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The frontispiece to a classic work of eighteenth century entomology, Moses Harris' *The Aurelian.* See commentary on pages 30-32.

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PERLODIDAE (PLECOPTERA) OF WISCONSIN[1]

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The family Perlodidae is one of the most abundant and widespread in the order Plecoptera. These stoneflies occur in a wide variety of clean-water habitats and as indicator organisms have potential for assessing water quality. Studies of this family in Wisconsin prior to 1965 were limited to occasional collections reported by Needham and Claassen (1925) and Frison (1935, 1937, 1942). In 1965 and 1966 a survey of the Wisconsin River and its tributaries yielded nymphs of 11 species of *Isoperla* (W. Hilsenhoff, unpublished report), and later, nymphs and adults of 9 species were found in the Pine-Popple River (Hilsenhoff and Narf 1972). Between 1966 and 1971 additional Perlodidae were collected throughout the state by several persons, many of them by Arvin Krueger while surveying the mayfly fauna of Wisconsin (Krueger 1969).

In 1969 we initiated a study to determine the distribution, abundance, and life cycles of Perlodidae in Wisconsin and revise keys to species. All previously collected specimens were studied and an intensive sampling program was initiated in nine 24-mile square sampling areas. These areas (represented by squares in Figs. 1-3) were selected as representative of the state on the basis of geographical location, soil type, geology, vegetative cover, and land use, and are described in detail by Billmyer (1971). Five of the areas were sampled in the fall of 1969, and in the spring of 1970 all areas were intensively sampled during three or more periods from March through July. Two species of *Isogenus* and 12 species of *Isoperla* were collected. These are listed below along with references to 1) original description, 2) most recent catalog including that species, 3) references used to identify the species, 4) first usage of different species names, 5) synonomy when needed, and 6) papers published since the last catalog that contain taxonomic or biological information.

ISOGENUS Newman 1833

Because of the similarity among species of *Isogenus* we have followed the Ricker (1952) classification rather than that of Illies (1966).

Isogenus frontalis

1838 *Isogenus frontalis* Newman:178
1942 *Isogenus frontalis* Frison:290 (synonomy and drawings of male, female, and nymph)
1943 *Isogenoides hudsonicus* Hanson:662
1952 *Isogenus (Isogenoides) frontalis* Ricker:108 (key)
1966 *Isogenoides frontalis* Illies:365 (catalog)

Isogenus olivaceus

1852 *Perla olivacea* Walker:144
1876 *Perla sulcata* Provancher:213
1942 *Hydroperla olivacea* Frison:296 (drawings of male and nymph, and description of nymph)
1943 *Isogenoides olivaceus* Hanson:663 (drawings and descriptions of male and female)
1952 *Isogenus (Isogenoides) olivaceus* Ricker:114 (key and synonomy)
1966 *Isogenoides olivaceus* Illies:365 (catalog)

[1]Research supported by the College of Agricultural and Life Sciences, University of Wisconsin, Madison, and by a grant from the Wisconsin Department of Natural Resources.

ISOPERLA Banks 1906

Isoperla bilineata

1823 *Sialis bilineata* Say:165
1925 *Isoperla bilineata* Needham and Claassen:154 (descriptions and drawings of male and female)
1935 *Isoperla bilineata* Frison:437 (description of nymph, and drawings of male, female, and nymph)
1952 *Isoperla bilineata* Harden and Mickel:39 (keys)
1966 *Isoperla bilineata* Illies:396 (catalog)

Isoperla clio

1839 *Isogenus clio* Newman:86
1935 *Isoperla confusa* Frison:441 (drawings and descriptions of male, female, and nymph)
1952 *Isoperla clio* Ricker:143 (synonomy)
1966 *Isoperla clio* Illies:398 (catalog)
1966 *Isoperla clio* Minshall and Minshall:340 (biology)

The name *clio* has caused much confusion, having been used for both *I. clio* and *Isoperla marlynia.* The problem developed when Needham and Claassen (1925) misidentified some *I. marlynia* females and called them *Clioperla clio.* The mistake was perpetuated by Claassen (1931). His *I. clio* nymphs were really *I. marlynia.* When Frison (1935) collected the true Newman *I. clio* he found it to be quite different from the species Claassen (1931) was calling *I. clio,* so he described it as a new species, *Isoperla confusa.* Had he had Newman's *I. clio* types he probably could have corrected the error at that time. Frison (1935) went on to call specimens that were the true *I. marlynia, I. clio,* because all he had were nymphs that fit descriptions of the species Claassen (1931) had erroneously called *I. clio.* Frison (1942) straightened out the *I. clio*'s that were truly *I. marlynia* when he studied Needham and Claassen's types and presented a synonomy. He let his own *I. confusa* stand because he did not have Newman's types to examine and Ricker (1938) had erroneously published a statement that Newman's types were from Canada. Frison (1942) did not think it likely that the Newman *I. clio* from Canada and his *I. confusa* from Illinois and Indiana were the same species. Ricker (1952) corrected his 1938 error and said that the Newman types were not from Canada but from Georgia. He did not mention that he studied Frison's *I. confusa* types, but stated "Large size and the terminal ridges of the 10th tergite distinguish *clio* and *confusa* equally, and are not found in other eastern Isoperlae." He went on to synonomize *I. confusa* to *I. clio.*

Isoperla cotta

1952 *Isoperla cotta* Ricker:144 (Descriptions of male, female, and nymph, drawings of male and female)
1966 *Isoperla cotta* Illies:399 (catalog)

Isoperla dicala

1942 *Isoperla dicala* Frison:321 (descriptions and drawings of male, female, and nymph)
1952 *Isoperla dicala* Harden and Mickel:39 (key)
1966 *Isoperla dicala* Illies:400 (catalog)

Isoperla frisoni

1937 *Isoperla truncata* Frison:94 (descriptions and drawings of male, female, and nymph)
1952 *Isoperla truncata* Harden and Mickel:47 (key)
1966 *Isoperla frisoni* Illies:402 (new name and catalog)

Isoperla lata

1942 *Isoperla lata* Frison:334 (descriptions and drawings of male, female, and nymph)
1952 *Isoperla lata* Harden and Mickel:40 (key)
1966 *Isoperla lata* Illies:407 (catalog)

Isoperla marlynia
1898 *Chloroperla montana* Banks:199 (in part)
1925 *Isoperla marlynia* Needham and Claassen:148
1925 *Clioperla clio* Needham and Claassen:139 (in part, see discussion under *I. clio*)
1931 *Clioperla clio* Claassen:69 (drawings and description of nymph)
1935 *Isoperla clio* Frison:439 (drawing and description of nymph)
1942 *Isoperla marlynia* Frison:330 (synonomy and drawings and descriptions of male, female, and nymph)
1952 *Isoperla marlynia* Harden and Mickel:42 (key)
1966 *Isoperla marlynia* Illies:408 (catalog)

Isoperla nana
1872 *Chloroperla nana* Walsh:367
1900 *Chloroperla minuta* Banks:244
1925 *Isoperla minuta* Needham and Claassen:147 (descriptions and drawings of male and female)
1935 *Isoperla minuta* Frison:453 (descriptions and drawings of male, female, and nymph)
1965 *Isoperla nana* Ricker:495 (synonomy)
1966 *Isoperla nana* Illies:411 (catalog)

Isoperla richardsoni
1935 *Isoperla richardsoni* Frison:429 (descriptions and drawings of male, female, and nymph)
1952 *Isoperla richardsoni* Harden and Mickel:44 (key)
1966 *Isoperla richardsoni* Illies:417 (catalog)

Isoperla signata
1902 *Perlinella signata* Banks:124
1925 *Isoperla signata* Needham and Claassen:149 (descriptions and drawings of male and female)
1931 *Isoperla signata* Claassen:75 (description and drawing of nymph)
1948 *Pictetia bimaculata* Banks:122
1948 *Isoperla signata* Ricker:409 (synonomy)
1952 *Isoperla signata* Harden and Mickel:44 (key)
1966 *Isoperla signata* Illies:419 (catalog)

Isoperla slossonae
1911 *Perla slossonae* Banks:335
1925 *Clioperla annecta* Needham and Claassen:140 (description of female)
1942 *Isoperla slossonae* Frison:329 (synonomy and drawings and descriptions of male and nymph)
1952 *Isoperla slossonae* Harden and Mickel:45 (key)
1966 *Isoperla slossonae* Illies:420 (catalog)

Isoperla transmarina
1938 *Chloroperla transmarina* Newman:499
1908 *Isoperla ventralis* Banks:66
1925 *Isoperla ventralis* Needham and Claassen:150 (drawing of male)
1933 *Isoperla fumosa* Neave:235 (drawing of male and female)
1938 *Isoperla transmarina* Ricker:146 (drawing of female)
1942 *Isoperla transmarina* Frison:316 (drawing of nymph and synonomy)
1946 *Isoperla transmarina* Ricker:6 (synonomy)
1952 *Isoperla transmarina* Harden and Mickel:46 (drawing of nymph and key)
1966 *Isoperla transmarina* Illies:422 (catalog)

The distribution and abundance of each species of Perlodidae is illustrated in Figs. 1-3. Numbers within each sampling area represent numbers of nymphs, adults, and exuviae collected from October 1969 through August 1970. A dot indicates the species was collected in that county other than from a study area during the above study period.

Table 1 summarizes the number of specimens that were collected and the periods of the year when they occurred. Since exuviae may be present for several weeks after emergence, only the earliest occurrence of exuviae is reported.

Only two species of *Isogenus* were collected in this study, both from the northern part of the state. *I. frontalis* was collected from Sidney Creek in Marinette County and from several streams in northern Bayfield County (Fig. 1). The typical habitat was a cold, rapid, very small (less than 8 ft wide) to medium-sized (30-75 ft wide) stream. *I. olivaceus* was found in similar-sized, cold, rock-bottomed streams, but was rarer and restricted in our study to the Namekagon River in Washburn County and Woods Creek in Florence County (Fig. 1). Collection records (Table 1) suggest that both species have a one-year life cycle with emergence in late May or early June. The eggs apparently hatch almost immediately since identifiable nymphs of *I. frontalis* were found as early as August 17. A third species of *Isogenus* was collected by S. A. Forbes from a small stream near Fontana in southern Wisconsin in 1892 and named *I. varians* (Needham and Claassen 1925), but intensive sampling of this stream yielded no specimens. Frison (1935) examined Illinois specimens identified as *I. varians* by Needham and Claassen and found that *I. fugitans* (Needham and Claassen) 1925 and *I. crosbyi* (Needham and Claassen) 1925 were included. This, coupled with Ricker's (1952) statement that *I. varians* "is a species of large rivers" leads us to conclude that the Fontana collection was perhaps *I. crosbyi,* although that species has not been collected north of central Illinois (Frison 1935).

