

Magical Musicians – The Periodical Cicadas

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Periodical cicadas are the strangest insects which were admired by many leading early American Entomologists namely Charles Marlatt, Benjamin Walsh and Charles Riley. The special attraction towards these creatures were their prime numbered life cycles, periodic massive and synchronized appearance and noisy behaviour (Williams and Simon, 1995).

Life of periodical cicadas

Generally, there are two types of cicadas including Annual cicadas (Dog ay cicadas) and Periodical cicadas. The first one can be seen every year whereas the second will emerge after a long periods of time usually 13 or 17 year forms. Periodical cicadas (Hemiptera: Cicadidae: *Magicicada*) are unique to North America.



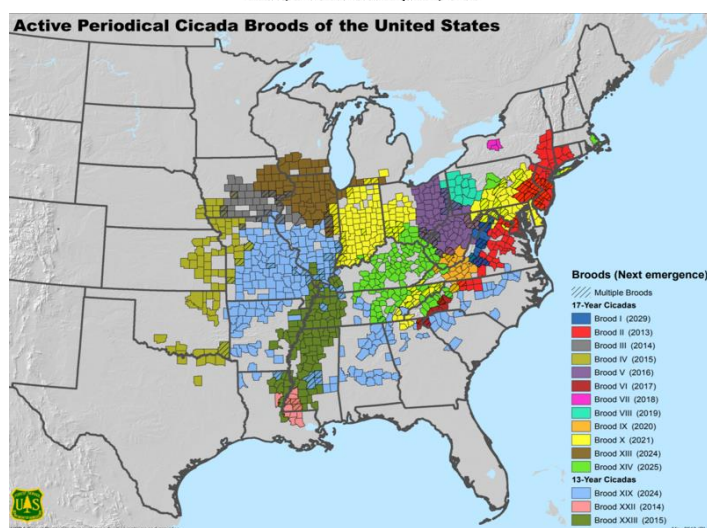
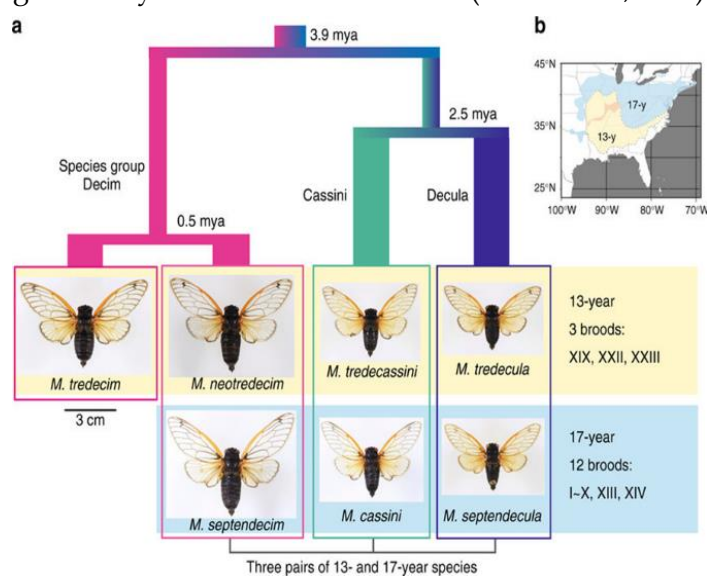
They undergo incomplete metamorphosis: eggs, nymph and adult. Adults emerge in late April, mate, lay eggs, hatch as nymphs and crawling underground for 13-17 years (Williams and Simon, 1995). Cicadas stay underground for five instars, feed on xylem, emerge via holes or mud turrets in wetter areas, become winged adults and undergo a teneral period for 4-6 days. Males sing to attract females and the females respond by wing flicking. The adults remain alive for 4-6 weeks (Lloyd and Dybas, 1966; Marlatt, 1907; White and Lloyd, 1975).

The *Magicicada* species groups, species and broods

Periodical cicadas belongs to the genus *Magicicada*, consisting of seven species in three distinct

groups: Decim, Cassini, and Decula, each with one or two 13 and a 17-year life cycle form (Williams and Simon, 1995). The Decim group includes two 13 year species *Magicicada tredecim*, *Magicicada neotredecim* and a 17 year species *Magicicada septendecim*. The Cassini group has a 13-year *Magicicada tredecassini* and a 17-year *Magicicada cassini*. Eventually, the Decula group has a 13-year *Magicicada tredecula* and a 17-year *Magicicada septendecula*.

They were morphologically, behaviorally, and genetically distinct from each other (Simon *et al.*, 2022).



All periodical cicadas that emerge in a given year in a given area on a predictable cycle are known as single brood or year-class (Sota, 2022). An American entomologist, proposed the classification of periodic cicadas into 30 broods, each with a Roman numeral

(Marlatt, 1898). Currently, 17-year cicadas have 12 possible broods (Broods I-X, XIII, and XIV), while 13-year cicadas have only three possible broods (Broods XIX, XXII, and XXIII) (Simon *et al.*, 2022). Some broods, including those originally mapped by Marlatt have gone extinct (Manter, 1974).

In certain cases, cicadas may appear where they are not predicted to in a particular year (off - schedule), but the area has a history of regular emergences on a different schedule. This behaviour often referred as straggling. Cicadas that emerge off-cycle, either before or after their brood is expected to emerge are called stragglers which can appear for any number of years off-cycle, with errors of 1 or 4 years being the most common (Lloyd and Dybas, 1966). Stragglers of 4 years occur in both 13- year and 17- year cicadas (Marshall *et al.*, 2017). Most stragglers are few in number and are quickly annihilated by predators (Dybas, 1969).

