NOTES ON THE OCCURRENCE of *Compsilura concinnata* (Meigen) IN SOUTHWEST OHIO, U.S.A.

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***Compsilura concinnata* (Meigen) is a well-known tachinid fly** that was introduced to the United States from Europe as a biological control agent of the spongy moth (*Lymantria dispar*) from the early 1900s until the 1980s (Sànchez 1995). It is now well established in much of the United States and Canada, having gradually spread from introduction sites mostly on the east and west coasts, and the northern U.S. Midwest. However, its spread into some regions of the U.S. appears to have been relatively slow. I[1], and members of my lab at Wright State University in Dayton, Ohio, have been haphazardly collecting tachinids and rearing caterpillars in southwestern Ohio (ca. 40°N, -84°W) for many years and had yet to observe *C. concinnata* until this past summer of 2024. In this article, we report our observations, briefly review the distribution of *C. concinnata* in the region, examine the accuracy of public databases for assessing its presence, and evaluate its occurrence in southwestern Ohio.

C. concinnata is a blondeliine tachinid that is broadly distributed across much of the Old World (O'Hara & Cerretti 2016, O'Hara et al. 2020). Based on records ranging from the British Isles to Japan, to South Africa, Malaysia, and even Papua New Guinea and Australia, it appears to be among the most widely distributed of any tachinid species (perhaps only outdone by the ubiquitous *Voria ruralis* (Fallén); O'Hara et al. 2020). *Compsilura* belongs to the *Blondelia* group of genera, in which females possess piercing structures derived from the seventh sternite and have the edges of the abdominal tergites usually forming a keel ventrally, beset with short stiff spines. Morphologically and phylogenetically, the genus is closely allied with *Blondelia* (e.g., Stireman et al. 2019). *Compsilura concinnata* is infamous among tachinids in its broad polyphagy, having been recorded as a parasitoid of at least 200 species of Lepidoptera and Hymenoptera (Symphyta) (Arnaud 1978, Boettner et al. 2000, Strazanac et al. 2001). Its attack of native caterpillars in its introduced range has caused some alarm, particularly due to high parasitism rates of large and charismatic Saturniidae in the Northeast U.S. (Boettner et al. 2000, Kellogg et al. 2003, Elkinton & Boettner 2004). Indeed, *C. concinnata* has been implicated in declines in these wild silk moths in the Eastern U.S (Elkinton & Boettner 2012). On the plus side, it also appears to have been a primary contributor to the extirpation of introduced populations of the browntail moth (*Euproctis chrysorrhoea*; Erebidae) in New England (Elkinton et al. 2006, Elkinton & Boettner 2012).

Introduction history and recorded range in North America

The first introductions of *C. concinnata* in North America began in 1906 in Massachusetts, with well-established populations occurring by 1909 (Howard & Fiske 1911, Burgess & Crossman 1929, Sànchez 1995). From these populations, further introductions were made across much of the Eastern States and Canadian Provinces including Vermont, New Hampshire, New Jersey, Rhode Island, Delaware, Maryland, Virginia and Florida (U.S.) as well as New Brunswick, Nova Scotia, Ontario, and Quebec (Canada) (reviewed in Sànchez 1995). These biological control

[1] In this article, "I/me/my" refers specifically to first author Stireman.

efforts continued into the 1970s, with introductions expanding to the Midwest U.S. (Indiana, Illinois, Wisconsin and Minnesota) as well as western states/provinces including Arizona, New Mexico, California, Oregon, Idaho, Colorado, Washington, and British Columbia (reviewed in Sànchez 1995). Due to the great range of hosts attacked and the high parasitism rates sometimes achieved, it appears that *C. concinnata* was introduced to control just about any lepidopteran forest pest that exhibited population irruptions. According to O'Hara & Wood (2004: 83), it is currently established in "northeastern United States and southeastern Canada, west to Minnesota and Illinois, south to Virginia, also British Columbia to California … Manitoba, Ontario to Nova Scotia."