Twelve species of *Isoperla* were collected in Wisconsin from a variety of streams. All had a one-year life cycle with emergence of adults from mid-April through June, depending on the species. *I. slossonae, I. signata,* and *I. clio* were the first to emerge, emergence beginning in mid-April and progressing through May. *I. nana* also emerged fairly early, its emergence period being confined to the month of May. Several species (*I. bilineata, I. lata, I. marlynia, I. richardsoni,* and *I. transmarina*) emerged mostly from mid-May to mid-June, while *I. cotta, I. dicala,* and *I. frisoni* were the last to emerge, their emergence period extending from late May to the end of June. Emergence was generally two to three weeks earlier in the southern counties than in the far north. No newly-hatched *Isoperla* nymphs were collected during the spring and early summer, and we suspect that

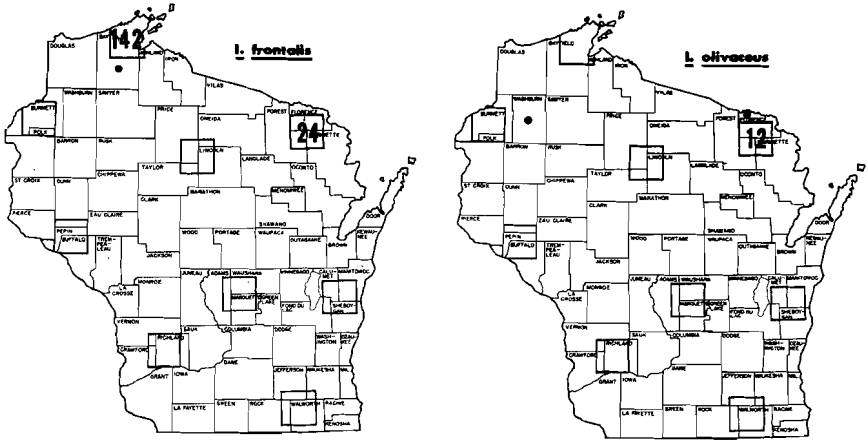

Fig. 1. Distribution of *Isogenus frontalis* and *I. olivaceus* in Wisconsin. Dots represent county records and numbers are totals collected in one year from each 576 square mile sampling area.

Table 1. Occurrence of nymphs, adults, and first exuviae of Perlodidae in Wisconsin.

Species	Number of Streams	Nymphs		Males		Females		Exuviae		Number Reared
		No.	Dates	No.	Dates	No.	Dates	No.	Date	
Isogenoides frontalis	13	74	8/17-5/26	0		3	6/6	96	6/6	58
I. olivaceus	2	14	11/18-5/3	0		0		11	6/21	0
Isoperla bilineata	10	66	11/22-5/27	101	5/22-6/25	190	5/22-6/25	24	5/15	6
I. clio	26	184	9/3 -5/28	2	5/15-5/28	0		14	4/25	3
I. cotta	67	422	9/13-7/7	6	5/28-6/25	4	6/4 -7/7	186	6/4	10
I. dicala	52	168	3/27-6/20	42	6/3- -6/29	47	6/4 -8/27	8	6/9	0
I. frisoni	55	312	5/5 -6/20	15	5/28-7/15	20	5/28-7/8	37	5/13	0
I. lata	26	66	10/3 -5/27	0		0		38	6/5	7
I. marlynia	15	120	10/2 -5/3	2	5/28	1	5/28	7	6/25	14
I. nana	10	101	4/23-5/27	2	5/9 -5/16	2	5/16	0		0
I. richardsoni	16	169	3/28-6/7	8	5/23-5/30	19	5/23-7/15	48	5/3	0
I. signata	152	1744	10/16-6/5	21	5/15-6/29	35	5/15-7/15	462	4/19	36
I. slossonae	115	461	8/25-6/7	0		5	5/9 -6/7	93	4/11	63
I. transmarina	146	1540	9/8 -6/20	12	5/22-6/10	16	5/22-7/7	145	5/2	63

most species spend the summer months as eggs, which hatch late in the summer or early in the fall. Nymphs of all but four species were collected in October, and two of these (*I. dicala* and *I. richardsoni*) were probably present at that time but too small to identify. Nymphs of *I. frisoni* and *I. nana,* however, were never collected before late-April, suggesting that these species wintered as eggs.

Although *Isoperla* nymphs were found in all types of streams, most species had rather specific requirements with respect to stream size. *I. clio* and *I. nana* occurred only in small (8-30 ft wide) or very small streams, some of which occasionally became dry in late summer. *I. clio* was found only in clear, cold streams while *I. nana* habited somewhat organically enriched streams. Frequently no other perlodid was found in streams inhabited by *I. clio* or *I. nana. I. cotta, I. lata, I. slossonae,* and *I. transmarina* were found primarily in small to medium-sized streams, the latter species occurring in larger streams as well. *I. frisoni* and *I. dicala* preferred somewhat larger streams than the above species, although they were commonly collected from medium-sized streams and rarely from small streams. *I. bilineata, I. richardsoni,* and *I. marlynia* were species of the larger rivers (more than 75 ft wide). *I. bilineata* and *I. marlynia* frequently occurred with *I. richardsoni* but were never found together, the former occurring commonly only in the largest rivers. *I. signata* was the least specific with respect to habitat requirements, being collected from small as well as very large streams.

The distribution of *Isoperla* in Wisconsin was not uniform (Figs. 2-3), the preponderance of species and the bulk of the individuals being collected from the northwestern three-fourths of the state. The southeastern fourth of the state contained mostly organically enriched streams that were not suitable habitat for Perlodidae. The most abundant and widely distributed perlodids in Wisconsin were *I. signata* and *I. transmarina,* the former occurring statewide and the latter in all but the southeast corner (Fig. 3). *I. slossonae* was also widespread and common, with a distribution very similar to *I. transmarina* (Fig. 3). Distribution records for *I. bilineata, I. richardsoni,* and *I. marlynia* are more poorly defined than for other species because of difficulties encountered in adequately sampling their large river habitat. The distribution of the latter, however, appears to be statewide (Fig. 3) while *I. richardsoni* was not found in the southern third or extreme north (Fig. 3). *I. bilineata* may be confined to the southern two-thirds of the state (Fig. 2), since intensive collecting of typical habitat in the St. Croix and Yellow Rivers in Burnettt County, and the lower Pine River in Florence County yielded no specimens. Populations of *I. lata* and *I. cotta* appeared to be confined to the northeastern third of Wisconsin, although a few *I. cotta* were also collected from Otter Creek in Sauk County (Fig. 2). Other northern species were *I. frisoni,* which was not found in the southern third of the state (Fig. 2), and *I. dicala,* which was confined to the northwestern two-thirds of the state (Fig. 2). The only species found in southeastern Wisconsin but not in the north was *I. nana* (Fig. 3). *I. clio* was found in southern Wisconsin streams, and in central Wisconsin as far north as Price and Oneida Counties (Fig. 2). These latter records constitute a significant northward extension of the known range of this southern species (Illies 1966).

Intensive sampling within the nine study areas and numerous collections from streams in other areas of the state make it unlikely that any species occurring in substantial numbers was overlooked. It is quite possible, however, that rare species or species with extremely localized distribution may not have been collected. *Arcynopteryx compacta* (MacLachlan) 1872 and *Isogenus krumholzi* Ricker 1952 probably occur in northern Wisconsin and have not yet been collected. The former has been collected in Upper Michigan from Lake Superior (Ricker 1964), a habitat we did not sample, while the latter was collected from streams in northwestern Lower Michigan and northeastern Minnesota (Ricker 1952). Only the male of *I. krumholzi* is known, and it can be distinguished from *I. frontalis* by a pair of short, acute lobes projecting posteriorly from the supra-anal process. *Isogenus doratus* (Frison) 1942, *I. nalatus* (Frison) 1942, and *I. varians* have all been found in southern Michigan, and *I. crosbyi* and *I. fugitans* were collected in central Illinois. All could occur in southern Wisconsin, but extensive sampling of unpolluted streams in this area has produced no specimens. Keys by Ricker (1952) can be used to separate these species of *Isogenus.*

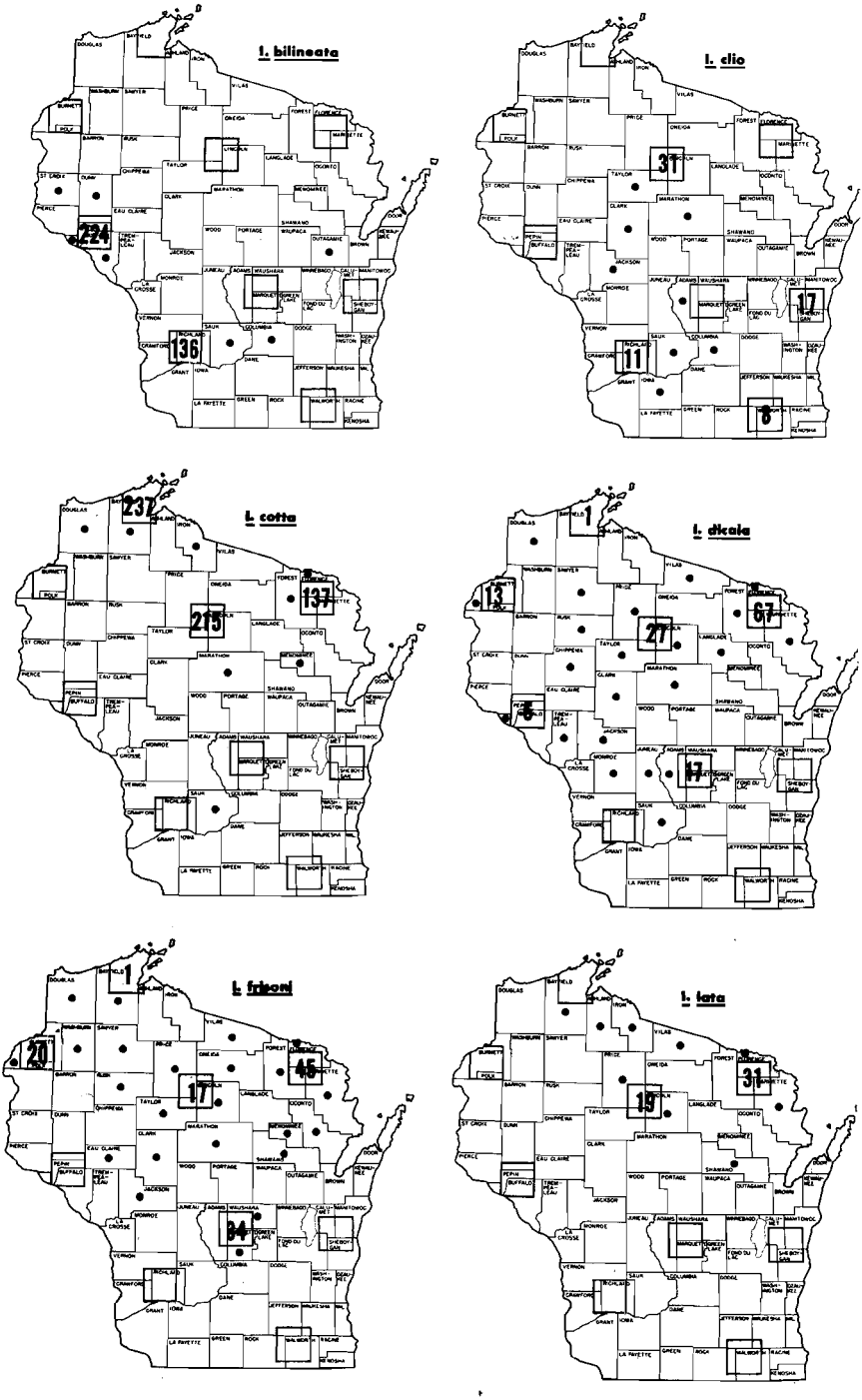

Fig. 2. Distribution of *Isoperla bilineata, I. clio, I. cotta, I. dicala, I. frisoni,* and *I. lata* in Wisconsin. Dots represent county records and numbers are totals collected in one year from each 576 square mile sampling area.

