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Source: The Journal of the Lepidopterists' Society, 70(1) : 9-14

Published By: The Lepidopterists' Society

URL: https://doi.org/10.18473/lepi.70i1.a3

*Journal of the Lepidopterists' Society*
70(1), 2016, 9–14

# UPDATED DISTRIBUTIONAL DATA FOR *CITHERONIA SEPULCRALIS* GROTE & ROBINSON, 1865 (SATURNIIDAE: CERATOCAMPINAE), WITH A NEW HOST PLANT RECORD

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**ABSTRACT.** The distribution of *Citheronia sepulcralis* (Saturniidae: Ceratocampinae) is updated. Compared to previous literature, a much more extensive inland distribution in the eastern United States is provided, including a new state report from Delaware. A recent photographic voucher from the Bahamas is reported and discussed. A new natural host plant, *Pinus clausa* (Pinaceae), is mentioned.

**Additional key words:** Bahamas, biogeography, insect-host plant association, pine devil, *Pinus*

*Citheronia sepulcralis* Grote & Robinson, 1865 (Saturniidae: Ceratocampinae), also known as the pine devil, is a moderately sized (wingspan: male: 67–85 mm; female: 68–95 mm), obscurely marked moth, found in pine and mixed forests throughout the eastern United States (Ferguson 1971, Lemaire 1988, Tuskes et al. 1996). The cryptic, horned, larvae of *C. sepulcralis* feed exclusively on various species of *Pinus* (Pinaceae). While reports in nature of this species are sparse, *C. sepulcralis* can be quite common in the correct habitats.

*Citheronia sepulcralis* is the only species of Ceratocampinae obligate on *Pinus*, and one of only a few Ceratocampinae that will feed on this genus of trees. The other ceratocampine known to feed on pine, *Eacles imperialis imperialis* (Drury, 1773) and *E. i. pini* Michener, 1950 are not obligate on *Pinus*. The former is polyphagous; with *Pinus* being just one of many host genera, and the latter is reported to feed on spruce (*Picea*) and broadleaved plants in addition to *Pinus* (Ferguson 1971, Stone 1991, Tuskes et al. 1996).

Historically, *C. sepulcralis* was encountered along the Atlantic coast in areas with an abundance of pines, from southern Maine south to the Florida Keys, and in all of the Gulf Coast states with the exception of Texas. Its occurrence inland is represented by scattered reports throughout the northern portions of the Gulf Coast states and northeast through the Appalachians.

This paper aims to present a more inclusive distribution map of *C. sepulcralis*, providing a clear pictorial representation of a range that, while limited, is more expansive than previously reported, potentially even reaching outside of the United States. Additionally, some hypotheses are proposed in an attempt to understand the distribution boundaries of this species, and why it is absent in some locations where *Pinus* is common.

## MATERIALS AND METHODS

The following institutions were either visited or contacted by the author to examine or request *C. sepulcralis* data:

AMNH American Museum of Natural History, New York, New York, USA
CGCM Collection of Carlos G. C. Mielke, Curitiba, Paraná, Brazil
CMNH Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA
CNC Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Ontario, Canada
CUIC Cornell University Insect Collection, Ithaca, New York, USA
FSCA Florida State Collection of Arthropods, Gainesville, Florida, USA
MEM Mississippi Entomological Museum, Mississippi State, Mississippi, USA
MGCL McGuire Center for Lepidoptera & Biodiversity, Gainesville, Florida, USA
NHM The Natural History Museum, formerly British Museum (Natural History), London, U.K.
TAMU Texas A&M University, College Station, Texas, USA
UCMS University of Connecticut, Storrs, Connecticut, USA
UGCA Collection of Arthropods, Georgia Museum of Natural History, Athens, Georgia, USA
USNM National Museum of Natural History, formerly United States National Museum, Washington, D.C., USA
YPNM The Yale Peabody Natural History Museum, New Haven, Connecticut, USA

Additional distributional data were gathered from the literature, personal communications, and online databases, such as the Butterflies and Moths of North America, BugGuide, and the Lepidopterists' Society Season Summary.