Based upon caterpillar rearing records of Strazanac et al. (2001), as well as my own collections in West Virginia and Eastern Kentucky (Stireman & Perilla López 2022, O'Hara & Stireman 2016, respectively) it appears well established in the Appalachian Region east of Ohio. Furthermore, Oberhauser et al. (2017) recorded rearing *C. concinnata* from Monarch butterflies (*Danaus plexippus*) in Iowa, Michigan, Minnesota and Texas over the years 2005 to 2016. In these rearing records, it was the third most common parasitoid of larval monarchs, accounting for about 10% of recorded parasitism events (69 individual flies reared from 45 host individuals; Oberhauser et al. 2017). It has also been reared from *Trichoplusia ni* (Lepidoptera: Noctuidae) in Minnesota cabbage fields (Wold-Burkness et al. 2005) and Sànchez & Cardé (1998) indicated that it is well established in Michigan. Finally, a specimen in the Canadian National Collection in Ottawa was collected in Amherst, Ohio (Northern Ohio) in 1958 by H.J. Reinhard (O'Hara, pers. comm.). Thus *C. concinnata* appears to be established to the east, north, west, and south of the Dayton, Ohio region where I have been observing, collecting, and rearing tachinids for nearly 20 years, and yet, I had never observed the species.

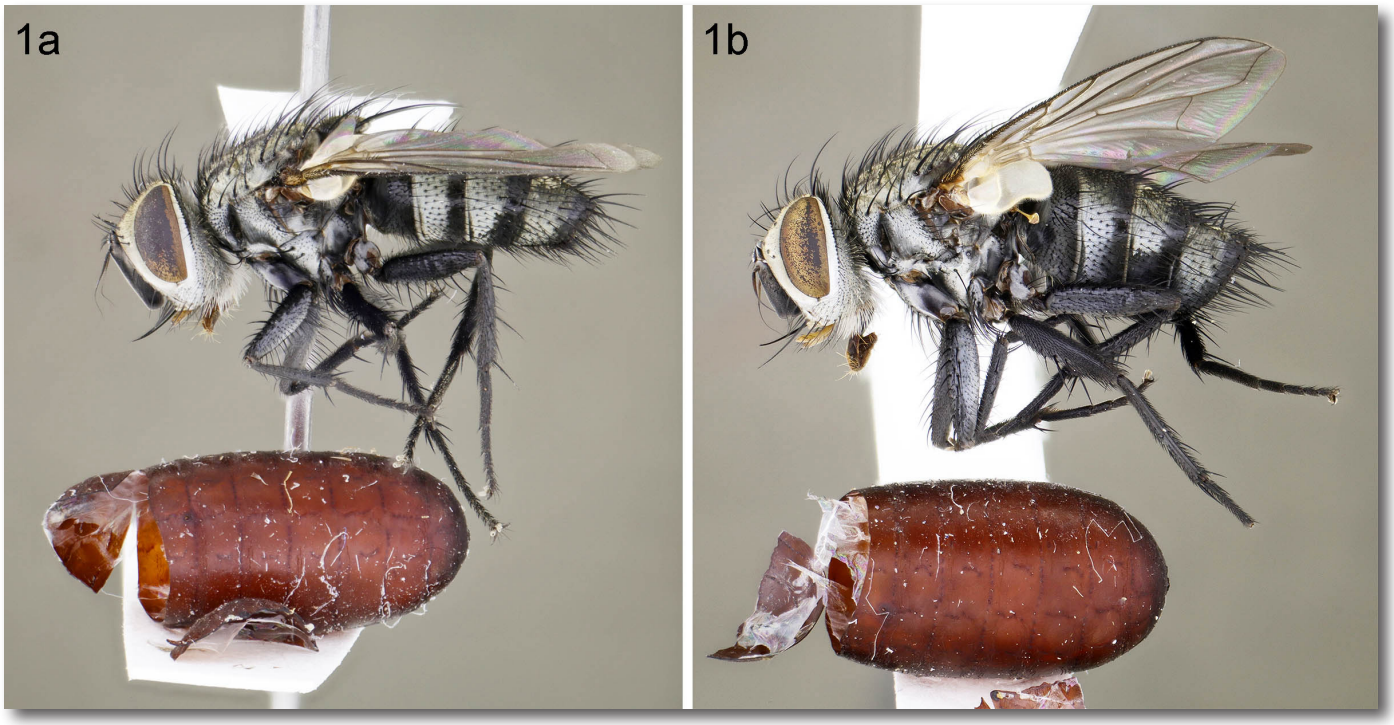


Figure 1. Male (**1a**) and female (**1b**) *Compsilura concinnata* specimens with puparia reared from *Lophocampa caryae* in southwest Ohio (see text).