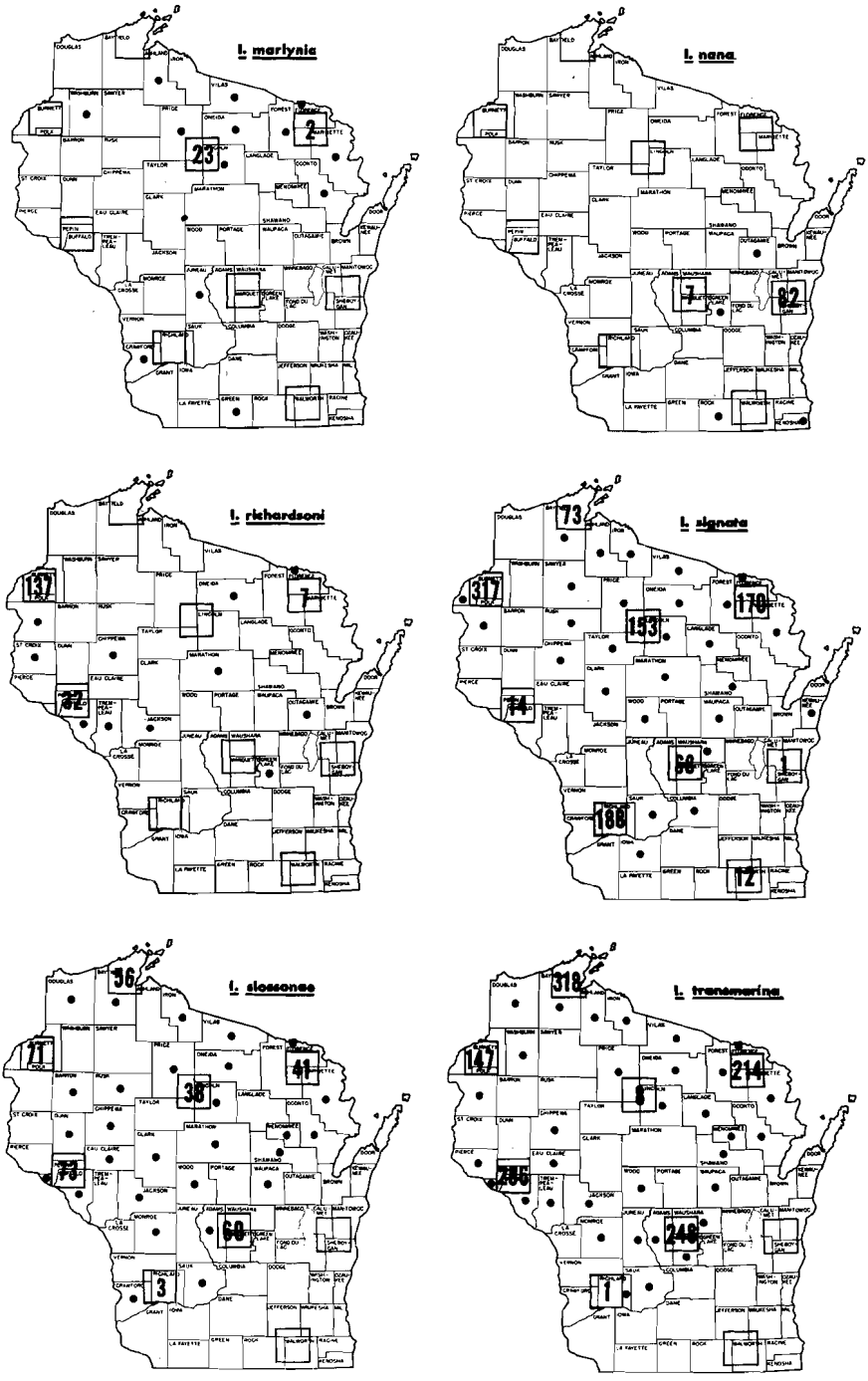

Fig. 3. Distribution of *Isoperla marlynia, I. nana, I. richardsoni, I. signata, I. slossonae,* and *I. transmarina* in Wisconsin. Dots represent county records and numbers are totals collected in one year from each 576 square mile sampling area.

Of the species of *Isoperla* collected in neighboring states, none appear likely to be found in Wisconsin. *I. longiseta* Banks 1906 is a prairie species that occurs east to Ames, Iowa with single females also having been collected at St. Paul, Minnesota and Quincy, Illinois (Frison 1942). Harden and Mickel (1952) did not find it in Minnesota. The *I. montana* (Banks) 1898 reported from Minnesota (Needham and Claassen 1925) was probably another species. This is a species of the eastern mountains and Ricker (personal communication) suggests that it probably does not occur west of Ontario. *I. conspicua* Frison 1935 (Illinois), *I. emarginata* Harden and Mickel 1952 (Minnesota), and *I. maxana* Harden and Mickel 1952 (Minnesota) were all described from single specimens and their status is uncertain. We also feel that *I. orata* Frison 1942 does not occur in Wisconsin, but its separation from *I. cotta* is based mainly on color pattern and is not always certain. All Wisconsin adults we have examined have the large dark mark anterior to the median ocellus, which is typical of *I. cotta*. Furthermore, the range of *I. orata* as reported by Frison (1942) was confined to mountainous regions from Vermont to Tennessee, although Ricker (1952) reports that ranges of *I. cotta* and *I. orata* overlap in Quebec, Ontario, and Michigan.

The following keys include only those species that we collected in Wisconsin.

KEY TO PERLODIDAE NYMPHS IN WISCONSIN

1a. Submental gills present ..... *Isogenus* 2
1b. Submental gills absent ..... *Isoperla* 3
2a. Abdominal terga with transverse pale bands just behind middle of each segment; male with long, curled genital lash ..... *I. olivaceus*
2b. Abdominal terga lighter posteriorly, but without pale bands near middle of each segment; males without a genital lash ..... *I. frontalis*
3a. Second tooth of lacinia absent (Fig. 4J) ..... *I. nana*
3b. Second tooth of lacinia present 4
4a. Truncate distal end of lacinia covered with a dense brush of setae (Fig. 4H); abdominal marking, if present, longitudinal and never transverse ..... *I. lata*
4b. Lacinia variable but without a dense brush of setae distally 5
5a. Lacinia with a tuft of setae below second tooth (Figs. 4E,G,K) 6
5b. Lacinia with setae scattered below second tooth, none clustered in a tuft 8
6a. First tooth of lacinia about as long as outer edge of ovate basal portion of lacinia (Fig. 4E); no paired dark spots on abdominal or thoracic terga ..... *I. cotta*
6b. First tooth of lacinia much shorter than outer edge of elongate basal portion (Figs. 4G,K); paired dark spots on either abdominal or thoracic terga 7
7a. Eight dark spots on each abdominal tergum; thoracic terga mottled with light and dark areas; dark bar on anterior portion of front-clypeus enclosing a light area just anterior to median ocellus ..... *I. richardsoni*
7b. Dark spots absent from abdominal terga; each thoracic tergum pale with paired dark spots; no dark bar on anterior portion of fronto-clypeus ..... *I. frisoni*
8a. Abdominal terga transversely banded or pale anteriorly and dark posteriorly, especially on posterior terga (telescoping of segments may give false appearance of banding), rarely dark nymphs are evenly colored, but dark pigment extends ventrally well down onto posterior margin of 9th sternum 9
8b. Abdomen with longitudinal stripes, light spots, or evenly-colored; if evenly-colored, dark pigment does not extend onto 9th sternum 10
9a. Distal end of lacinia truncate with several strong setae (Fig. 4I) ..... *I. marlynia*
9b. Distal end of lacinia not at all truncate, with only a few strong setae on margin (Fig. 4L) ..... *I. signata*
10a. Large, quadrate, nearly square light area anterior to median ocellus; dark bands on femur and tibia near their articulation ..... *I. slossonae*

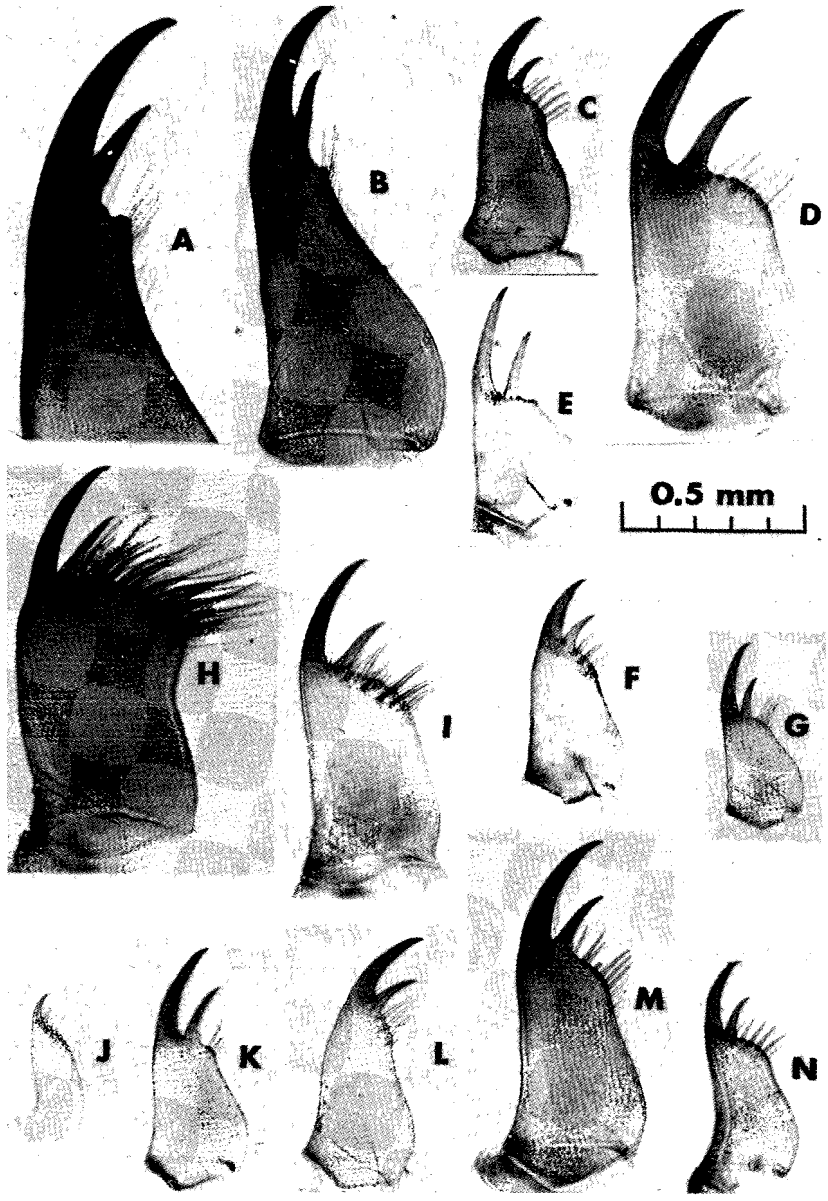

Fig. 4. Ventral view of right lacinia of nymphs of A. *Isogenus frontalis*, B. *I. olivaceus*, C. *Isoperla bilineata*, D. *I. clio*, E. *I. cotta*, F. *I. dicala*, G. *I. frisoni*, H. *I. lata*, I. *I. marlynia*, J. *I. nana*, K. *I. richardsoni*, L. *I. signata*, M. *I. slossonae*, and N. *I. transmarina*.

