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HYLESIA UMBRATA (SATURNIIDAE: HEMILEUCINAE): A MYSTERY

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ABSTRACT. *Hylesia* moths are known to occur in outbreaks and are infamous for their medical importance both as larvae and adults. Among these, the colorful (white, with black and red markings), processionary larvae of *Hylesia umbrata* Schaus, 1911 occur in large aggregations and pupae communally, yet little is known of their life history. During the dry season of 1999 in Panama, we took the opportunity to collect and dissect a *Hylesia umbrata* cocoon mass and keep the pupae under laboratory conditions to document the timing of their expected mass emergence and record any parasitoids. These data are presented and discussed, and cases of lepidopterism (contact dermatitis) by *Hylesia* adults in Panama are reported.

Additional key words: emergence sequence, communal cocoon, lepidopterism, Panama

Hylesia moths are not beautiful, but people seldom notice that and they learn to recognize and avoid them as plain as they are (Fig. 1a). Well-known in the Neotropics for the misery they can inflict on people who come into physical contact with them, they are unusual among Lepidoptera in having an impact on human health both as caterpillars (stinging setae) and as adults (urticating setae on the adult female abdomen).

Urticating caterpillars are equipped to defend themselves using poison-filled setae ("hairs" or spicules) (Costa 2006, Mullen 2009) that when touched, penetrate the skin easily and break at the tip, injecting a painful venom whose irritating effects may last for hours, and in very rare cases (e.g., *Lonomia obliqua*) can cause hemorrhaging and sometimes death. "Lepidopterism" refers to a dermatitis caused by urticating caterpillar or adult moth setae coming into contact with the skin, also referred to as caterpillar dermatitis or moth dermatitis. This urticating defense is largely passive, but in the case of a number of taxa, including *Hylesia* Hübner, 1820, it can be facilitated by the caterpillar because, when disturbed, it flexes its body to orient the venom-filled setae into a position optimal for contact with potential predators. Among the more than 60 families of Lepidoptera, only a few include urticating caterpillars: the Limacodidae, with the Saddle-back caterpillars, e.g., *Acharia hyperoche* (Dognin, 1914); the Megalopygidae, or puss-caterpillars, e.g., *Megalopyge opercularis* (J.E. Smith, 1797); the Saturniidae: Hemileucinae, e.g., *Hylesia*, *Automeris* Hübner, 1819, *Lonomia* Walker, 1855; and several other families minor in the Neotropics (Mullen 2009).

The abdomens of adult *Hylesia* females are densely clothed in thousands of barbed, irritating setae that are shed and fractured easily to provide a protective matrix in which females embed their eggs (Rodriguez-Morales et al. 2005, Mullen 2009, Paniz-Mondolfi 2011). Typically *Hylesia* adults, as well as adults of other urticating saturniids, raise the wings when disturbed and curl the abdomen beneath them to reveal contrasting intersegmental bands, four white ones in the case of *H. umbrata* Schaus, 1911. This posture is considered to be a defensive display (Janzen 1984). In addition, if highly provoked, they release a thick red–brown slightly irritating meconium, particularly if the provocation occurs soon after eclosion when the meconium still is abundant.

Hylesia in Panama

Though other authors (e.g., Lemaire 2002) have reported fewer taxa, Panama is home to at least nine of the more than 260 taxa listed by Ratnasingham & Hebert (2007) as belonging to the Neotropical genus *Hylesia*: *Hylesia aeneides* (Druce, 1897), *Hylesia annulata* Schaus, 1911, *Hylesia continua* (Walker, 1865), *Hylesia dalina* Schaus, 1911, *Hylesia praeda* Dognin, 1901, *Hylesia praedpichinchensis* Brechlin & Käch, 2016, *Hylesia rufipes* Schaus, 1911, *Hylesia schausi* Dyar, 1913, and *Hylesia umbrata* (Basset et al., unpubl. data). Adult moths are strongly attracted to lights, and thus to human dwellings and public buildings that are illuminated at night. They are notorious for falling into swimming pools and getting sucked into ventilation systems or entering open windows and doors, events during which the irritating setae can become detached from the female abdomen, dispersed by water surfaces or air currents, and find their way onto the skin of unwitting swimmers and workers, or into their eyes or lungs (Dr. Melvin Boreham, former Entomology Unit Supervisor in the Panama Canal Commission, pers. comm.), causing serious dermatitis.