Our Record from Ohio

On July 2, 2024, as part of a project surveying caterpillars and their parasitoids on woodland shrubs and trees, we collected 16 caterpillars of the hickory tussock moth, *Lophocampa caryae* (Harris) (Lepidoptera: Erebidae). They were collected from bitternut hickory (*Carya cordiformis*) in Sugar Creek Metropark, which is located on the south side of the Dayton Metropolitan area (39.617, -84.096). These caterpillars were brought back to the lab and fed leaves of their host plant until they died, pupated, or a parasitoid emerged. Parasitoid larvae/puparia were noted in the rearing tubs of two of these caterpillars on August 5, 2024, and two adult *C. concinnata* (one male, one female; Fig. 1a,b, respectively) were noted on August 21. *Compsilura concinnata* has previously been recorded from this host species (as *Halysidota caryae*; Arnaud 1978 and references therein), which is widespread in the midwestern and northeast U.S. and southeastern Canada.

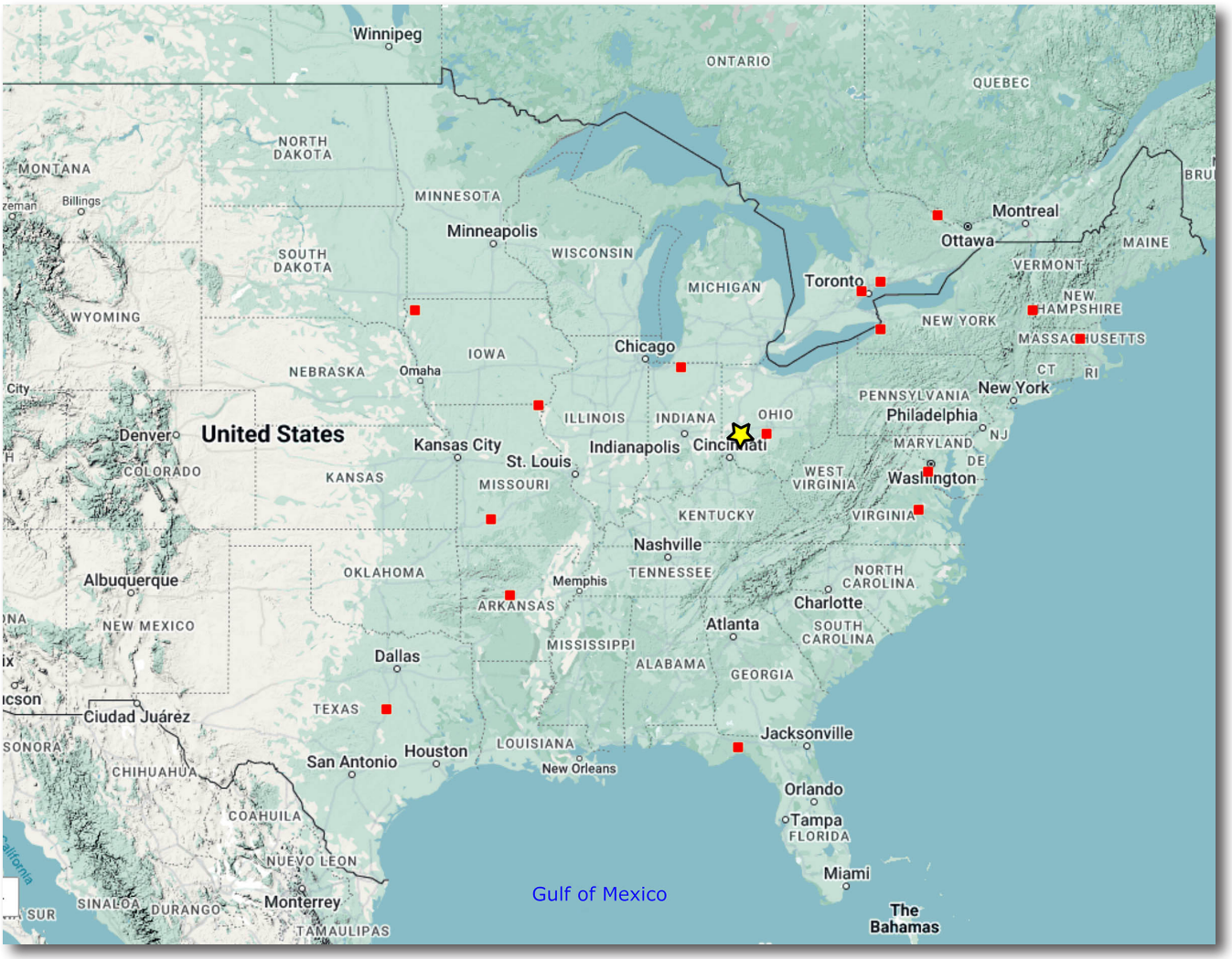


Figure 2. Map of iNaturalist records of *C. concinnata* in the middle and eastern U.S. and southeastern Canada. Red squares indicate photographic records. The yellow star indicates the Dayton area of southwestern Ohio, where the authors are based.

