University of Florida Book of Insect Records
Chapter 12 *Longest Life Cycle*

YONG ZENG

Department of Entomology & Nematology
University of Florida, Gainesville, Florida 32611-0620

8 May 1995

Under exceptional conditions, some individuals of wood-boring beetles (Ceram-bycidae and Buprestidae) have the longest life cycle. One Buprestis aurulenta *larva emerged after 51 years. Three species of 17-year periodical cicadas,* Magicicada septendecim, M. cassini, *and* M. septendecula, *are well-known to have the longest synchronized development times in natural conditions.*

Life cycle is defined as the sequence of events from egg to reproducing adult. Metamorphosis is a characteristic of insect life cycles, and the different stages become distinct units of development time. Each of these units must face environmental exigencies often quite different from those of the others. Insects have solved the problems of synchronizing life cycles to seasonal periodicities and responding to other biotic and abiotic factors with an impressive array of tactical alternatives. These include flexibility in diapause and development rates (Dingle 1986). On the other hand, there are many cases in which life cycles are made longer by prolonged development time rather than diapause. This paper is a literature review of the longest life cycles in the class Insecta.

Methods

CD-ROM versions of *Biological Abstracts* and AGRICOLA were searched from year 1989 to the present. The more useful resources were personal communications with scientists, and secondary literature.

Results

In some insect species, different individuals have different spans of life cycle depending on individual inhabited environment. On the other hand, some species have an unchangeable period for their life cycle regardless of inhabited environment.

Many recorded cases of prolonged of life cycle are in Coleoptera. The wood boring beetle, *Eburia quadrigeminata* (Ceram-bycidae), when feeding in dry wood, may have its development so greatly retarded that adults emerge from furniture and flooring many years after manufacture or installation. Delayed emergence of *E. quadrigeminata* was discovered from a birch bookcase 40 years old (Jaques 1918). Huguenin (1915) was the first to record a development time of *Buprestis aurulenta* (Buprestidae) from structural timbers as long as 26 years after infestation. Thirty-two additional cases of delayed emergence in *Buprestis* were presented by Smith (1962), with 11 of the total cases between 26 and 51 years. For some of these cases, infestation by later direct attack was suggested. However, considering the potential of these wood beetle species for prolonged larval development, Smith (1962) believed that when wood beetles emerge from a structure, it indicates larval development at least equivalent to the age of the structural members they emerged from, unless local and more recent repairs have introduced the infestation.

Compared with the lack of convincing concrete evidence of prolonged development time for these two beetle species, the periodical cicada's requirement of 17 years to complete nymphal development is well documented. Marlatt (1907) studied the development in the 17-year nymphs by digging up specimens from the same grove of trees over a period of 17 years. This seventeen year development time is shared by three distinct species—*Magicicada septen-decim* (Linnaeus), *M. cassini* (Fisher), and *M. septendecula* Alexander and Moore. The three species are sympatric, but are separated microspatially by preferring different but overlapping forest types. Within the same brood, emergences co-occur with definite synchrony.

Discussion

As described above, some cases of prolonged development time are extrinsically mediated by direct effects the environment, such as *Buprestis aurulenta*. Smith (1962) suggested there are innate differences in rate of development amongst individuals of the same *B. aurulenta* brood; some have short rates of development and others prolonged develop-ment under the same environmental conditions. Obviously, the poor nutritional quality of dead wood causes significantly prolonged development (Haack & Slansky 1987). As, Howard (1942) pointed out, under these exceptional conditions, the larvae of certain wood-boring beetles (Cerambycidae and Buprestidae) in furniture and manufactured wooden articles may have the longest lives recorded among insects.

Conversely, for three species of 17-year periodical cicadas, the prolonged development time is the result of an endogenous mechanism. Cicadas feed exclusively on xylem fluid as nymphs and as adults (Cheung and Marshall 1973). Slow development in cicadas could be comprehensible due to their exceedingly dilute diet of xylem fluid that is energetically expensive to procure (White and Strehl 1978; Lloyd 1984). Furthermore, the nymphs may only be able to feed during the limited period when xylem pressures are positive or when the negative pressures are not impossible to overcome. In addition, the size of the cibarial pump may limit the rate of ingestion. Karban (1986) advanced a detailed hypothesis for the relationship between nutrition and prolonged development in cicadas. The mechanism that maintains the precise developmental periodicity is not simply a uniform determined development rate. The first individuals to complete their growth have to wait to emerge until the 'scheduled' number of years has elapsed (Lloyd and Dybas 1966).

In summary, although 17-year cicadas are well-known for their long life cycle in natural habitats, some wood beetle species definitely have the longest life cycles in exceptional habitats.

Acknowledgements

I thank Drs. Thomas J. Walker, James E. Lloyd, and Mike Thomas for helpful advice.

References Cited

Cheung, W. W. K. & A. T. Marshall. 1973. Water and ion regulation in cicadas in relation to xylem feeding. J. Insect Physiol. 19: 1801-1816.

Dingle, H. 1986. The evolution of insect life cycle syndromes, pp.187-203. *In* F. Taylor & R. Karban [eds.], The evolution of insect life cycles. Springer-Verlag, New York.

Dybas, H. S. & M. Lloyd. 1974. The habitats of 17-year periodical cicadas (Homoptera: Cicadida: *Magicicada* spp.). Ecol. Monogr. 44: 279-324.

Haack, R. A. & F. Slansky Jr. 1986. Nutritional ecology of wood-feeding Coleoptera, Lepidoptera, and Hymenoptera, pp. 449-486. *In* F. Slansky Jr. & J. G. Rodriguez [eds.], Nutritional ecology of insects, mites, spiders and related invertebrates. Wiley Interscience, New York.

Howard, L. O. 1942. Ageing of insects, pp. 49-65. *In* E. V. Cowdry [eds.], Problems of ageing, biological and medical aspects. Williams & Wilkins, Baltimore.

Huguenin, J. C. 1915. An observation on a buprestid. Entomol. News 26: 364-365. [Not seen; cited by Linsley 1943, p. 349.]

Jaques, H. E. 1918. A long-life wood-boring beetle. Proc. Iowa Acad. Sci. 25: 175. [Not seen; cited by Linsley 1962, p. 67.]

Karban, R. 1986. Prolonged development in cicadas, pp. 222-235. *In* F. Taylor & R. Karban [eds.], The evolution of insect life cycles. Spring-Verlag, New York.

Linsley, E. G. 1943. Delayed emergence of *Buprestis aurulenta* from structural timbers. J. Econ. Entomol. 36: 348-348.

Linsley, E. G. 1962. The Cerambycidae of North America: part III. Taxonomy and classification of the subfamily Ceram-bycinae, tribes Opsimini through Mega-derini. University of California Press, Berkeley, Calif.

Lloyd, M. & H. S. Dybas. 1966. The periodical cicada problem. II. Evolution. Evolution 20: 466-505.

Lloyd, M. 1984. Periodical cicadas. Antenna 8: 79-91.

Marlatt, H. B. 1907. The periodical cicada. USDA Bur. Entomol. Bull. 71: 1-181.

Smith, D. N. 1962. Prolonged larval development in *Buprestis aurulenta* L. (Coleoptera: Buprestidae). A review with new cases. Can. Entomol. 94: 586-593.

White, J. & C. Strehl. 1978. Xylem feeding by periodical cicada nymphs on tree roots. Ecol. Entomol. 3: 323-327.