Historically *Hylesia* moths appear in outbreaks, and their attraction to light facilitates monitoring of both the timing and magnitude of these outbreaks. However with the transfer of the Canal to Panama, details of most of the early records have been lost. Among the surviving records (Table 1) a few cases are worth mentioning; one occurred during October and November 2000; a boat owner from the Pedro Miguel Yacht Club developed a highly pruritic dermatitis on his arms and chest (Fig. 1b) and; investigators found *Hylesia* moth remains in his boat. That same year a number of outbreaks occurred at all three Canal locks during August through December and dozens of workers were affected. Training was initiated to educate workers of the dangers from *Hylesia* moths at lock sites and the need to take precautions: wear long-sleeved shirts, use gloves, change and wash work clothes after each shift, wash down ropes and wipe down tools at the beginning and end of each shift. In July 2003 a large outbreak, luckily without medical consequences, occurred at the Miraflores Water Treatment Plant (Fig. 1c). In July 2008, contractors were affected severely and developed allergic rashes at a base camp called Bas Obispo located in a forested area on the east side of the canal; investigation revealed that locker room windows had been left open and lights were on at night, attracting *Hylesia* moths to the area where workers kept their clothing and personal belongings. In all these cases presence of *Hylesia* was confirmed during inspection by Entomology Branch personnel. Unfortunately, no vouchers were collected for any of these cases, and the moths were not identified to species.

Hylesia caterpillars appear to be polyphagous. In Panama they have been reported eating the leaves of trees in at least nine plant families (Anacardiaceae, Annonaceae, Euphorbiaceae, Lauraceae, Lythraceae, Malpighiaceae, Phyllanthaceae, Polygonaceae, and Rutaceae) and they are gregarious. They feed and molt as a group, laying silk trails (often quite visible) on their journeys from one feeding area to another, or to and from molting sites on tree trunks. When mature, the caterpillars of some species go their separate ways to spin pupation cocoons in leaves. But others, such as *H. umbrata*, spin communal cocoons, often on the trunk of their larval food tree. We decided to rear the adults from a *H. umbrata* cocoon mass to find out just how

TABLE 1. *Hylesia* Moth Outbreaks and Dermatitis Reports for the Panama Canal Watershed.

Location	**Date and Description**	**Year**	**Reference**
No details given	Mentioned in 1980 report of outbreaks at Canal locks.	1971	Anonymous record from Gorgas Hospital
No details given	Mentioned in 1980 report of outbreaks at Canal locks.	1972	Anonymous record from Gorgas Hospital
No details given	Mentioned in 1980 report of outbreaks at Canal locks.	1975	Anonymous record from Gorgas Hospital
Gamboa Pool	18 July	1980	*The Panama Canal Spillway*, 1980
Gatun Locks	Early August: more than 30 Canal workers affected	1980	Anonymous record from Gorgas Hospital
Gamboa and nearby areas	Mid-September: several Canal workers affected	1980	Anonymous record from Gorgas Hospital
Miraflores and Pedro Miguel Locks	Early December: 18 Canal workers affected	1980	Anonymous record from Gorgas Hospital
Pedro Miguel Yacht Club	October and November: boat owner affected with dermatitis	2000	Direct communication with boat owner. Inspection and photograph (Figure 1b).
South District (Pacific end of Canal)	October: At least 15 cases reported among Canal workers	2000	Direct communication with dermatitis affected cases
Miraflores Water Plant	21 July: report of outbreak; no personnel affected	2003	Inspection and photograph (Figure 1c).
Bas Obispo	July: contractor reported dermatitis cases among field workers.	2008	Direct communication with contractor
Gamboa	June and July: several Canal workers affected with dermatitis	2014	Direct communication with occupational health nurse