Records from Public Databases

As this was a new observation for us in this area, I examined the public natural history database iNaturalist (https://www.inaturalist.org) to see if there were other records in or near southwest Ohio. I then expanded this query to look at other records of *C. concinnata* west of the Appalachian region and east of the Rocky Mountains. The results of this brief survey can be seen in Figure 2 and assessment of the records in Table 1. Of the 12 records examined (including one from BugGuide) only one, from western Iowa, can be classified as likely to be *C. concinnata*. Two additional records of adult flies are possibly correct, but the flies cannot be identified with confidence from the images. Four records are based on immature stages, which could be any of a number of Tachinidae. The single record from Ohio is an adult specimen of *Archytas* sp. (Tachininae: Tachinini), and five other records are either clearly incorrect or unlikely based on observable features. Examination of these records leaves us with a couple of conclusions:

1. Records of tachinids (and probably many other fly groups) on iNaturalist should not be trusted without inspection. It should be noted that these records are all flagged as "needs ID" and *C. concinnata* is just a "suggested ID" for them, but these records show up on maps and in data regarding this species, even though most of them are incorrect, unlikely, or impossible to verify. We are not necessarily criticizing iNaturalist, which is a fantastic public resource, just advising the use of caution in accepting records derived from the database without verification.
2. There seems to be a tendency for *C. concinnata* to be assumed as an identity for flies reared from Saturniidae – perhaps stemming from Boettner et al.'s (2000) study documenting high rates of parasitism of this family by *C. concinnata* in Massachusetts. Finally, we note that the common name for *C. concinnata* used by iNaturalist is "European Tachinid Fly", which seems somewhat problematic given the many hundreds of other European tachinid fly species that exist.

Table 1. Evaluation of records of *C. concinnata* east of the Appalachian region and west of Rockies from iNaturalist and BugGuide.

Record	Validity	Notes
S. Ohio	X	This is *Archytas* sp. (adult)
N. Indiana	Possible	Reared from *Lymantria dispar*, photos are consistent, but inadequate for determination. (adults)
W. New York	Possible	Only pupae. Impossible to identify.
SW. Ontario 1	Possible	Only larva. Impossible to identify. (Mississauga, ON)
SW. Ontario 2	Possible	Only pupae. Impossible to identify. (Oshawa, ON)
SE. Iowa	X	Exoristini? (adult), not *C. concinnata*.
NW. Iowa	Likely	Reared from *Euptoieta claudia* (Nymphalidae). Appearance consistent with *C. concinnata*. (adult)
S. MO	X	Possibly *Lespesia* sp. (adult)
C. Arkansas	X	Reared from *Polyphemus* caterpillar (Saturniidae). Probably *Lespesia* sp. (adults)
E. Texas	Unlikely	Cannot identify from photo, but probably not. Appears parasitized by fungus? (adult)
N. Florida	Possible	Only larvae/pupa. Impossible to identify. Reared from *Actias luna* (Saturniidae).
Minnesota*	Possible	Cannot identify from photo. Abd. discal setae not apparent. Reared from *Hyalophora cecropia* (Saturniidae). (adult)

*from BugGuide (https://bugguide.net)

Why haven't we observed it earlier?

I find it curious that we have not observed this species in southwestern Ohio up until this past season, despite regular collecting over the past 20 years by hand and with various traps, and extensive rearings of caterpillars. Below, we explore some possible explanations for this lack of observation.

