
Chapter 5 *Most Tolerant of Desiccation*

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1 May 1994

The larvae of the chironomid, Polypedilum vanderplanki *Hinton, breed in small pools on unshaded rocks in northern Nigeria and Uganda where they withstand an environment which is alternately dry and flooded.* Polypedilum vanderplanki *is the only insect definitely known to endure cryptobiosis and survive drying to <3% moisture. However, the hemolymph and certain tissues of some insects also tolerate the extreme desiccation associated with the cryptobiotic state.*

Organisms have a variety of strategies which allow them to tolerate extremely dry environments and avoid desiccation. These strategies range from physiological adaptations such as the use of metabolic water, to behavioral adaptations such as moving from the sun to the shade during the hottest part of the day. One very peculiar tactic used by a few organisms is a phenomenon known as cryptobiosis. According to Keilin (1959) cryptobiosis is defined as "the state of an organism when it shows no visible signs of life and when its metabolic activity becomes hardly measurable, or comes to a standstill". Recovery after exposure when dry to temperatures of over 100ºC is evidence that the organism or tissue had been in a state of cryptobiosis (Hinton 1960a). Cryptobiosis is known to occur in a wide variety of organisms including viruses, bacteria, fungi, seeds of higher plants, and even in animals—including tardigrades, eelworms (Keilin 1953), and eggs of some crustacea (Hinton 1960a). An insect which can undergo cryptobiosis would surely be able to withstand drier conditions than an insect that cannot.

Methods

In order to find whether there is an insect that can undergo cryptobiosis I searched general entomology texts (Blum 1985; Chapman 1982; Borror, Triplehorn, et al. 1989; Edwards 1991) and the CD-ROM version of BioAbstacts from 1991 to 1993.

Results

Polypedilum vanderplanki is the only insect known to endure the cryptobiotic state and survive dehydration to a moisture content of <3%.

Polypedilum vanderplanki breeds in small pools in shallow depressions on unshaded rocks in northern Nigeria and Uganda. The pools are alternately dry and flooded. During the dry periods the larvae dry out on the mud under 4 to 8 mm of plant debris in depressions. Larvae are exposed to temperatures as high as 70ºC (Hinton 1952).

Hinton (1951) brought the larvae into the laboratory to determine how the larvae survive. The larvae were dried to <3% moisture and were heated at several temperatures for varied amounts of time. Some of the larvae metamorphosed after exposure to 102-104ºC for 1 minute, and some recovered temporarily after exposure to 106ºC for 3 hr or 200ºC for 5 min (Hinton 1960b). According to Hinton (1960a), the ability to survive these temperatures is indisputable evidence that the larvae were in a state of cryptobiosis.

Discussion

Since virtually all insects are not capable of entering the cryptobiotic state, they cannot tolerate a moisture content lower than 10-20% (Hinton 1960a). Dehydration is generally slowed in insects by the impermeability of the embryonic membrane, chorion, or cuticle, or by the production of metabolic water (Hinton 1960a). The eggs of *Locustana pardalina* survive moisture contents as low as 40% (Matthee 1951). The American coccid, *Margarodes vitium* was found alive after at least 17 years in a museum (Ferris 1919), and the development of the larva of the wood boring beetle, *Eburina quadrigeminata*, has been delayed for up to 40 years in dry wood (Jaques 1918); however, their moisture contents are not know. Although many insects are resistant to moisture loss they tolerate a drop in moisture only to a critical level (Hinton 1960a). However, some insect tissues are capable of surviving the cryptobiotic state. For example, the epidermis of several species of Coleoptera and Diptera (Hinton 1957) and the hemocytes of *Sialis lutaria* L. (Megaloptera) survive cryptobiosis (Selman 1961).

Although *Polypedilum vanderplanki* is the only insect known to survive the extreme desiccation associated with the cryptobiotic state, other insects may have this ability; for example, the larva of the mycetophylid, *Sciara medullaris* (Giard 1902) and a ceratopogonid larva occur in the same environment in Africa as *Polypedilum vanderplanki* (Hinton 1960a). Further investigation is needed to confirm whether these or other insects can enter cryptobiosis.

Acknowledgements

I thank James Nation and Bob Stewart (Department of Entomology and Nematology, University of Florida) for their advice on this paper.

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