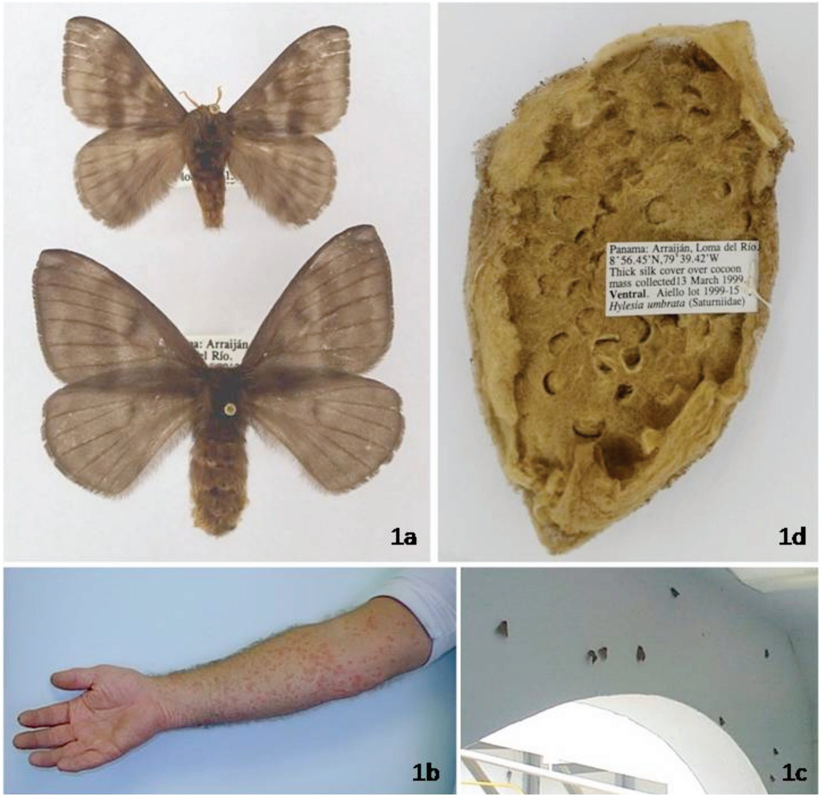

FIG. 1. *Hylesia* (Saturniidae: Hemileucinae). **1a.** *H. umbrata* adults reared as Aiello lot 1999-15: male #48 (above, STRI database #0-128-122), female #50 (below, STRI database #0-128-129). **1b.** Dermatitis caused by *Hylesia* sp. moths on the arm of a Pedro Miguel Yacht Club boat owner. **1c.** *Hylesia* sp. adults resting near a fluorescent lamp in the Miraflores Water Treatment Plant. **1d.** Ventral view of thick silk sheet that covered the *Hylesia umbrata* cocoon mass reared as Aiello lot 1999-15 (STRI database #0-128-186); note the crescent shaped slits prepared by the caterpillars to facilitate adult emergence.

synchronous adult emergence from a single brood might be, whether one gender emerged before the other, whether males and females were randomly mixed or segregated within the mass, and whether parasitized individuals were located in a particular area of the mass.

METHODS

On 13 March 1999, mid dry season, we collected a mass (8 cm × 14 cm) of beige silk cocoons attached to one corner of the back of a wooden bench in Panamá: Arraiján, Loma del Río, (8.9407 -79.6568). Because it conformed to the form of the bench, the mass was wedge-shaped. The exposed side was covered by a thick outer blanket of silk. When the mass was viewed from the attachment side, at least 60 individual cocoons could be counted. We placed the mass into a covered rearing cage pending time to dissect it and assigned it an identifying number, Aiello lot 1999-15.

Nothing had emerged since collection when on 21 March, in preparation for separating the cocoons, we peeled the thick silk blanket (Fig. 1d) covering the mass, used a permanent marker to number the cocoons while still in place, and then drew a diagram showing their relative positions (Fig. 2). We then separated the cocoons, cut each one open, recorded the contents, and set each one up in a separate snap cap plastic container to see what would emerge. The containers were kept in an air-conditioned laboratory, at 23 degrees centigrade, with no possibility of outside effects of temperature, humidity, rainfall, or nighttime artificial lighting. When the adults emerged, we gave them a few hours to expand and sclerify, then carefully added a strip of wet paper towel to their containers, to prevent freeze-drying, and placed them in a freezer. During pinning and spreading, we worked in a draft-free area and kept strips of masking tape ready to capture airborne fluff and setae, standard procedure for any lepidopteran operations in my lab. Despite our precautions, we were unable to avoid some contact with the irritants, but the consequences were minimal. Reared specimens and their exuviae pertaining to Aiello lot 1999-15 are in the collections of the Smithsonian Tropical Research Institute (STRI), Balboa, Ancon, Panama (see Aiello rearing database at http://stri.si.edu/sites/aiello/). An

TABLE 2. Eclosion sequence for all individuals. Emergences were equally likely to occur at any point in the mass (compare with Figure 2). Five individuals already had eclosed before the mass was collected on 13 March 1999. Dates are month/day. 3/<13 = before March 13th.