Hypothesis 1: *Compsilura concinnata* has been present but at low densities

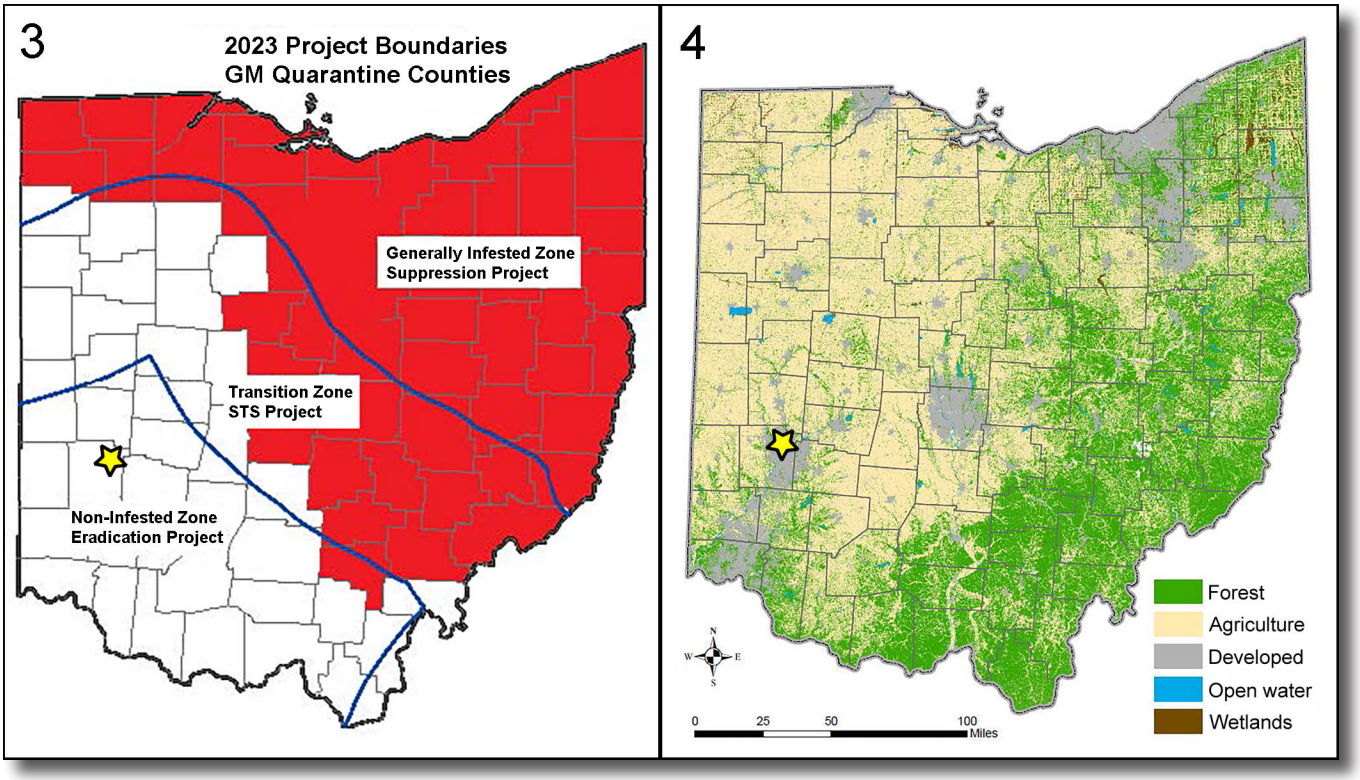
This is entirely possible. There are certainly a number of tachinid species that occur in southwestern Ohio that we have yet to encounter, whether due to chance, or lack of collecting during appropriate season or in the appropriate habitat. Thus, perhaps *C. concinnata* has been present for decades in the region, but at relatively low densities, and has somehow escaped the attention of me and my various students over the years. However, a few lines of evidence suggest that this may not be the case. First, I have collected *C. concinnata* in both West Virginia and Kentucky, despite having collected flies in these areas only a few times. This would suggest that the species should not have escaped our notice locally. Second, my lab has reared approximately 7,500 field-collected caterpillars over the past 18 years in southwest Ohio, including hundreds of *L. caryae* (the host species recorded here) and have never before reared *C. concinnata*. Given its broad polyphagy and the high parasitism rates sometimes reported, it seems likely we would have encountered the species previously.

Hypothesis 2: *Compsilura concinnata* has only recently colonized the region

The other possibility is that *C. concinnata* has been absent from the Dayton region in recent decades and has only recently expanded into southwestern Ohio. This seems a reasonable conclusion, but why should this be the case? Why, after having been established in North America for well over 100 years, with subsequent introductions into the northern U.S. Midwest, and a definitive record from northern Ohio over 60 years ago, would this tachinid species not have made it to southwest Ohio?