Natural larval host plant data was gathered from Geddes (1903), Packard (1905), Forsyth (1933), and Ferguson (1971) in order to confirm the new host plant record reported below. Records, particularly those included in Stone (1991) that list *Pinus* species not native to the distribution of *C. sepulcralis*, or those that do not explicitly state the collection of larvae from a given species of pine, were not considered "natural hosts."

The map was created with SimpleMappr (Shorthouse 2010) and edited with CS4 (Adobe 2008). All geographical coordinates are approximate, and are based on the localities provided on specimen labels. GPS data were acquired with Google Earth.

## RESULTS

The accompanying map (Fig. 2) illustrates a number of inland records, which extend the traditional, largely coastal distribution of *C. sepulcralis*. New peripheral reports come from central and western Tennessee (K. Childs pers. com.; B. Reynolds pers. com.; CUIC), as well as from northern Alabama (B. Reynolds; MEM) and central Mississippi (AMNH), displaying an inland extent of distribution from the Gulf of Mexico that was not presented by Lemaire (1988), Opler (1995), or Tuskes et al. (1996). In addition to numerous new county records for all states, *C. sepulcralis* is reported here for the first time from Delaware (MGCL) and Washington D.C. (CNC).

A single photographic voucher of *C. sepulcralis* from Grand Bahama, Bahamas, from February 2009 provides the first evidence of this species being found outside of the United States.

No additional natural host plant records have been reported since those consolidated in Ferguson (1971). The single *C. sepulcralis* larva that I have found in nature was feeding on *Pinus clausa* Chapman (Vasey) near Ocala, Florida, which is a new host record, reported here for the first time.

## DISCUSSION

Pine trees are the only known natural host of *C. sepulcralis*, and thus its distribution very clearly follows the range of various pines in the eastern United States. Natural host records exist only for *Pinus strobus* L. (Packard 1905), *P. rigida* Mill (Packard 1905), and *P. caribaea* Morelet (Forsyth 1933) (all cited by Ferguson 1971). Other *Pinus* species reported in literature refer to host plants probably used in captivity, as evident by the various European *Pinus* species listed by Stone (1991).

Apparently the distribution of *C. sepulcralis* does not merely follow the distribution of pine, but more specifically, that of the *Australes* subsection (Gernandt et al. 2005). These pines comprise the familiar hard pines of the southeastern United States with some species ranging more northward, such as the pitch pine, *P. rigida*. This association with southern pines certainly provides some explanation as to the relationship of *C. sepulcralis* with pitch pine in the Northeast, which is the only *Australes* pine present in New England and most of New York (Critchfield & Little 1966). Similarly, the distribution of *C. sepulcralis* is restricted in other states where *Australes* pines are not widespread. For example, in Ohio and Kentucky, *C. sepulcralis* is present only in the portions of these states where *Australes* pines are found (Critchfield & Little 1966, Metzler & Horn 2009, Covell 1999).

FIG. 1. *Citheronia sepulcralis* found on February 21, 2009, Grand Bahama Island, Bahamas. Photo credit: Larry Manfredi, used with permission.

Although there is a clear association between *C. sepulcralis* and *Australes* pines in the Northeast, records do exist for *C. sepulcralis* feeding on white pine, *P. strobus*, which is not a member of the *Australes* subsection (Packard 1905, Gernandt et al. 2005). However, when reared on white pine, *C. sepulcralis* does not attain large size or maintain good health. More specifically, I have reared *C. sepulcralis* on white pine on two occasions and on pitch pine three times. The first time that I reared *C. sepulcralis* on white pine, indoors, resulted in a 40% pupation rate out of 10 larvae. The second time that I reared this species, sleeved outdoors, on white pine, resulted in complete mortality of about a dozen larvae, potentially from disease and malnutrition. Siblings from this second white pine batch were also sleeved outdoors on pitch pine with only minimal mortality. Similar low, to zero,