10b. Light area anterior to median ocellus, if present, rounded or W-shaped; no dark bands on femur and tibiae near their articulation 11
11a. Distinct W-shaped pale area anterior to median ocellus, extending almost to antennae, and often posteriorly to lateral ocelli and compound eyes; abdominal terga each with eight white spots or solidly colored ..... *I. clio*
11b. Pale area near median ocellus rounded, indistinct, or absent, but never distinctly W-shaped; abdominal terga with longitudinal stripes except on very immature nymphs 12
12a. Pale mark immediately anterior to median ocellus indistinct or lacking; numerous conspicuous freckle-like spots on abdomen, especially on posterior sterna; dark longitudinal abdominal stripes with very narrow pale borders ..... *I. dicala*
12b. Distinct pale mark immediately anterior to median ocellus; conspicuous freckle-like spots absent; longitudinal stripes, if present, with wide pale borders 13
13a. Wing pads with dark, conspicuous setae; veins in wing pads colored similarly to background; dark spots on abdominal terga lacking or inconspicuous . *I. transmarina*
13b. Wings pads with pale, inconspicuous setae; pale veins visible in dark-colored areas of wing pads; 8 dark spots on each abdominal tergum ..... *I. bilineata*

KEY TO PERLODIDAE ADULTS IN WISCONSIN

1a. Submental gills present ..... *Isogenus* 2
1b. Submental gills absent ..... *Isoperla* 5
2a. Eighth abdominal sternum unmodified; conspicuous supra-anal process ... males 3
2b. Eighth abdominal sternum produced posteriorly as a subgenital plate; no supra-anal process ..... females 4
3a. Supra-anal process short with an apical hood directed posteriorly ..... *I. frontalis*
3b. Supra-anal process a long, coiled lash ..... *I. olivaceus*
4a. Subgenital plate with a shallow, broadly V-shaped notch ..... *I. olivaceus*
4b. Subgenital plate with a deep U-shaped notch ..... *I. frontalis*
5a. Small insects, less than 6mm long; head mostly dark ..... *I. nana*
5b. Larger, more than 7mm long; if near 7mm, head mostly light 6
6a. Ninth abdominal sternum produced, mostly or entirely concealing tenth; eighth sternum slightly produced or with a small lobe in middle of posterior margin . . males 7
6b. Ninth abdominal sternum not produced, tenth visible; eighth sternum broadly rounded to strongly produced as a subgenital plate ..... females 17
7a. Recessed lobe of 8th abdominal sternum twice as long as wide. ..... *I. dicala*
7b. Recessed lobe of 8th abdominal sternum as wide as or wider than long 8
8a. Subanal lobes sclerotized, dark, recurved upward and often forward above 10th tergum 9
8b. Subanal lobes not sclerotized, pale (except occasionally at tip), and if recurved not extending forward above 10th abdominal tergum 13
9a. Large pale mark immediately anterior to median ocellus almost square, concave in front and slightly convex behind; recessed lobe on 8th abdominal sternum more than 1/2 as wide as segment and paler than sternum ..... *I. slossonae*
9b. Pale mark anterior to median ocellus, if present, not almost square; recessed lobe on 8th sternum less than 1/3 as wide as segment 10
10a. Ninth abdominal sternum distinctly longer than wide; subanal lobe recurved over 10th abdominal tergum; abdominal sterna dark ..... *I. lata*
10b. Ninth abdominal sternum as wide as or wider than long; subanal lobe may or may not be recurved over 10th tergum; abdominal sterna pale (may be dark laterally) . . 11
11a. Subanal lobes past bend long and extremely slender, about as long as basal portion and often recurved forward over 10th tergum ..... *I. marlynia*
11b. Portion of subanal lobes past bend much shorter than basal portion, pointed dorsad, and usually not recurved forward over 10th tergum 12

12a. Abdominal terga dark with a darker central longitudinal stripe; pale spot between lateral ocelli large, pointed anteriorly; pronotum pale with dark markings ..... *I. transmarina*

12b. Middle of abdominal terga pale; pale spot between lateral ocelli, if present, small and ovoid; pronotum predominantly tan with a pale central stripe ..... *I. signata*

13a. Tenth abdominal tergum with a median notch; pronotum dark with a wide, pale, central longitudinal stripe; greater than 11mm long ..... *I. clio*

13b. Tenth abdominal tergum entire; pronotum pale with dark markings between pale central stripe and pale margins; less than 11mm long 14

14a. Basal abdominal terga pale, without dark stripes; "V-mark" connecting ocelli usually indistinct or lacking, if distinct rarely wider than black ocellar spots; subanal lobes pointed and curved dorsad ..... *I. bilineata*

14b. Basal abdominal terga with indistinct dark dorsal stripe, or darkly pigmented; "V-mark" distinct and wider than ocellar spots; subanal lobes pointed or blunt . 15

15a. Pale area between lateral ocelli poorly defined and usually covering less than half of area between ocellar spots; large dark area on fronto-clypeus separated from anterior ocellus by a narrow U-shaped pale area; subanal lobes bluntly pointed and curved inward ..... *I. cotta*

15b. Pale area between lateral ocelli sharply defined and covering most of area between ocellar spots; dark area on fronto-clypeus, if present, broadly or diffusely separated from anterior ocellus; subanal lobes pointed and curved dorsad or rounded 16

16a. "V-mark" covers an area inside lateral ocellar spots about equal to width of those spots; dark area anterior to median ocellus; subanal lobes pointed and curved dorsad ..... *I. richardsoni*

16b. "V-mark" covers very little or none of the area inside lateral ocellar spots; area anterior to median ocellus pale, except occasionally on anterior margin of fronto-clypeus; subanal lobes triangular, rounded, and projecting posteriorly ... *I. frisoni*

17a. Dark area on dorsum of head encloses a large, almost square (concave in front and slightly convex behind) pale area anterior to median ocellus, and an ovoid area between lateral ocelli ..... *I. slossonae*

17b. If present, enclosed pale area anterior to median ocellus never nearly square, but ovoid or transverse 18

18a. Pronotum predominantly pale with dark markings between pale central stripe and wide pale margins 19

18b. Pronotum predominantly tan or brown with a wide pale central stripe and scattered darker and sometimes pale markings in dark areas 24

19a. Eighth abdominal sternum with broadly rounded posterior margin barely projecting over 9th sternum; dark marking connecting ocelli about width of ocellar spots and distinctly U-shaped ..... *I. richardsoni*

19b. Posterior margin of 8th abdominal sternum produced as a subgenital plate and projecting over at least 1/3 of 9th sternum; in species with a rounded subgenital plate, dark area connecting ocelli very broad, much wider than ocellar spots ... 20

20a. Basal abdominal terga pale, without dark stripes; subgenital plate sub-triangular, not truncated, and at least half as long as 9th abdominal sternum; "V-mark" connecting ocelli often indistinct or lacking, if distinct rarely wider than black ocellar spots . 21

20b. Basal abdominal terga with indistinct dark dorsal stripe or darkly pigmented; subgenital plate, if sub-triangular, about 1/3 length of 9th sternum; distinct "V-mark" or broad dark area connecting ocelli 22

21a. Sides of subgenital plate concave just before produced apex; "V-mark" connecting ocelli absent or barely visible anteriorly, rarely distinct ..... *I. dicala*

21b. Sides of subgenital plate straight, apex often emarginate; "V-mark" often distinct, occasionally absent ..... *I. bilineata*

22a. Sides of subgenital plate sub-parallel before wide truncated apex and at least 2/3 as long as 9th abdominal sternum; "V-mark" distinct and covering very little or none of area inside lateral ocellar spots; area anterior to median ocellus pale, except occasionally on anterior margin of fronto-clypeus ..... *I. frisoni*

22b. Sides of subgenital plate, if truncate, not more than 1/2 as long as 9th sternum; a broad dark area connecting ocellar spots, with much pigment inside lateral ocellar spots; extensive dark pigmentation on fronto-clypeus 23
23a. Subgenital plate highly variable, narrowly rounded, sub-triangular, or truncate, but not more than half as long as 9th abdominal sternum; pale area anterior to median ocellus ovoid or spear-shaped, often indistinct; pale mark between lateral ocelli large, distinct, and pointed anteriorly ..... *I. transmarina*
23b. Subgenital plate broadly rounded, usually emarginate, and about 2/3 as long as 9th sternum, a sharply defined, narrow U-shaped pale area immediately anterior to median ocellus; pale mark between lateral ocelli small and indistinct, or lacking ... . *I. cotta*
24a. No pale area between lateral ocelli; large, 14mm or longer ..... *I. clio*
24b. Pale mark between lateral ocelli; if mark is diffuse or absent, length less than 12mm. 25
25a. Abdominal sterna usually yellow, much lighter than pleural areas; large pale area centered on anterior mesoscutum (occasionally obscure) 26
25b. Abdominal sterna brown or tan, about as dark as or darker than pleural region; center of mesoscutum dark ..... *I. lata*
26a. Center of at least first two abdominal terga white with a dark central stripe; greater than 12mm long; pale spot between lateral ocelli large, occupying 2/3 area between black ocellar spots; subgenital plate well developed and usually broadly and distinctly emarginate ..... *I. marlynia*
26b. First two abdominal terga pale and without a dark central stripe; less than 12 mm long; pale spot between lateral ocelli, if present, small and usually occupying 1/2 or less of area between black ocellar spots; subgenital plate low and rounded, occasionally feebly emarginate ..... *I. signata*

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JOHN WHITE'S DRAWINGS OF *PAPILIO GLAUCUS* L. (LEPIDOPTERA: PAPILIONIDAE): NEW LIGHT ON THE 'FIRST AMERICAN BUTTERFLY' AND THE PROBLEM OF *GLAUCUS* VERSUS *ANTILOCHUS* L. PART I: WHITE TO MOFFET[1]

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All American lepidopterists are familiar with the "first picture of an American butterfly." William J. Holland's account of one of John White's watercolors of *Papilio glaucus* L. first appeared as a separate article (Holland, 1929), and was later adapted for the second edition of his immensely popular *The Butterfly Book* (Holland, 1931). Subsequent research has added many facts to our knowledge of White's life, and much more can now be said about his paintings and later use of them. A reappraisal of the first identifiable record of a North American butterfly is now possible, and, more important to taxonomists, evidence can be provided to support a decision upon the suggestion of F. Martin Brown (1968) that the name of the yellow form of *Papilio glaucus* should be *antilochus* L.