Date in 1999	Cocoon number	Contents	Outcome	Parasitoid(s)
3/<13	7	dead larva		
3/<13	45	dead larva		
3/<13	58	dead larva		
3/<13	65	dead larva		
3/<13	35	dead pharate adult female full of eggs		
3/<13	38	female pupal exuviae	adult eclosed before cocoon mass collected	
3/<13	49	female pupal exuviae	adult eclosed before cocoon mass collected	
3/<13	52	male pupal exuviae	adult eclosed before cocoon mass collected	
3/<13	59	male pupal exuviae	adult eclosed before cocoon mass collected	
3/<13	63	male pupal exuviae	adult eclosed before cocoon mass collected	
4/9	64	male pupa	15 wasps	*Conura* (Chalcididae)
4/29	47	female pupa	adult moth	
6/7	8	female pupa	adult moth	
6/10	32	male pupa	adult moth	
6/11	5	male pupa	adult moth	
6/12	40	male pupa	adult moth	
6/15	3	male pupa	adult moth	
6/15	11	male pupa	adult moth	
6/17	15	male pupa	adult moth	
6/21	12	male pupa	adult moth	
7/19	31	male pupa	adult moth	
7/19	41	male pupa	adult moth	
7/26	22	male pupa	adult moth	
8/9	50	female pupa	adult moth	
8/11	56	male pupa	adult moth	
8/30	28	male pupa	adult moth	
9/5	9	male pupa	adult moth	
9/9	19	female pupa	adult moth	
9/13	16	male pupa	adult moth	
9/15	61	male pupa	adult moth	
9/16	6	female pupa	adult moth	
9/18	2	male pupa	adult moth	
9/18	30	male pupa	adult moth	

TABLE 2. (CONTINUED)

Date in 1999	Cocoon number	Contents	Outcome	Parasitoid(s)
9/24	60	female pupa	adult moth	
10/3	55	male pupa	adult moth	
10/5	4	female pupa	adult moth	
10/10	43	male pupa	adult moth	
10/11	17	female pupa	male fly	*Belvosia* (Tachinidae)
10/17	21	male pupa	female fly	*Belvosia* (Tachinidae)
10/19	57	male pupa	adult moth	
10/24	39	female pupa	adult moth	
10/31	54	male pupa	male fly	*Belvosia* (Tachinidae)
11/3	25	female pupa	adult moth	
11/4	18	male pupa	adult moth	
11/4	51	male pupa	adult moth	
11/6	26	female pupa	adult moth	
11/8	1	female pupa	adult moth	
11/8	13	female pupa	adult moth	
11/8	24	male pupa	adult moth	
11/9	53	male pupa	adult moth	
11/10	46	female pupa	adult moth	
11/12	48	male pupa	adult moth	
11/13	33	female pupa	adult moth	
11/14	10	male pupa	adult moth	
11/16	27	female pupa	adult moth	
11/16	42	male pupa	adult moth	
11/16	62	male pupa	adult moth	
11/17	29	male pupa	adult moth	
11/17	37	female pupa	adult moth	
11/19	36	female pupa	adult moth	
12/4	14	female pupa	female fly	*Belvosia* (Tachinidae)
12/14	34	female pupa	male fly	*Belvosia* (Tachinidae)
	20	number not used		
	23	number not used		
	44	number not used		