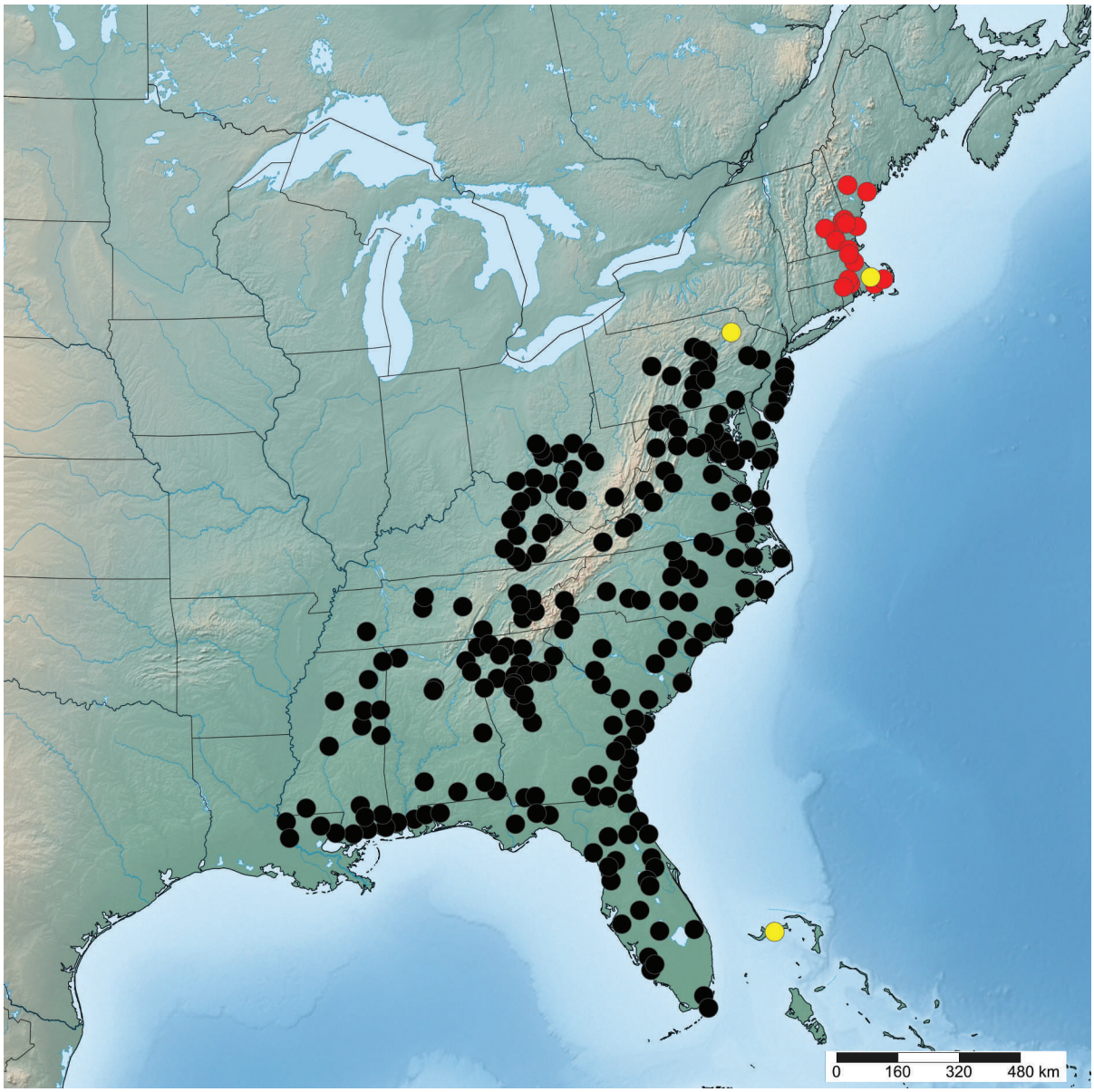


FIG. 2. The distribution of *Citheronia sepulcralis* in the United States and the Bahamas. Red circles represent localities of extirpation; black circles represent records from localities where *C. sepulcralis* is still considered extant; yellow circles represent potential populations that have not yet been confirmed or may now be extirpated.