The chapter "John White: An Attempt at Identification" in Hulton and Quinn (1964) summarizes what is now known about White. He seems to have been born between 1540-50, and there is good evidence that he accompanied Frobisher on his second (1577) voyage to find a Northwest Passage. White's watercolors of Eskimos, now with the rest of his paintings in the British Museum, probably date from this voyage. By 1584 White had fallen in with Walter Raleigh, who was then planning colonization in the New World. The first of White's voyages to "Virginia" was quite probably with the Amadas-Barlowe coastal reconnaissance in 1584. The second was the colonization voyage of 1585, which established the first English settlement in the New World on Roanoke Island, in what is now North Carolina. White remained in the area, making sketches and maps, until the summer of 1586. He returned to England when the first colony was disbanded, and early in January 1587 he was named governor in Raleigh's grant for a new attempt. The story of his "Lost Colony" is well known, and his service with the Raleigh enterprises as artist-explorer and governor is reasonably well documented, but White's life after the return from the search for the "Lost Colony" can only be traced imperfectly; he was a resident of Newtown, Kilmore, Ireland in 1593, and he may have been the John White "late of parts beyond the seas" who died outside of England in or before 1606 (Hulton and Quinn, 1964).

The paintings of aborigines, fauna and flora made by White during his American voyages have had a long and complicated history. Hulton and Quinn (1964) have suggested that he first made 'field sketches' which were later used to produce the finished watercolors which now remain. The main collection was eventually bound together, and after a succession of fortunes, was sold to the British Museum by the American dealer Henry Stevens in 1866. One of White's colored drawings of *Papilio glaucus,* evidently made from his field sketch, is in the collection obtained from Stevens (Figure 1), but the more famous watercolor of the "first American butterfly", the one publicized by Holland (Figure 2), had quite a different history. It is part of the manuscript of Thomas Moffet's *Insectorvm sive Minimorum Animalium Theatrvm* (London, 1634), also in the British Museum. How it came there is much clearer now than in Holland's time.

This finished painting, probably from the same field sketch, was given by White to the English naturalist Thomas Penny in 1587. On the drawing is a note in an Italianate hand

[1]Based on a paper delivered at the twentieth annual meeting of the Lepidopterists' Society, East Lansing, Michigan, June 1969.

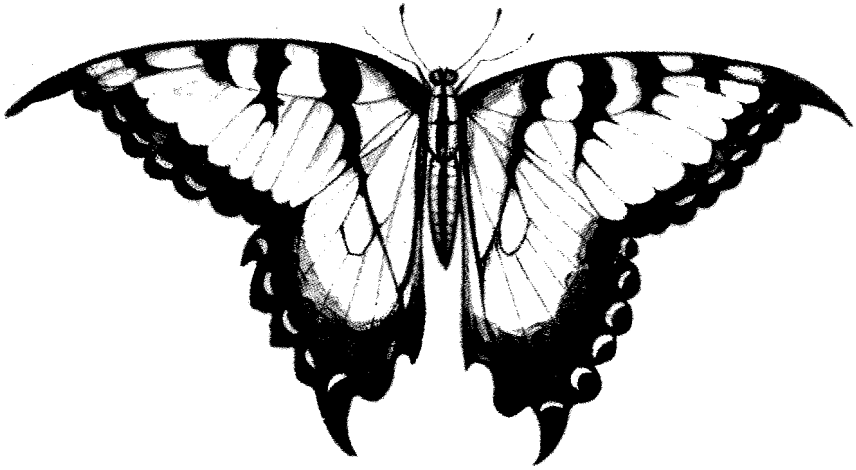

Fig. 1. Watercolor by John White. British Museum P&D 1906-5-9-1 (66); C-M. & H. 58.

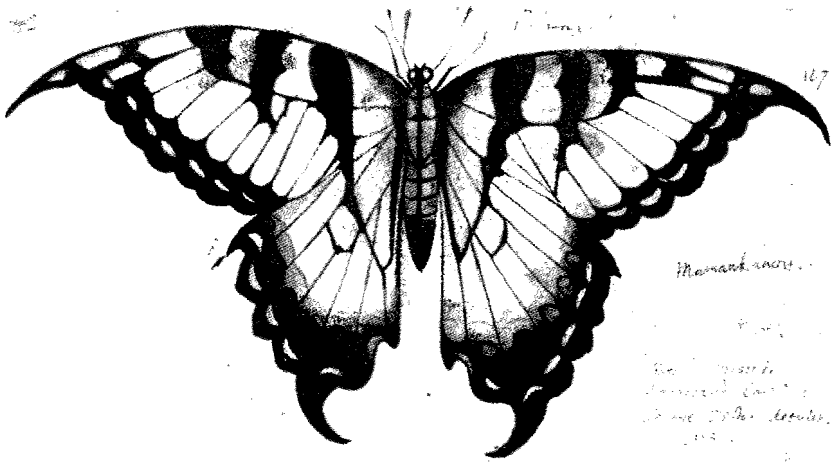

Fig. 2. Watercolor by John White. British Museum MSS. Sloane 4014, f. 96r.

explaining that "Hanc e Virginia Americana Candidus [i.e. White] ad me Pictor detulit. 1587" (White the painter brought me this [drawing] from American Virginia, 1587). Holland was not sure whether the comment was in the hand of Thomas Wotton or Penny, but in his chapter on "John White's Significance for Natural History" in Hulton and Quinn (1964), Raven infers that Penny wrote the 'caption'.

Thomas Penny (ca. 1532-88) was one of the earliest English students of insects. Born at Gressingham, Lancashire, he graduated from Trinity College, Cambridge in 1551, and

remained at the College in various offices until 1565. During his later Cambridge years he studied botany and medicine, and his interest in entomology dated from at least 1563 (Moffet, 1634, p. 270). In 1565 Penny travelled to Zurich, having received an introduction to the great Renaissance naturalist Conrad Gesner. He arrived shortly before Gesner's death, and was entrusted with the notes for the section on insects to have been published by Gesner in the *Historia Animalium.* Penny travelled through Europe studying plants and insects, returning to England in 1569 with his M.D. degree. For the remainder of his life he collected information for a book on insects which would incorporate Gesner's data, and many of his friends contributed their assistance. Penny's entomological activities are discussed by Raven (1947) and Lisney (1960).

The watercolor discussed by Holland was apparently given to Penny by White as information for the book that Penny did not live to finish. Precisely when White made the drawing is another problem. The note that it was brought from "Virginia" in 1587 gives some help, but this is hardly decisive. Raven, in Hulton and Quinn (1964), suggests that White's connection with Penny extended over at least several years, and points out that White donated other entomological illustrations to Penny's records; a gadfly, two fireflies and a cicada (Sloane MS. 4014, ff. 63r, 69v, 109r, 124v). Raven queries whether the watercolor of *glaucus* was the result of an earlier voyage and was given to Penny early in 1587, before White's 1587 voyage to "Virginia" (May-December), or whether the drawing was a result of the 1587 voyage. This question cannot now be decided, but one can assume that the specimen itself was captured on the Atlantic coast between 1584 and 1587. That the insect was indeed *glaucus* can hardly be doubted, despite the fantastic apices of the forewings and the pointed tails, embellishments probably explained by the fact that White worked from rough sketches made in the field. Of course the specimen itself has long since perished, if it was ever kept; the earliest remaining North American specimens of Lepidoptera are in the collection of the English entomological entrepreneur James Petiver, and these date from slightly over a century later (Wilkinson, 1969). One can also say that the White specimen may have been captured without the aid of a net, as the earliest verified usage of that device is in the next century (Wilkinson, 1966).

The White-Penny drawing was among Penny's papers at his death. The entomological notes were put in order by his friend Thomas Moffet (1553-1604), a fashionable London physician. Moffet had a passing interest in natural history, including entomology. There is at least some evidence that he observed insects in the field; for example, in his *Theatrvm* there is a passage about his and Penny's herbalizing in an Essex wood, which, incidentally, tells a little about collecting methods in the pre-net era. Moffet was examining a nest of wasps, and the insects attacked his party; they were forced to defend themselves by the means of branches of the broom-plant which they were using to collect insects: "in manibus genistae aliquot ramos (quibus insecta comprehendere soliti fuimus) in tulelam & defensionem nostram portassemus. . . ." (Moffet, 1634, p. 45).

Yet, Moffet's obvious additions to Penny's papers are rather uncritical, and show more literary than entomological knowledge. He worked the notes into a book manuscript between Penny's death and 1589, adding observations of his own and over a hundred and fifty illustrations. The manuscript (Sloane 4014), containing the White-Penny drawings of *glaucus* and other insects, was licensed in 1590 to be published at The Hague, but the printing never took place. Raven (1947) repeats the suggestion that the book may have been printed in 1598 (at Frankfurt?), but no copy of such an edition remains. Whatever the reason for delay, Moffet wrote a new dedication to James I, but never secured printing of the manuscript. It was sold after his death to Theodore de Mayerne, who finally arranged for its publication at London in 1634 (Raven, 1947).

The printed work contained the drawing of *glaucus,* transformed into a woodcut (Figure 3). The description of the insect in the *Theatrvm* is of some interest: "Diurna Papilio Prima, omnium maxima, maximam partem flavescit, ijs locis partibus[que] exceptis, quae hic attramento denigrantur. Quinetiam extremi illi internarum alarum globuli coeli colorem spirant: ut genuinis saphyris consitum putares. Oculi chrysolythu[m] referunt, magnitudinem formam[que] adeo ad normam exculptam hic exhibemus, ut plura de ijs attexere non sit necessum" (Moffet, 1634, p. 98). When, in 1658, the Gesner-Penny-Moffet accretion was translated into English by John Rowland and

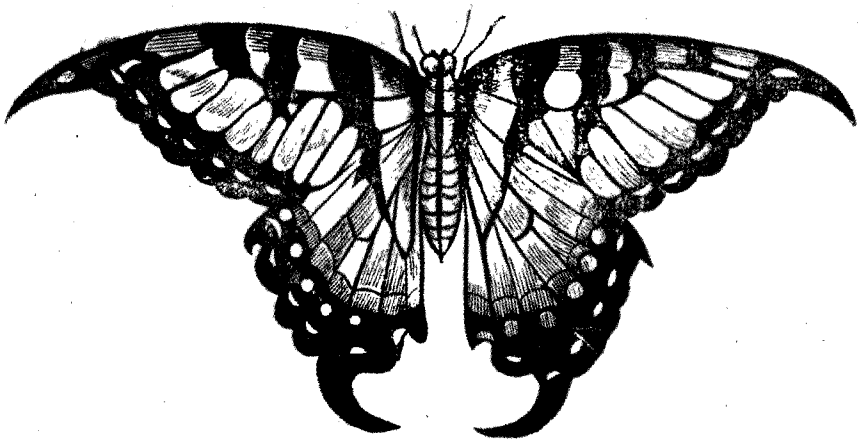

Fig. 3. Woodcut after watercolor in Fig. 2, used in Thomas Moffet, *Insectorvm sive minimorum animalium theatrvm* (London, 1634), 98.

appended to Edward Topsell's *The History of Four-footed Beasts and Serpents* (London, 1658), the description was loosely rendered as follows; "The first Day-Butterfly being the greatest of all, for the most part all yellowish, those places and parts excepted which are here blacked with inke. Moreover, the roundles of the inner wings [the secondaries] are sky-colour, insomuch that you would think they were set with Saphire stones; the eyes are like the Chrysolite: the bignesse and form is so exactly set forth in the figure, that there needs no more to be said of it" (Moffet, 1658, p. 967).

Thus, at least one of White's finished drawings of *Papilio glaucus* found its way into print in the seventeenth century. Its later history, and that of still a third drawing which was eventually copied and adapted by Mark Catesby for his *Natural History of Carolina, Florida and the Bahama Islands*, will be traced in the concluding part of this paper.