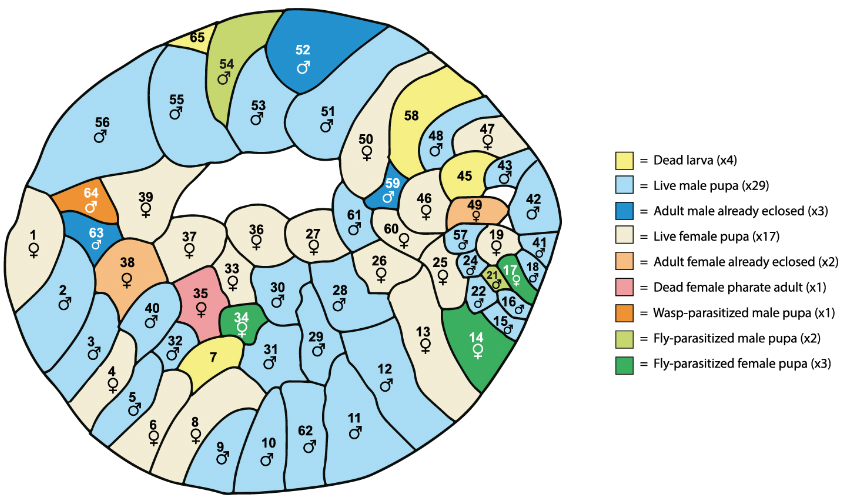

FIG. 2. Diagram of *Hylesia umbrata* (Saturniidae: Hemileucinae) cocoon mass reared as Aiello lot 1999-15, showing cocoons in their original arrangement and labelled with their contents at the time of collection, 13 March 1999. Five adults already had eclosed. In error, we skipped three numbers, 20, 23, and 44.

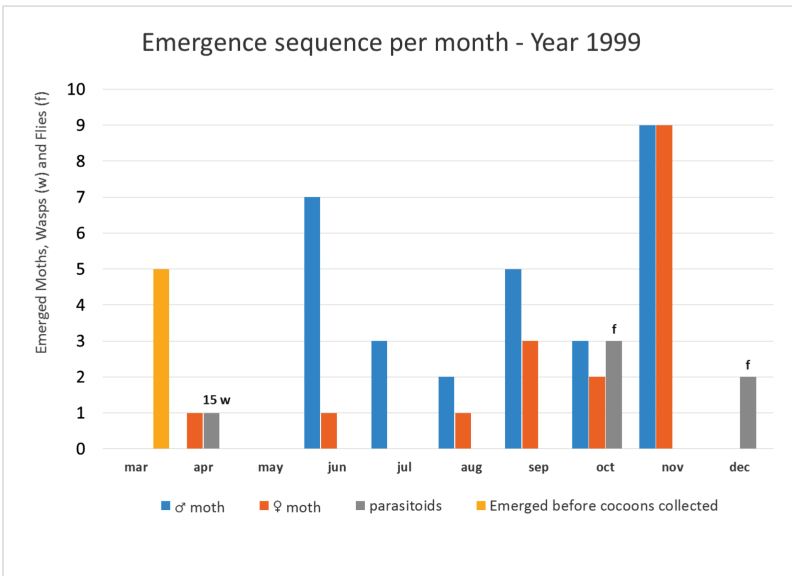

FIG. 3. Emergence sequence per month for *Hylesia umbrata* (Saturniidae: Hemileucinae) reared from cocoon mass Aiello lot 1999-15. Note there was no activity in May, and there were peaks of eight moths in each of June and September, and a larger peak (18 moths) in November. **f** = fly, **w** = wasps.

TABLE 3. Countries, pupal durations, and pupation habits (single or in a common mass) for 13 species of *Hylesia* (Saturniidae: Hemileucinae).

Name	Location	Pupa duration	Pupation mode	Source
Hylesia acuta Druce, 1886	Mexico	8 months; emergence took place over three weeks	Mass	Wolfe, 1988
Hylesia continua (Walker, 1865)	Costa Rica	15-22 days	Singly	Calero, 2013
Hylesia continua (Walker, 1865)	Colombia	22-24 days	Mass	Alvarez Garcia et al., 2015
Hylesia dalina DHJ01	Costa Rica	15-22 days	Singly	Calero, 2016
Hylesia ebalus (Cramer, 1775)	Paraguay	30-35 days	Singly	Drechsel, 2014
Hylesia iola Dyar, 1913	Mexico	7 weeks	Singly or small groups	Carrillo-Sanchez et al., 2002
Hylesia lineata Druce, 1886	Costa Rica	20.74-23.75 days	Singly	Janzen, 1984
Hylesia metabus (Cramer, 1775)	Venezuela	?	Singly	Hernández et al., 2009
Hylesia metabus (Cramer, 1775)	French Guiana, Venezuela	15-20 days	Singly	Jourdain et al., 2012; Hernandez et al., 2009
Hylesia metapyrrha (Walker, 1855)	Brazil	50.56 days	Singly	Specht et al., 2007
Hylesia nanus (Walker, 1855)	Brazil	15.7 days	?	Santos et al., 1996
Hylesia nigricans (Berg, 1875)	Brazil	2-3 weeks	Singly	Specht et al., 2006; Iserhard et al., 2007
Hylesia paulex Dognin 1922	Brazil	21.67 ±0.79 days	Small mass	Azevedo Pereira et al., 2009
Hylesia rufipes Schaus, 1911	Costa Rica	30-45 days or up to 6 months	Singly	Martinez, 2015
Hylesia umbrata Schaus, 1911	Panama	1-8 months	Mass	Aiello & Young, present paper