mortality was seen each additional time when *C. sepulcralis* was reared on pitch pine. Geddes (1903) reported trouble rearing *C. sepulcralis* on white pine, and had better results on pitch pine as well. This same author also mentioned *P. mitis* (=*P. echinata*) as a possible host but did not state that larvae were found on this species. Perhaps if *C. sepulcralis* had adapted to feeding on white pine, the distribution northward could have been much more extensive, considering the distribution of white pine in New England relative to pitch pine (Critchfield & Little 1966). Thus the northern extent of the historical distribution of *C. sepulcralis* in southern Maine and New Hampshire mirrors the northeastern distribution of pitch pine. Similarly, the westernmost distribution of *C. sepulcralis*, to be discussed further below, parallels the distributions of all southeastern *Australes* subsection pines, at least as far west as the Mississippi River Valley (Critchfield & Little 1966).

With a clearer representation of the inland and westernmost distribution of *C. sepulcralis*, (Fig. 2), it now becomes possible to elucidate the western

terminus of the geographic range of this species. Data gathered in the present work shows that this species has not been reported west of the Mississippi River Valley, although one record that reports otherwise must be noted. The *C. sepulcralis* figured by D'Abrera (1995) was labeled as being from Texas, without further information. I was able to locate a short series of specimens at the NHM labeled "Texas", including the male figured by D'Abrera. But these obviously very old specimens, without much wear; appear to have been reared—perhaps in Texas, especially considering that an uncommonly collected female was included. Lemaire (1988) mentioned Texas as part of the distribution and Tuskes et al. (1996) hesitantly repeated this record. The specimens at the NHM appear to be the origin of these reports. Additionally, there are no recent records of this species from Texas despite intensive collecting in the state (E. Knudson pers. com.). However, it is important to mention that *Australes* pines are distributed in eastern Texas (Critchfield & Little 1966) and so it is not impossible for *C. sepulcralis* to exist there. Similarly, there are no records from southern Arkansas, northern Louisiana, or northwest Mississippi, despite appropriate hosts (Critchfield & Little 1966). The lack of records from otherwise seemingly appropriate habitat in this region suggests that there is a natural barrier limiting the western edge of distribution to just east of the Mississippi River. The three species of *Australes* pines that range in this region, *P. palustris* Mill, *P. taeda* L., and *P. echinata*, are all absent immediately along the Mississippi River. There is a roughly 80 km gap between the distributions of these pines in the southeastern United States east of the Mississippi, which includes much of the known southeastern distribution of *C. sepulcralis*, and their reappearance in western Louisiana, eastern Texas, and northwards to Arkansas (Critchfield & Little 1966). The lack of naturally occurring *Australes* pines in the Mississippi River Valley offers an explanation as to why *C. sepulcralis* is apparently not found in the pine forests west of southeastern Louisiana, where they have been commonly collected for decades (Brou 1997).

The distribution presented in Figure 2 not only provides some insight as to the edge of the distribution of *C. sepulcralis*, but also provides an opportunity to publish some records from within the known range that were previously unreported and to allow the invalidation of numerous questionable records. The only states within the known area of distribution that apparently lack published records are Delaware and Connecticut. I have only seen a single, old specimen from Delaware (MGCL), and I consider this a state record. Unfortunately, it lacks specific data, but the male specimen appears to have been collected in May. *Citheronia sepulcralis* likely occurs in the loblolly pine forests in the southern part of the state, especially considering the number of records from the Delmarva Peninsula from nearby Maryland and Virginia, thus its presence in Delaware is not surprising. For Connecticut, one specimen from Tolland County in the Yale Peabody Museum "collected" in 1954 bears a label reading "probably reared from Georgia specimens", and thus is a doubtful, but not impossible record. Furthermore, records have not been published from Washington D.C. A handful of very old specimens at the CNC are labeled as originating from Washington D.C. Numerous reports from adjacent Maryland and Virginia (see Fig. 2) corroborate the likelihood of *C. sepulcralis* occurring in D.C., either historically or currently.