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FIVE SPECIES OF THE ANT GENUS ACANTHOMYOPS (HYMENOPTERA: FORMICIDAE) AT THE EDWIN S. GEORGE RESERVE IN SOUTHERN MICHIGAN

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This paper supplements one written ten years ago (Talbot 1963) concerning the *Acanthomyops* nesting in a two square mile area in south eastern Michigan. It presents a fifth species *(A. subglaber)* for the E. S. George Reserve, gives flight activities of *A. claviger,* adds a description of a method used by *A. murphyi* to invade *Lasius neoniger* colonies and extends some brood and flight records and habitat ranges.

Acanthomyops subglaber (Emery)

This species has not been reported previously for the Reserve, and only two colonies have been discovered. Both nested on a ridge in a rather dense oak-hickory-cherry woods above a swamp. Each dug out for flight around a stone. The second nest surrounded a large immovable stone and continued out at one side to extend lengthwise of a long tree trunk. The trunk and soil under and around it were all well galleried. The first colony was collected only once but the second was known from 1967 through 1971.

Brood was difficult to locate so records of development are sparse. Alate pupae have been found from June 29 until August 27 and adult alates from August 24 until September 28. In 1967 females were present but in 1970 and 1971 only males were produced.

No good flight records were obtained, but in 1971 preflight activities were watched on a number of days and the end of one flight was witnessed. On August 27 males and a few male pupae were present under a movable slab lying beside the big stone but on September 1 there was still no sign of digging out for flight. The colony was not checked again until September 8 at which time males were out at the base of the stone and were trying to climb it but were held back by a ring of guarding workers. Next afternoon they tried again to climb the stone and were again kept back by workers. These days were dry and remained warm until light was quite dim. Conditions stayed the same but on September 14 it looked as if they would surely fly. At 5:10 PM (79° F, 200 ft-c straight up and 400 ft-c brightest) when the sun was slanting through the trees, males were filling several openings. By 5:20 six tight little clusters of them were pushing up along the stone side but not advancing much. A few workers were present but most of the males seemed just not ready to move up further or to spread out from the mass. At 5:35 they were essentially as before; still trying to climb the stone up into the sun's rays but making no progress (77°, 100 ft-c up and 520 ft-c brightest). No more advances took place and by 6 PM there were only a few males out (76°, 50 ft-c up, 57 ft-c brightest) and the sun was almost gone. The soil was very dry and the temperature was probably still too high as light dimmed.

During the next few days there were several rains but it was cold and windy. September 27 was a good flight day. There had been rain in the night, it was cloudy all day, temperatures ranged between 70° and 73°, there was no wind and humidity was high. I had been very busy checking flights of *Acanthomyops latipes, Lasius speculiventris, Lasium minutus, Lasius umbratus* and *Lasius neoniger* and did not arrive at the *A. subglaber* nest until 4:25 (72°) when light was quite dim in the deep woods. Evidently a good flight had taken place for many males were running about on top of the stone with their wings open and vibrating. More were on the log and vegetation nearby. A few were still flying. At 4:30 PM it was very dark in the woods and the temperature had dropped to 69.5°. A few males were still attempting to fly but were not succeeding and a few workers were trying to herd them back. Presumably flights continued into October but observations ceased.

It would appear that *A. subglaber* follows the usual *Acanthomyops* pattern of flying between mid-afternoon and early evening, when light is lessening and temperature dropping into the low 70's.

Acanthomyops claviger (Roger)

The 28 colonies of *A. claviger* found on the Reserve over a period of 22 years were distributed in a number of habitats as was reported in 1963 (Talbot). They were the latest of all five species in developing their males and females. Alate pupae have been collected from July 9 to August 30 and adult alates from August 13 to October 7.

Flights have not previously been reported from the Reserve but in 1972 I could stay until October 7 and was able to observe two complete flights. They took place from a colony nesting in barren, sandy soil in an opening of scattered oaks at the south end of the Blowout. When found, on September 29, the nest was dug out for flight with 16 large exits spread over 5 times 2 feet. Males and females could be seen down in the openings.

The distinctive feature of the *A. claviger* flights was that they occured at lower temperatures than those of other *Acanthomyops* species at the Reserve. They did not start until the temperature fell below 70° F and they continued until 64° was reached. Thus they began at about the temperature when most flights of other species were ending.

Probably some flights took place in September, but those seen occurred on October 2 and 3. The first flight was a sparse one so the second will be reported. This flight was probably typical for the species except that it started rather early in the day because the afternoon was hazy and lasted a long time because the temperature decreased slowly. Table I.

At 2 PM (75°, 2800 ft-c) there was no sign of impending flight but at 2:20 (72°, 2600 ft-c) females were filling the lower parts of the openings and workers were forming a ring above them. By the time the temperature had lowered to 71° (2:43 PM, 2000 ft-c) females were making their way to the tops of entrances and a few were over their rims. When the first females began to move out onto the ground and to try to climb grasses the temperature was 70° (3:15, 1800 ft-c) and the first females flew when the temperature was just above 69° (3:23, 1600 ft-c). Only five females flew in the next 17 minutes, but during that time many females were massing about the entrances. Some were standing almost upright at their rims and others were outside on the ground. Most were looking upward and waving antennae. It seemed that conditions were not quite right for flying. Then at 3:40 (69°, 1400 ft-c) there was a sudden mass movement away from the openings. Females began climbing grasses and the abundant flying began.

At this time it was discovered that there were a good many males in the group. They flew along with the females but were, at all times, hard to see because of their small size and the great number of females.

Table 1. *Acanthomyops claviger* flights 1972.

	Time		Temperature		Light	
	Oct. 2	Oct. 3	Oct. 2	Oct. 3	Oct. 2	Oct. 3
Came up onto ground	4:45	2:55	69°	71°	–	2900
First alates flew	4:59	3:23	68°	69°	–	1600
Height of flight	5:23	4:10	65°	68°	–	1400
End of flight	5:36	5:14	64°	64°	–	440

Time–p.m. Eastern Standard.
Temperature-Fahrenheit, 10 inches above the ground.
Light-Foot candles, straight up.
Oct. 2. 17 + females flew, Oct. 3 - 7500 + females flew, together with a lesser number of males.

Soon the ground was covered with the brown females, small plants nearby were loaded with them and flying was general. Most flew away to the south where there was a break in the trees giving a wide expanse of sky (uniformly gray all afternoon). Some females fell as they tried to fly and others walked some distance before climbing so the flight area was soon very large and flying ants were hard to count even with the method of counting them against the sky as they rose from the ground.

By 3:57 they were flying at the rate of over 100 a minute and between 4:03 and 4:22 (69°-68°, 1600-1400 ft-c) they flew in excess of 230 a minute. This was the height of the flight and in this 20 minutes over 5000 females and a lesser number of males left the nest.

Between 4:30 and 4:45 (67°-66°, 1000-700 ft-c)flying gradually diminished from 100 to only about 25 flying a minute. Soon the first females began to climb down stems. Up to that time they had all been strongly impelled to move upward. Any females on my hand had insisted on climbing upward no matter how I turned them. Now some were reversing this and walking down my hand just as persistently.

Within 15 minutes (65°, 700 ft-c) only about four females were flying a minute and most had dropped or walked down from grasses and were going back into nest entrances. After the temperature reached 64° (5:11, 460 ft-c) there were few females to be seen. Eight flew after this, the last one at 5:14 (64°, 440 ft-c) and all alates which did not fly were back below ground.

It seems that, although decreasing light was necessary for flight, the range tolerated was rather wide. The ants began to fly at 1600 ft-c but could probably have flown in brighter light if temperatures had been favorable. On the other hand temperature seemed critical. They did not start flying until the temperature went below 70° and stopped at 64°. The sparse flight seen the day before had started at 68° (light was not recorded but was greater because of a hazy, slanting sun) and concluded at 64° (Table 1).

The habit of flying late in the year and at low temperatures correlates with the report of Wing (1968) that *A. claviger* queens overwinter above ground either singly or in aggregates. They may be active at quite low temperatures and perhaps infiltrate *Lasius* colonies and acquire the nest odor while the *Lasius* are still hibernating, thus becoming temporary social parasites.

Acanthomyops murphyi (Forel)

Only eleven colonies have been found on the Reserve but five of these have been known for 13, 12, 11, 9 and 7 years. Their distribution, nest structure and flight activities have been reported in the 1963 paper. Alate pupae have been collected between June 19 and August 17, males and females between July 3 and August 31. Eleven flight dates have been recorded between July 19 and August 28.

A. murphyi, like *A. latipes* is known to start colonies as social parastites (as perhaps all *Acanthomyops* do). The 1963 record I gave of a colony of *A. murphyi* with *Lasius neoniger* turned out to be a misidentification. Wing later identified the species involved as *A. latipes.* However, Sanwald (1964-65) has reported mixed colonies of *A. murphyi* and *Lasius neoniger.* He also remarked briefly that *A. murphyi* females may "flood" the entrances of *L. neoniger* nests trying to gain entrance. A conspicious example of this "flooding" was seen at the Reserve on August 3, 1965. Rains had softened the ground and *L. neoniger* entrances were wide open and well dug out, for it was nearing their time of flights. *A. murphyi* had flown that afternoon, which had been overcast and humid with temperatures in the 70's. At 5:30 I happened along a stretch of road which had many craters of *L. neoniger.* At each a group of from 2 to 25 *A. murphyi* females were congregated and were pushing (not digging) into the entrance. Those which could get into the openings were head down; some had only the head and forebody in the hole, some had all but the tip of the gaster in and others were entirely inside. Those which could not get in were wandering about. The females seemed to be blocking each other in their attempt to enter but perhaps the sheer force of numbers helped push some down in. Unlike those which Sanwald saw, the *L. neoniger* above ground were not attacking the females or attempting to hinder them.

Acanthomyops latipes (Walsh)

This is by far the most abundant species on the George Reserve, for 56 colonies were discovered between 1951 and 1972. Probably many of these were not present throughout that entire period but several have been known for a number of years. A check on one has been kept for 21 years (1952-1972) and it is still producing males and females. This colony is located in the North Gate House lawn and it produces alpha females. At first it dug out for flights around a stump, but by 1958 the stump was thoroughly decayed and the ants moved their flight place away from it and out from under a growing mulberry tree. Later the tree was cut down and they continued to dig out from the open lawn. Another *A. latipes* colony has had flights down the middle of a road for the past 12 years.

Alate pupae are known to be present between June 6 and August 29 and adult alates between July 13 and September 29. Parts or all of 33 flights have been seen. These records enlarge the span of flights reported before as to time of year, (August 17-September 27), time of day (2:45-6:15 PM), temperature (81°-73° F) and light (2400 ft-c–360 ft-c). Twenty four of the 33 flights took place during the last week of August (16) and the first week of September (8).

A. latipes colonies may produce two types of queens, with each colony having either the alpha or the beta type. Wing (1968) considers colonies producing alpha females to be hybrids between *A. latipes* and *A. claviger*. Six such colonies have been found among 25 colonies from which females have been collected. No differences have been discerned between these and the beta producing colonies as to time of alates in the nest and time of flights.