Songs of magical musicians

“Happy are cicada’s lives, for they all have silent wives”. In line with this saying, only the male periodical cicadas produce “songs” to attract their mates. Sound is produced by a pair of ribbed tymbals on the abdomen. Visual cues may stimulate mating, but songs are more critical (Dunning *et al.*, 1979). Male periodic cicadas sing in a way unique to their species. One sounded like wheeee-ooo or phar-r-r-r-aoH (*M. septendecim*) (Riley, 1885), the second like an old-fashioned lawn sprinkler, click-click-click-buzzzzzzzz (*M. cassini*) and the third possessed an intermittent mini-chainsaws, zzzzzzzzz (*M. septendecula*) (Milam, 2023). Male cicadas use a combination of calling and flight (sing-fly behavior) to locate females, with calls structured to stand out in dense choruses (Cooley and Marshal, 2001).

Male signals: Males produce five different acoustic signals and they are alarm call, calling songs, courtship calls (1 to 3). Alarm sounds are rough buzz produced when the males startled or handled. Calling songs that attracts both males and females to the chorus. Courtship calls are to approach and attempting to mate with females. Males approach females while making call phrases similar to those in chorusing, but without intervening flights (Dunning *et al.*, 1979). Court I (CI) is to locate the responding female. CII is usually produced by the male before attempting to mount a female or while approaching. CIII is produced while the males preparing to mount and which continues up to mounting and copulation (Cooley and Marshal, 2001).

Female signals: Female cicadas make a unique "wing-flick" signal when males call which is species specific (Cooley and Marshal, 2001). The teneral females are sexually inactive and do not wing-flick. The periodical cicada females mate only once (White, 1973). Wing movements after mounting interrupt courtship and indicate mating rejection.

Prime numbered life cycle and synchronized emergence

Periodical cicadas use prime numbers in their life cycle as an evolutionary strategy to avoid synchronization with shorter life cycle predators or parasites. This strategy reduces the likelihood of cicadas being wiped out by predators or parasites that may synchronize their life cycles. This strategy allows cicadas to take advantage of surprise and minimize the impact of predation on their populations, ultimately enhancing their survival and reproductive success (Simon *et al.*, 2022).

Periodical cicadas exhibit a unique strategy called Predator satiation, a rare antipredator behavior of arthropods (Witz, 1990). Predators eat cicadas, such as birds, raccoons, squirrels, dogs, and snakes and satisfy them by providing enough food until they become wary and avoid them entirely. For example, the synchronized emergence of periodical cicadas is resulted in their dramatic population increase, avian predators rapidly were satiated so that they appeared to remain so for several weeks. Therefore, only a small proportion of the adult cicada population was actually consumed by avian predators. This gives the remaining cicadas a chance to escape the predators (Williams *et al.*, 1993).

Hard knock life for cicadas



Periodical cicadas, despite their predator satiation strategy, face a hard knock due to fungal disease *Massospora cicadina*, which appears as spores

on the ground surface for 17 years. Stage I *Massospora* infections occur in nymphs emerging from soil, while Stage II infections spread among adult cicadas, multiplying and turning the abdomen into a fungus garden.

Infected cicadas, despite being replaced with fungal tissue, move around unaware of their illness due to fungus manipulations that keep the host alive rather than killing them. Infected cicadas lose mate ability and attempt to transmit the fungus to healthy females. The fungus feminizes male cicadas, attracting them to mate with other males and infecting them. This spreads among the population, turning them into zombies (Cooley *et al.*, 2018).

How do they calculate the period of emergence

The periodical cicadas will emerge, on an average, when the soil 8 inches below the ground reaches 64 degrees Fahrenheit. Synchrony in emergence may be due to animals reaching a critical threshold temperature (Heath, 1968). Still the duration of emergence of cicadas remains mystery.

Periodical cicadas as herbivory and its management

Over 270 species of plants serve as hosts though the most preferred plants include White oak, Hickory, Black walnut, Black cherry, Hawthorn, Boxelder, Black locust, Flowering dogwood, White ash, green ash, Apple, Redbud. Pine and spruce trees are not damaged (Clay *et al.*, 2009).



Adult cicadas cause slight plant damage through feeding but major damage is caused by female egg laying. They split bark and splinter sapwood to deposit 2 to 4 dozen eggs per site, causing twigs to die and the resulting symptom referred as “flagging”. Larger trees can withstand damage while smaller ones may be severely injured or killed (Cutright *et al.*, 1949; Hamilton, 1953, Graham *et al.*, 1957).

Control measures for well-established trees are minimal, as they can be easily recovered. Newly transplanted trees should be protected with fine netting to prevent egg-laying females from laying and damaged twigs should remove within 6 weeks of oviposition. Insecticide sprays during egg laying can reduce tree damage but are not recommended as they

can disturb natural enemies and harm pollinators or beneficial insects.

Cicadas as entomophagous insects

Insects and arthropods are consumed globally as a delicacy and staple food due to their nutritional value. Cicadas, low-fat insects with nutty flavor and shrimp-like quality, offer protein and avoid if allergic to shellfish.

Conclusion

Magicicada, a unique insect, faces extinction due to urban development and loss of underground habitat. Observing and mapping these cicadas is challenging due to their varying emergence locations. Since 2004, iNaturalist and Cicada Safari apps have helped scientists map their distribution. Cicada Safari, developed by CITE at Mount St. Joseph University, uses photographs to verify and map cicada’s distribution. 2024 is a special year for periodical cicadas, with the simultaneous emergence of two broods (XIII and XIX), a rare occurrence once every 221 years, last reported in 1803. This rare event will not occur again until 2245.

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