Questionable records of *C. sepulcralis* have persisted in the literature from Illinois and New York. The often-reported outlier record from Illinois is incorrect. Cashatt & Godfrey labeled this record erroneous as early as 1990, when they said the following in a footnote: "A dubious state record. *Citheronia sepulcralis* apparently was reared in Normal, McLean County, where there are no native *Pinus* species prior to the relocation of the Illinois Natural History Survey to Urbana in 1885." Unfortunately this reference was overlooked for many years and the record has been perpetuated in later literature (Bouseman & Sternburg 2002), and subsequently in online databases (R. A. St. Laurent pers. obs.). New York similarly has dubious records, with some old, obscure, literature references to specimens coming from Albany (T. McCabe pers. com.). One specimen from 1938 at the AMNH bears an Albany label with an explanation that it was reared stock received from A. E. Brower (potentially originating from Maine), and thus this particular specimen could signify the sole NY literature record. Also, the New York Natural Heritage Program mentions a specimen from Montauk in Suffolk County, known from "a pupa" collected in 1984, which is a very bizarre record indeed, as subterranean ceratocampine pupae are the least likely life stage to be encountered, let alone identified to species. According to T. McCabe (pers. com.), the Montauk *C. sepulcralis* is incorrectly reported in the online database, and is in fact *E. imperialis*. To further invalidate *C. sepulcralis* reports from otherwise seemingly ideal habitat on Long Island, H. McGuinness has not encountered this species in the Long Island pine barrens despite extensive sampling (H. D. McGuinness pers. com.). Furthermore, the CUIC lacks any specimens of *C. sepulcralis* from Long Island despite the presence of numerous large series of other Ceratocampinae collected there by R. Latham. Packard

(1905), reported *C. sepulcralis* from New York City, citing both Grote and Edwards, but this is questionable as well, because I have been unable to trace the source of this locality information in Packard's cited sources. Forbes (1923) also mentioned *C. sepulcralis* as occurring in New York, but did not give specific information or a citation. While *C. sepulcralis* is well represented from New England (Massachusetts, Maine, New Hampshire, and Rhode Island) by pre-1950s specimens, Connecticut and New York form a distinct gap between the current northernmost distribution in Pennsylvania and New Jersey and the historical distribution in New England. Whether or not *C. sepulcralis* was widely distributed in these intervening states is not clear.

Of all records to be reported in this current work, perhaps the most interesting is one from Grand Bahama, Bahamas. Larry Manfredi posted a picture to his website (Manfredi 2009) of a relatively fresh individual photographed during the day, on the side of a restaurant on the coast of the island (Fig. 1). Saturniidae are nearly absent throughout the Caribbean Islands, except for Automeris io (Fabricius, 1775), thus this report of *C. sepulcralis* is particularly surprising (T. McCabe & J. Miller pers. com.). The topic of island colonization by Saturniidae has only been briefly mentioned in literature, and thus our understanding of this family in the Bahamas is not well investigated (Rougerie & Herbin 2006, Goldstein 2010). This evidence suggests that the individual may have arrived at Grand Bahama due to some human assistance. However, if there is a population of *C. sepulcralis* on the island, it surly represents only one of a few instances of Saturniidae colonizing a Caribbean island, human assisted or otherwise. The possibility that this recent record represents a natural population is not improbable however, especially considering the short distance between Florida and Grand Bahama. More importantly, Caribbean pine, *P. caribaea*, is present on Grand Bahama and other Bahama islands (Critchfield & Little 1966). *Pinus caribaea* is a member of the *Australes* subsection (Gernandt et al. 2005) and one of the few *Pinus* species that actually has been recorded as a host of *C. sepulcralis* (Forsyth 1933). Regardless of its origin, the Grand Bahama record is certainly a country record for *C. sepulcralis*.