Acanthomyops interjectus (Mayr)

Thirteen colonies of *A. interjectus* have been discovered. Most were, as reported before, in deep to open woods or woods edge, but one was in a field not far from woods edge and one was in an open field near a pond but far from any trees. Five colonies dug out for flights around stumps, two beside logs, five formed low mounds at flight time and one was simply under heavy leaf cover.

Alate pupae were collected between June 7 and July 9, males and females between June 11 and August 25. Forty-six flights have been recorded from June 16 to August 22. Most took place between mid-June and mid-July. The six seen in August had been delayed by bad weather and were small. A record of flight activities has been given (Talbot 1963).

One colony, known for nine years, was large and vigorous when discovered. It had flights of both males and females from 1954 through 1959 but in 1960, '61 and '62 only males were produced. In 1954, when 14 flights were watched, more males than females were released during early flight days. Females then exceeded males for the next few flights. Gradually, the females declined until the last flights were composed principally of males. In the earlier years flights took place around a fairly solid stump. As time passed it decayed and the colony became smaller. By 1962 the stump was gone and the ants dug out at only a few places around a series of small stones.

LITERATURE CITED

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MOTHS TAKEN IN BERRIEN COUNTY, MICHIGAN (WITH 102 NEW COUNTY RECORDS)

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Moore (1955) published a listing of the moths of Michigan, exclusive of the Tineoidea, Other writers (anon., 1968; Voss, 1970) have extended the list of Michigan records. During the fall of 1970, and through the summer of 1971, I lived in Sawyer, Berrien County and collected a number of records new for that area. At the encouragement of M.C. Nielsen, a listing of these records is made available.

Sawyer is located in the heart of a grape growing region. An ultraviolet light trap was used for the bulk of the collecting, and grape fields were within the area in view of the collecting light. Much of the remainder of the immediate area consisted of open fields along the western edge of a railroad right-of-way. Beyond the track, about three hundred yards from the trap, was a background of scattered hardwoods.

Collecting in the Fall of 1970 was sporadic, records after mid-August are from that year. The light trap was set up again, early in 1971, about the first week of April. From that time on, it was run continually, including on rainy nights, except for a three week period in late June and early July during my absence from the area. An attempt was made to retain as many of the macroheterocera as occurred in the trap, and only a few microlepidoptera were retained. Empty egg cartons on the bottom of the trap provided a hiding place for the moths, and prevented much potential damage. (I am indebted to Leslie Ferge for this suggestion). Therefore most of the specimens taken were in very good condition.

A listing of the species captured follows, with an indication of flight period. Each month is divided into three parts, from the 1st to the 10th, the 11th to the 20th, and the 21st through the end of the month. An "x" in a particular column records at least one specimen captured during that part of the month. No comments on the relative abundance are given, because the number of actual specimens collected frequently depended upon the time available for pinning and the space left on the pinning boards. An attempt was made, however, to secure any newly observed species on the first date of their appearance, and to collect at least one for as long as the flight period lasted.

The order of the listing follows Forbes (1948, 1954, and 1960) for species within each family, and the order of the families follows Moore (1955). Species marked with an asterisk represent new records for Berrien County, since the publication of Moore's list.

I am indebted to M. C. Nielsen and J. H. Newman for determinations of difficult species.

Table 1. List of moths taken in an ultraviolet light trap at Sawyer, Berrien County, Michigan, 1970-1971.

Species	April 1 2 3	May 1 2 3	June 1 2 3	July 1 2 3	August 1 2 3	Sept. 1 2 3	Oct. 1 2 3
SPHINGIDAE							
Phlegethontius sextus				x	x x		
P. quinquemaculata				x	x		
Pholus satellitia					x		
* *Ceratomia amyntor*			x				
* *C. catalpae*			x x	x	x x		
C. undulosa			x	x x			
Sphinx chersis				x			
S. eremitus				x			

*New record for Berrien County, Michigan.

Table 1. Continued.

Species	April			May			June			July			August			Sept.			Oct.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
SPHINGIDAE (Continued)																					
Lapara bombycoides							x			x											
* *Smerinthus geminatus*								x													
Poanias excaecatus										x	x	x									
P. myops						x					x										
Pachysphinx modesta								x													
* *Deidamia inscripta*					x	x	x														
Darapsa myron							x	x		x	x		x								
SATURNIDAE																					
Automeris io							x	x													
Tropaea luna														x							
Telea polyphemus						x	x			x											
* *Samia cecropia*						x															
CITHERONIIDAE																					
Eacles imperialis											x										
Anisota rubricundra							x	x			x										
SYNTOMIDAE																					
Scepsis fulvicollis							x											x			
* *Ctenucha virginica*							x	x													
ARCTIIDAE																					
* *Cycnia inopinatus*					x								x								
C. tenera							x	x				x									
Estigemene acraea							x	x			x	x									
Halisidota caryae										x	x										
H. maculata								x													
H. tesselaris										x	x										
Eubaphe aurantica														x							
Euchaetias egle							x	x			x										
* *Phragmatobia fuliginosa*										x	x	x	x								
* *Euchaetias oregonensis*							x	x		x		x									
Pyrrharctia isabella						x	x	x													
Spilosoma virginica				x	x	x	x	x			x										
Apantesis virgo												x									
A. anna							x														
A. arge				x						x	x	x						x			
* *A. figurata*						x															
A. phalerata					x	x	x	x													
* *Hyphantria cunea*					x	x		x													
NOCTUIDAE																					
Schinia lynx								x					x	x							
S. trifascia														x							
Rhodophora florida												x	x	x							
* *Heliothis phloxiphagus*								x				x									
* *H. zea*																		x			
Agrotis tesselata										x	x										
A. ypsilon											x										
Peridroma margaritosa		x		x				x			x							x			

*New record for Berrien County, Michigan.

Table 1. Continued.

Species	April			May			June			July			August			Sept.			Oct.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
NOCTUIDAE (Continued)																					
* *P. lubricans*							x	x													
P. plecta						x															
* *Eurois occulta*											x										
Noctua c-nigrum						x	x	x										x			
N. clandestina							x	x													
N. brunneicollis												x									
* *Cerastis tenebrifera*		x		x																	
Scotogramma trifolii				x		x	x				x										
* *Mamestra subjuncta*					x	x	x	x													
* *M. legitima*								x		x											
* *M. lilacina*														x							
* *M. adjuncta*				x	x	x	x	x						x							
* *M. lutra*							x														
M. latex							x	x													
* *Sideridis rosea*						x															
* *Anepia capsularis*								x													
Orthodes crenulata						x	x	x						x							
* *Ceramica picta*							x	x													
* *Crocigrapha normani*					x																
* *Morrisonia evicta*			x	x	x																
* *M. distincta*		x			x																
* *M. confusa*				x	x																
Nephelodes emmedonia																		x			
* *Taeniocampa hibisci*	x	x																			
* *T. garmani*		x																			
Leucania unipuncta		x		x	x													x			
L. albilinea				x	x																
* *L. multilinea*						x	x														
L. pseudargyria							x														
L. commoides											x										
* *L. phragmatidicola*								x		x											
Cucullia asteroides							x							x							
* *Eulotype electilis*		x																			
* *Copivaleria grotei*		x	x																		
* *Lithophane bethunei*		x																			
* *L. antennata*		x																			
* *L. unimoda*		x																			
* *Eupsilia morrisoni*		x																			
Septis cariosa								x													
S. lignicolora							x	x				x									
S. arctica										x	x	x									
S. obscura separans								x													
S. devastator											x	x	x	x							
Apamea velata								x													
* *Apamea americana*										x	x										
* *Papaipema marginidens*														x				x			
* *Luperina passer*								x						x							
Oligia fractilinea											x										

*New record for Berrien County, Michigan.

Table 1. Continued.

Species	April 1	April 2	April 3	May 1	May 2	May 3	June 1	June 2	June 3	July 1	July 2	July 3	August 1	August 2	August 3	Sept. 1	Sept. 2	Sept. 3	Oct. 1	Oct. 2	Oct. 3
NOCTUIDAE (Continued)																					
* *O. bridghami*										x	x										
Arzama obliqua							x	x				x									
* *Euplexia benesimilis*					x		x														
Hyppa xylinoides					x	x								x							
Nedra ramosula	x	x		x	x	x				x											
* *Prodenia ornithogalli*					x						x	x		x							
Ipimorpha pleonectusa											x										
Chytonix palliatricula												x									
Trachea delicata							x	x													
Apatela americana								x				x									
A. dactylina							x	x													
* *A. lepusculina*					x	x		x			x	x									
A. hasta								x													
* *A. clarescens*								x			x	x									
* *A. connecta*						x															
A. impressa												x									
A. oblinata												x	x								
Simyra henrici		x		x	x		x				x										
* *Stibadium spumosum*																	x				
Eudryas unio							x	x						x							
E. grata											x										
* *Callopistria monetifera*													x								
* *Pyrrhia umbra*						x															
Crambodes taldiformis								x													
Amphipyra pyramidoides												x		x							
* *A. tagopoginis*											x										
* *A. glabella*											x	x									
Leuconycta diptheroides							x	x													
* *Balsa melana*					x	x	x														
Ogdoconta cinereola							x				x										
Cerma cerintha							x				x										
Perigea videns					x		x				x										
* *P. xanthoides*							x														
Agriopodes teratophora								x				x									
Erastria albidula												x									
Neoerastria apicosa												x									
* *Eutelia pulcherrima*								x													
* *Marathyssa basalis*					x																
* *Abrostola urentis*								x													
Panthea furcilla											x										
Raphia frater							x	x				x		x							
Charadra deridens					x																
* *Demas propinquilinea*								x													
Plusia falcifera				x	x			x			x						x				
* *P. contexta*							x	x													
P. precationis					x	x	x					x									
P. formosa											x										
* *P. aerea*							x	x					x								

*New record for Berrien County, Michigan.

Table 1. Continued.

Species	April			May			June			July			August			Sept.			Oct.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
NOCTUIDAE (Continued)																					
* *Catocala innubens*													x								
* *C. vidua*																x	x			x	
* *C. nebulosa*													x								
* *C. subnata*													x								
C. neogama													x	x		x					
C. relicta												x		x			x				
* *C. parta*											x										
* *C. briseis*													x								
C. unijuga												x									
C. concumbans											x	x	x		x						
C. amatrix															x						
* *C. coccinata*											x										
C. ultronia											x	x									
* *C. mira*											x	x									
* *C. grynea*											x	x									
* *C. gracilis*											x	x									
C. amica												x	x								
Caenurgia erechthea			x	x	x		x	x			x	x				x					
Zale undularis					x	x	x				x										
Z. lunata												x		x							
Z. lunifera				x			x	x				x		x							
* *Z. unilineata*			x		x																
* *Panopoda carneicosta*											x										
* *Euparthenos nubilis*							x							x							
* *Melipotis jucunda*											x										
Drasteria grandirena							x														
Scoliopteryx libatrix							x														
Scolecocampa liburna											x										
Bomolocha abalienalis								x													
B. baltimoralis								x													
Plusiodonta compressipalpis													x								
Plathypena scabra										x											
Bleptina caradrinalis											x										
NOTODONTIDAE																					
Melalopha apicalis				x	x						x										
Datana ministra								x													
D. perspicua												x									
* *D. contracta*								x		x	x	x									
Gluphysia septentrionalis					x			x			x	x									
* *G. lintneri*	x																				
Ellida caniplaga	x										x	x									
* *Nadata gibbosa*							x				x	x	x								
Peridea angulosa											x		x								
* *Hyperaeschra georgica*						x	x	x			x										
* *Odontosia elegans*								x						x							
Pheosia dimidiata					x	x	x	x				x									
* *Nerice bidentata*					x		x				x	x									
* *Oligocentria lignicolor*											x										

*New record for Berrien County, Michigan.