adult male and a female and their associated exuviae have been deposited in the Museo de Invertebrados G. B. Fairchild de la Universidad de Panamá (MIUP).

RESULTS

What we found inside the cocoons were: four dry larvae (individuals #s7, 45, 58, 65) (three in cocoons, and one (#65) that had failed to spin a cocoon); one dead pharate female (#35) still in her pupal skin and loaded with her presumably unfertilized eggs; five pupal exuviae (three males #s52, 59, 63; two females #s38, 49), indicating that five adults had emerged before the mass was collected; one male pupa (#64) that later yielded 15 wasps (*Conura*: Chalcididae); five pupae (#s17, 21, 54, 14, 34) (2 males; 3 females) that later yielded one fly each (*Belvosia*: Tachinidae); 46 live pupae (29 males, 17 females) each in its own cocoon with its final larval exuviae.

Thus, in the mass, originally, there had been a total of 62 individuals, 35 male, 23 female, and 4 dry larvae that could not be sexed. The cocoons were arranged parallel to one another, and perpendicular to the outer blanket covering the mass. Within each cocoon, the pupae were oriented head outward, i.e., with the head towards the silk blanket. The blanket had crescent shaped slits that appeared to be exit flaps in preparation for adult emergence. Male and female pupae were well mixed in the cocoon mass. There was no obvious evidence (e.g., wasp cocoons, fly puparia) of any parasitoids, at that time. We have no reason to suspect that the caterpillars were not siblings.

Typical reports of *Hylesia* in Panama are for massive adult emergences, and because five individuals already had eclosed previous to collection of the cocoons, we expected that the rest of the moths soon would emerge *en masse*. But, and here's the mystery, that is not what happened. Adults came out one here, one there over a period of nine months. Table 2 gives the eclosion sequence for all individuals. Comparing that sequence to the cocoon mass diagram (Fig. 2) shows that emergences did not follow a logistical pattern; they were equally likely to occur at any point in the mass. There did not appear to be preferred emergence dates, though eclosions did clump mildly in June and September, and strongly in November (Fig. 3).

The first to appear were 15 parasitoid wasps, *Conura* (Chalcididae), that emerged over a period of two hours (noon–1400 h) on 9 April, directly from male pupa #64, just 27 days after collection. Then nothing more appeared until 20 days later, 29 April, when adult moths began to emerge. Most emerged singly, except for five instances in which two or three adults eclosed on the same day. The first two and final two adult moths were females; the rest of the females were scattered among the males, which outnumbered them 1.5:1.

Three flies emerged in October, more than half way through the emergence process, and the final two in December and those two were the last creatures produced from this lot. The low parasitism rate is not surprising because parasitoid levels tend to be low during dry season, when host plant leaves, and thus insect herbivores are less abundant. Among the flies, there was no correlation between the genders of the moth pupae and that of the flies. Two of the three parasitized female pupae yielded male flies, the other a female fly. One of the two parasitized male pupae yielded a male fly, the other a female fly. Four of the five flies were located around the periphery of the cocoon mass, three of them quite close together, initially suggesting that parasitization might have occurred just before or soon after the *Hylesia* larvae arrived at the pupation site. However that possibility can be discarded by the fact that *Belvosia* flies are known to lay micro-eggs on leaves for caterpillars to ingest (Norman Woodley, pers. comm.) so parasitization had to have occurred while the caterpillars still were eating their host plant. All fly larvae had pupated inside the pupae of their hosts, and thus were not detected when we opened the cocoons, though if we had examined them carefully the star-shaped spiracular scars would have been visible.