Forsyth (1933) was the last to publish a new, natural host plant for *C. sepulcralis* until this present work. This is not surprising considering the crypsis of the larvae. I have, for example, searched for many seasons targeting *C. sepulcralis* larvae in Pennsylvania, West Virginia, and Florida, only to reveal a single larva on *P. clausa*, a species of pine on which *C. sepulcralis* had not been previously reported. It is probable that further targeted searches will reveal larvae on additional species of *Australes* pines found within the natural distribution of *C. sepulcralis*.

Although the distribution of *C. sepulcralis* is not restricted, this species has seen serious declines in parts of its range. *Citheronia sepulcralis* is one of the Saturniidae and other large moths that declined from the northeastern United States around the 1950s–1960 due to various debated factors, such as the introduced parasitoid *Compsilura concinnata* (Meigen, 1824) and DDT spraying (Goldstein 2010, Schweitzer et al. 2011, Wagner 2012). Schweitzer et al. (2011) reported the last records of *C. sepulcralis* from New England as 1952 and mentioned a record from the Myles Standish State Forest in Plymouth, Massachusetts, from 2010. I attempted to confirm this contemporary record and set out to this location with M. Nelson of the Massachusetts Natural Heritage with a number of reared *C. sepulcralis* females in tow in order to utilize them in an attempt to attract wild males. Despite numerous nights spent in the state forest and other pine barren habitats in Massachusetts and Rhode Island with reared females emitting pheromones in June and July of 2011, 2012, and 2014, no males were attracted. Therefore, it is possible that the 2010 record may have been an introduction, or potentially a serendipitous discovery of an apparently very low or transitory natural population. A recent sighting of *C. regalis* (Fabricius, 1793) from central New York may signal repopulation of the northeastern states by this other previously extirpated, large ceratocampine (Lepidopterists' Society Season Summary 2014). Therefore, sightings of the congeneric *C. sepulcralis* in the Northeast may increase in frequency in coming years assuming that the declines of both species were caused by similar factors.

## Acknowledgments

This work would not have been possible without the kind assistance of many individuals that were willing to provide me with personal collecting data of *Citheronia sepulcralis*. The following individuals provided important locality information: M. Arey, V. Brou, K. Childs, P. Dennehey, S. Johnson, E. Knudson, D. Lawrie, L. Manfredi, C. Mielke, B. Reynolds, and M. Soukup. I would also like to thank those that enabled access to various institutional collections, either by providing access during my own visits or by sending requested information during one of their visits. R. S. Peigler supplied data from TAMU and literature, L. Glines and J. J. Dombroskie provided data from the UCMS and YPNM collections, R. Hoebeke provided data from UGCA, and C. Jaeger supplied data from MEM. Dr. A. Warren (MGCL), A. Giusti (NHM), Dr. J. Rawlins (CMNH), Dr. D. Grimaldi (AMNH), V. Nazari (CNC), L. Thayer (AMNH), and B. Harris (USNM) all provided access to collections. Mike Nelson (Massachusetts Natural Heritage) greatly aided me in my search for the pine devil in Myles Standish State Forest (Plymouth, Massachusetts) and my initial follow-up surveys there would not have been possible without his assistance. Teá Kesting-Handly pro-

vided support with access to other locations in Massachusetts. Also, I would like to thank J. J. Dombroskie, R. S. Peigler, A. P. S. Carvalho, and two anonymouss reviewers for providing valuable feedback and suggestions on the manuscript.

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*Submitted for publication 20 August 2015; revised and accepted 29 September 2015.*