It could be proposed that *C. concinnata* are simply limited in their ability to disperse. This however, does not seem likely. Although data are sparse, the general view of those that study tachinids is that they are quite adept at dispersing and individuals are capable of flying considerable distances. Case studies support this conjecture. For example, the phasiine tachinid *Trichopoda pictipennis* Bigot (as *T. pennipes*; see Dios et al. 2021) was first recorded in central Italy in the early 1980s (Colazza et al. 1996, Tschorsnig et al. 2012, Bystrowski 2012); within a dozen years it was distributed throughout Italy and had reached Spain (Catalán & Verdú 2005). By 2012 this species had spread across much of Europe and has been recorded as far east as Israel (Tschorsnig et al. 2012) (although part of this spread could have been facilitated by human-mediated movement of parasitized hosts, Bystrowski 2012). As another tachinid example, the polyphagous leafroller parasitoid *Trigonospila brevifacies* (Hardy) (Blondeliini) was estimated to disperse naturally at a rate of 8–15 km/year after its introduction into New Zealand to control the light brown apple moth *Epiphyas postvittana* (Walker) (Lepidoptera: Tortricidae; Munro 1998). [At this rate, ca. 10 km/yr, *C. concinnata* could have arrived in the Dayton region years ago if dispersing only from coastal Massachusetts.] Indeed, early indications suggested that *C. concinnata* was able to disperse and colonize new areas quite rapidly (Howard & Fiske 1911) and reports have indicated that this tachinid has spread as much as 25 miles in a single season (Burgess & Crossman 1929). Thus, limited dispersal ability seems an unlikely explanation for the apparent absence of *C. concinnata* in southwest Ohio.

An alternative hypothesis is that the spread of *C. concinnata* is not limited by inherent dispersal abilities, but by ecological factors. For one, *L. dispar* has not yet colonized southwest Ohio. This is the species which *C. concinnata* was most often introduced to control and which it parasitizes consistently and, at least sometimes, at high frequencies (reviewed in Elkinton & Boettner 2012). The spread of *L. dispar* has been actively slowed through a combination of outreach, quarantine, pheromone trapping, and pesticide spraying (e.g., https://www.slowthespread.org/), and these efforts have resulted in a somewhat steady line of advance or static front, with established populations being limited to eastern parts of Ohio (Fig. 3). It may be that although *C. concinnata* can use many other hosts, it is reliant on *L. dispar* to become established in an area or to remain so. While possible, this seems unlikely based on the enormous global range of *C. concinnata* and many reliable records of this species in North America well-outside the distribution of *L. dispar* (e.g., Iowa record above; West Coast populations). Also, Burgess & Crossman (1929) noted that *C. concinnata* spread much faster than its host *L. dispar* after establishment, being recorded 125 miles beyond the spongy moth dispersion line.



Figures 3–4. 3. Map showing (in red) the current county distribution of *Lymantria dispar* (spongy moth) in Ohio along with "Slow the Spread" (STS) and eradication zones (Ohio Department of Agriculture 2023). **4.** Map showing forest cover in Ohio from the Forest Resource Assessment of Ohio's Statewide Forest Action Plan (Ohio Department of Natural Resources, 2020: 6). The yellow star in both figures indicates the Dayton area of southwestern Ohio.

Finally, it may be that spread of *C. concinnata* is limited by habitat affinities. *Compsilura concinnata* appears to be a primarily forest dwelling species, mainly attacking forest dwelling host Lepidoptera such as gypsy moths and (most) Saturniidae. Although forests historically covered most of Ohio, the glaciated region of Western Ohio has largely been cleared for agriculture due to its relative flatness and rich soils. The remaining forested lands in the area are highly fragmented (Fig. 4). It is possible that *C. concinnata* individuals require forested habitat for dispersal. They may be reluctant to fly across large open areas between forest fragments or require particular conditions (e.g., light gaps) for mating – although their apparent conduciveness to laboratory propagation would suggest otherwise (e.g., Fusco et al. 1978). Records of parasitism of caterpillars in open habitats (e.g., monarch butterflies and cabbage moths mentioned above) indicate that females do seek out hosts in open habitats, but it is possible that these interactions tend to occur near forest edges.

In summary, the reasons for this abrupt appearance of *C. concinnata* in our area of southwest Ohio, and its apparent absence or rarity previously, are unclear. There are a number of possible hypotheses raised here and probably other explanations that we have not considered. Now that we know the species is in the area, we look forward to seeing if we will collect adults in the coming field season or rear them from additional caterpillar species. If we do not encounter more, this would support the "present but low density" hypothesis (which in itself would still require explanation). If we do begin to encounter *C. concinnata* more frequently, this would support the "recent colonization hypothesis". It sounds like a good excuse to continue venturing out into the woods to collect flies and caterpillars!

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