Discussion

Given that wild *Hylesia* populations reportedly produce outbreaks, what could account for the huge discrepancy between the natural populations and the reared one? Was this particular clutch an anomaly or have we been wrong about the synchrony in wild populations of *Hylesia*? One could argue that the scattered emergences were the result of having been reared in captivity. However, given that five adults already had eclosed before the mass was collected, that idea is not supported. And the fact that not even one death occurred after the day of collection argues against stress in captivity. Every pupa that was alive at the time of collection yielded something living: a moth, a fly, or wasps.

Possible explanations for this extended and scattered emergence pattern are: a strategy for at least some individuals to survive extreme rainy or dry seasons; or avoid predatory insects, bats, and birds during their times of abundance; or a way to promote out breeding and avoid inbreeding within a clutch; or simply to maintain a year round presence. Regardless, we don't know whether the pattern is typical for *H. umbrata* because so far there are no other published records of its life history.

Published information on *Hylesia* life histories is sparse, which is understandable given the unpleasantness of working with these moths. However, based on the few reports available (Table 3), we see that pupal duration varies among species, and that it shows a slight tendency to be longer in those species that pupate in a mass, e.g., *Hylesia umbrata* and *H. acuta* Druce, 1886, though not in *H. continua*. *Hylesia paulex* is intermediate; reportedly it pupates in small groups, but has an average pupation duration. The other species listed in Table 3 pupate singly and have shorter pupation durations, the longest being *H. metapyrrha* which can spend a month and a half as a pupa. Reports in the literature for mode of pupation in *Hylesia continua* are conflicting, with Calero (2013) saying they pupate singly and Alvarez Garcia et al. (2015) including a photograph of what clearly shows a pupal mass. However, because seeing is believing we tend to trust Alvarez Garcia et al. (2015). Further, Donald Windsor (STRI, pers. comm.) found that *H.* continua reared by him pupated in a cocoon mass.

Thus, it may turn out that our rearing of *H. umbrata* yielded quite normal results for that species after all, and that the massive outbreaks reported from Panama were for other species of *Hylesia*. Clearly we don't have enough information to draw any firm conclusions, and we need to pay more attention to what is going on in this fascinating and medically important group. At least now we have a hypothesis to test; a correlation between communal versus solitary pupation, and pupation duration and adult emergence synchrony.

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Literature Cited

Álvarez Garcia, D. M., J. A., Díaz Pérez, & Á. Amarillo-Suárez. 2015. *Hylesia continua* (Walker, 1865) (Lepidoptera: Saturniidae) en una localidad del norte de Colombia: dimorfismo en pupas y lepidopterismo. Acta Zool. Mex. (n. s.) 31: 327-330.

Calero, R. 2013. *Hylesia continua* (Saturniidae). Area de Conservación Guanacaste. https://www.acguanacaste.ac.cr/paginas-de-especies/insectos/102-saturniidae/368-i-*hylesia*-continua-i-saturniidae

Calero, R. 2016. *Hylesia dalina*DHJ01 (Saturniidae). Area de Conservación Guanacaste. https://www.acguanacaste.ac.cr/paginas-de-especies/insectos/102-saturniidae/3568-i-*hylesia*-dalinadhj01-i-saturnidae

Carrillo-Sánchez, J. L., A. Equihua-Martinez, & C. M. Sosa-Torres 2002. Biology and Life History of *Hylesia iola* Dyar, a corn-leaf feeder of Ttlaxcala, Mexico. Southwest. Entomol. 27:91-95.

Costa, J. T. 2006. The other insect societies. Belknap Press. Cambridge, Mass. xiv + 767 pp.

Drechsel, U. 2014. The immature stages of *Hylesia ebalus* (Cramer, 1775) (Lepidoptera: Saturniidae: Hemileucinae). Paraguay Biodivers. 1:44-50.

Hernández E., J. V., F. Osborn & M. Herrera 2012. Rasgos de *Hylesia metabus* (Cramer, [1775]), pp. 15-24. *In* Hernández, J. V., Osborn F. & J. E. Conde (Eds), Estudio multidisciplinario de la palometa peluda *Hylesia metabus*. Ediciones IVIC, Instituto Venezolano de Investigaciones Científicas (IVIC). Caracas, Venezuela. 224 pp.

Hernández, J. V., F. Osborn, B. Herrera, C. V. Liendo-Barandiaran, J. Perozo, & D. Velásquez 2009. Parasitoides Larva-Pupa de *Hylesia metabus* Cramer (Lepidoptera: Saturniidae) en la Región Nororiental de Venezuela: un Caso de Control Biológico Natural. Neotrop. Entomol. 38:243-250.

Hylesia moth returns to irritate area residents. (1980 July 18). The Panama Canal Spillway. Vol. XVIII, no. 45, pp. 1 & 4.

Iserhard, C. A., L. A. Kaminski, M. O. Marchiori, E. C. Teixeira & H. P. Romanowski 2007. Occurrence of Lepidopterism Caused by the Moth *Hylesia nigricans* (Berg) (Lepidoptera: Saturniidae) in Rio Grande do Sul State, Brazil. Neotrop. Entomol. 36:612-615

Janzen, Daniel H. 1984. Natural history of *Hylesia lineata* (Saturniidae: Hemileucinae) in Santa Rosa National Park, Costa Rica. J. Kansas Entomol. Soc. 57:490-514.

Jourdain, F., R. Girod, J. M. Vassal, F. Chandre, C. Lagneau, F. Fouque, D. Guiral, J. Raude, & V. Robert 2012. The moth *Hylesia metabus* and French Guiana lepidopterism: centenary of a public health concern. Parasite, EDP Sciences 19:117-128.

Martinez, D. 2015. *Hylesia rufipes* (Saturniidae). Area de Conservación Guanacaste. https://www.acguanacaste.ac.cr/paginas-de-especies/insectos/102-saturniidae/789-i-*hylesia*-rufipes-i-saturniidae

Mullen, G. R. 2009. Moths and Butterflies (Lepidoptera), pp. 353-370, *In* Mullen, G. R., & L. A. Durden (eds) 2009. Medical and Veterinary Entomology, second edition. Academic Press, Elsevier. xvii + 637 pp.

Paniz-Mondolfi, A. E., A. M. Pérez-Alvarez, U. Lundberg, L. Fornés, O. Reyes-Jaimes, M. Hernández-Pérez, & E. Hossler 2011. Cutaneous lepidopterism: dermatitis from contact with moths of *Hylesia metabus* (Cramer 1775) (Lepidoptera: Saturniidae), the causative agent of caripito itch. Int. J. Dermatol. 50: 535–541.

Pereira, A., A. Igor, V. Vinha Zanuncio, A. Simões Lorenzon, H. Bolognani, B. Vique Fernandes, O. H. Hendrik Mielke, J. E. Serrão & J. C. Zanuncio 2009. Biological and morphological characteristics of *Hylesia paulex* (Lepidoptera: Saturniidae) fed with *Eucalyptus urophylla* (Myrtaceae). Interciencia 34:645-649.

Ratnasingham, S. & P. D. N. Hebert. 2007. BOLD: The Barcode of Life Data System (www.barcodinglife.org). [http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Hylesia&searchMenu=taxonomy&query=*Hylesia*]

Rodriguez-Morales, A. J., M. Arria, J. Rojas-Mirabal, E. Borges, J. A. Benitez, M. Herrera, C. Villalobos, A. Maldonado, N. Rubio, & C. Franco-Paredes 2005. Lepidopterism due to exposure to the moth *Hylesia metabus* in northeastern Venezuela. Am. J. Trop. Med. Hyg., 73:991–993

Santos, G. P., T. V. Zanuncio, O. S. Dias, & J.C. Zanuncio. 1996. Biology of *Hylesia nanus* (Walker) (Lepidoptera: Attacidae). An. Soc. Entomol. Bras. 25: 479-482.

Specht, A., A. C. Formentini, & E. Coreruil. 2006. Biologia de *Hylesia nigricans* (Berg) (Lepidoptera, Saturniidae, Hemileucinae). Rev. Bras. Zool. 23: 248-255.

Specht, A., A. C. Formentini, & E. Corseuil. 2007. Biological aspects of *Hylesia metapyrrha* (Lepidoptera; Saturniidae; Hemileucinae), in laboratory. Braz. J. Biol., 67: 173-177.

Wolfe, K.L. 1988. *Hylesia acuta* (Saturniidae) and its aggregate larval and pupal pouch. J. Lepid. Soc. 42:132-137.

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