Table I. Continued.

Species	April			May			June			July			August			Sept.			Oct.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
NOTODONTIDAE (Continued)																					
Schizura unicornis					x						x	x									
S. ipomeae								x			x										
Heterocampa bilineata												x									
Misogada unicolor								x				x		x							
* *Cerura occidentalis*					x		x					x									
C. cinerea							x						x								
THYATIRIDAE																					
Pseudothyatira expultrix								x													
EUPTEROTIDAE																					
Apatelodes torrefacta								x													
LASIOCAMPIDAE																					
* *Malacosoma americana*								x													
Epicnaptera americana		x	x	x							x	x									
GEOMETRIDAE																					
* *Heliomata cycladata*								x													
* *Itame pustularia*										x	x										
* *Semiothisa distribuaria*											x	x									
* *Tornos scolopacinarius*		x		x							x										
* *Anacamptodes humaria*					x		x	x			x	x									
Ectropis crepuscularia			x																		
Epimecis hortaria								x													
Melanolophia signataria					x	x	x	x						x							
* *Lycia cognataria*						x	x	x				x									
* *L. ursaria*		x																			
* *Phigalia titea*		x	x																		
Euchlaena effecta								x													
E. serrata								x		x	x										
* *E. obtusaria*								x													
E. johnsonaria							x	x													
Xanthotype sospeta								x				x		x							
* *X. urticaria*								x				x									
* *Pero honestaria*				x			x							x							
* *Ennomos magnarius*														x							
Metanema inatomaria								x													
Metarrhanthis duaria								x													
M. hypochraria								x													
Apicia confusaria					x		x			x											
Tetracis cachexiata							x	x													
Sabulodes transversata				x	x	x	x	x		x	x					x					
S. thiosaria					x	x	x				x	x	x								
Synchlora aerata								x													
Campaea perlata								x													
Eugonobapta nivosaria											x										
Haematopsis grataria							x									x					
Scopula limboundata								x			x										
* *Triphosa affirmaria*							x	x			x	x									
* *Lygris testata*												x									

*New record for Berrien County, Michigan.

Table 1. Continued.

Species	April			May			June			July			August			Sept.			Oct.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
GEOMETRIDAE (Continued)																					
Percnoptilota centrostrigaria								x													
P. obstipata							x	x			x										
* *Eupithecia ravocostaliata*	x																				
Dyspteris abortivaria								x													
LIMACODIDAE																					
* *Prolimacodes scapha*											x										
* *Cochlidion biguttata*								x													
COSSIDAE																					
* *Prionyxtus robinae*								x													
AEGERIIDAE																					
* *Sylvora acerni*							x	x						x							

*New record for Berrien County, Michigan.

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COVER ILLUSTRATION: THE WELL-DRESSED ENTOMOLOGIST

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This issue's cover illustration is the frontispiece to a classic work of eighteenth-century entomology, Moses Harris' *The Aurelian,* which began to appear in parts in 1758 and was published entire in 1766 (Lisney, 1960). Harris, who was the illustrator as well as the author, pictures the contemporary entomologist with part of his array of collecting equipment. (By tradition, the frontispiece is supposed to be a self-portrait.)

Until relatively recent times, proper style and deportment were more important in the entomologist's choice of collecting costume than the comfort and adaptability to the needs of the field which most of us now demand. When class standing could usually be discerned by clothing and behavior, entomologists who were of the higher classes were expected and naturally wished to dress the part (and most entomologists *were* gentlemen or middle-class persons who affected similar modes of dress, in an age when science was not yet really a popular pursuit). Entomology did not have a broad popular appeal until the mid-nineteenth century, and the prior result, at least as it affected field dress, can be traced in many other illustrated works than *The Aurelian;* a few examples pictured in earlier issues of this journal have been taken from eighteenth and nineteenth-century France (Wilkinson, 1967, 1968, 1969) and nineteenth-century England (Wilkinson, 1966).

Despite obvious shortcomings, at least some benefits were gained from more formal clothing in the field. If servants were not present to carry collecting equipment, some of it could be placed in the very commodious pockets of our ancestors' coats. Especially well formed for this were the "chip-boxes" illustrated in Harris' frontispiece and used for pinning specimens for the journey home; in *The Aurelian* he directs that they should be "lin'd within-side, Top and Bottom with Cork of about a Quarter of an Inch or somewhat less in Thickness, which should be pasted over with White Paper." (Before the days of rapid chemical agents, insects were often pinned into these boxes alive, especially those such as Lepidoptera which would not benefit from being killed in spirits, although as early as the seventeenth century, the English naturalist James Petiver advocated 'pinching' butterflies.)

The clap-net, the usual eighteenth-century English device for capturing flying insects, is illustrated in Harris' frontispiece, one folded in the lap of the seated collector, and another 'in action' at the left. According to Harris, the net could be concealed, "one of the Sticks of which may be used as a Walking-stick, and the other, may be made to take in Half or put to gather at Pleasure, by a Brass Socket in the Middle, and carried convenient . . . in a Canvas Bag under the Coat." The reason is obvious; the eighteenth-century entomologist was as sensitive to the laughter of the uninitiated and the scorn of small boys as many of his later colleagues. The necessity of keeping the net under the coat was not new to Harris' time; when James Petiver's correspondent Jezreel Jones collected at Cadiz in 1701, he wrote that he had been "suspected for one that studys witchcraft, necromancy and a madman" by the natives (British Museum, Sloane MS. 4063, f. 76r).

The use of the collapsible clap-net, so convenient to the entomologist of the eighteenth century, was described by Harris; "On seeing the Insect come flying toward you, you must endeavour to meet it, or lay yourself in its Way, so that it may come rather to the right Side of you, as if you intended to let it pass; then having the Net in your Hands, incline it down to your right Side, turning yourself a little about to the Right, ready for the Stroke; not unlike the Attitude in which a Batman in the game at Cricket stands, when he is ready to strike the Ball, only his Bat is lifted up, but your Nets must incline rather downward: When the Fly is within your Reach, strike at it forcibly, receiving the Fly in the Middle of your Net, as it were between the two Sockets of the Benders, that being the Part of the Net which best receives the Insect; . . . Having closed the Net with the Insect in it, immediately grasp both the Sticks in your left Hand, and with your Right lay hold of the bottom Part of your Net, pulling the Gause

pretty tight, giving that also to the Gripe of the left Hand, this confines your Fly on one Side, and bringing the Top of your Forefinger on his Body, and with your Thumb on the other, squeeze him gently, then lay your Nets on the Ground, and take out your fly by a Horn or a Leg, and holding him in an advantageous Manner by the Body in your left Hand, run a Pin thro' the thick Part of the Body, or Chest, perpendicularly, and put it in your Box."

Despite the onslaught of the bag-net, the clap-net was used by some die-hard traditionalists as late as the end of the nineteenth century. And, there was another sort of folding net, which appealed to the shy Victorian collector and remained in vogue well after 1900; it was an especially designed bag-net which flattened out neatly and in its retracted form looked very much like a closed umbrella. The hesitant entomologist could reach the collecting site in safety, change his supposed umbrella into a net, and disguise the device again for the journey home. The clap-net has apparently perished; diligent searching by a number of investigators has revealed no surviving examples, but two well-preserved folding bag-nets of the umbrella type, with differing handles meant to simulate those of the contemporary umbrella, are in the author's collection of historical apparatus; early examples of such nets are among the rarest of entomological antiques.

The well-dressed entomologist had other ruses to conceal his net. Although a *real* umbrella could hardly be used to collect flying insects, it could be put to good use when beating trees and shrubs (indeed, this was one of the sources of our modern beating tray). The young Raymond Ditmars, who would become a distinguished herpetologist but was then an assistant in entomology at the American Museum of Natural History, attended a field meeting of the New York Entomological Society at which the prominent business man Otto Dientz "was attired in a gray summer suit and looked as well tailored as if he had stepped from a bandbox. That was always the way with Dientz. He could collect all day, flick the dust from his shoes with a handerchief, and look ready to step into a smart hotel lobby.... On all his trips he carried a tan silk umbrella, slipped into a cover which made it look like a cane. Arriving at the area of operation he would open his umbrella, stroll leisurely along a wood road, and coming to certain bushes invert the umbrella, then tap the branches with a stick" (Ditmars, 1932). Banks (1909) pictures an umbrella with a jointed handle, and describes its use in beating.

On the same field trip in the eighteen-nineties, Ditmars noted seemingly netless lepidopterists whisking small nets from their hip pockets. Today, the English firm of Watkins and Doncaster will supply a very convenient bag-net with a socket handle of several inches and a ring of spring steel which will coil neatly (the bag being folded) to fit in the hip pocket. Such nets appeal to some who, like Harris' collector, do not have the aplomb of such entomological showmen as W. J. Holland, whose account of a youthful pursuit of a magnificent *Speyeria diana* (Cramer) past the well-populated windows of a girls' boarding school is familiar from being printed in *The Butterfly Book* (1898), but who demonstrated the same uncanny fearlessness in later years; in *To the River Plate and Back* (1913) he related that at a formal dinner which he attended as one of the honored guests, "the attention of the throng of fashionably dressed ladies and gentlemen was attracted to a large moth, brilliantly colored, which came fluttering about the tables. I slipped into the hall and seized my net, and as the gay insect came by, with a quick stroke captured it; I was greeted with a salvo of applause from the assembled guests." One wonders what the reaction would have been had he missed the moth.

As for dress, at least some concession was allowed as early as 1826, when the fourth volume appeared of Kirby and Spence's *An Introduction to Entomology,* then the standard general work in English. The authors recommended that "the plain fustian jacket with side and other pockets used by English sportsmen will very well suit your purpose; only let the pockets be sufficiently ample." Styles had changed considerably, and one need only see a plate of fashion from the era of Beau Brummell to appreciate the wisdom of Kirby and Spence. The authors thought it necessary to reassure the timorous collector; "With all your implements about you, you will perhaps at first be stared and grinned at by the vulgar; but they will soon become reconciled to you, and regard you no more than your brethren of the angle and of the gun. Things that are

unusual are too often esteemed ridiculous; and the philosopher whose object is to collect and study the wonderful works of his Creator, is often regarded by the ignorant plebeian as little short of a madman." Cold comfort indeed!

As we know from other sources, all collectors did not discard more formal attire for the purposes of the field; an earlier cover illustration (Wilkinson, 1966) provides an example which seems rather extreme by modern standards. And, the tall-hatted entomologist did not fail to improve upon his new appendage. As early as 1690, Petiver suggested that specimens could be carried by pinning them to the hat (Sloane MS. 3332, f. 2r-v); the new commodiousness of that article in the nineteenth century led Kirby and Spence (1826) to hint that "the cavity of a modern hat, if lined with cork, might be made a very useful receptacle for these animals in a long excursion," although considering the possible popular reaction, they could not "recommend such an exhibition in a civilized region." William Swainson (1840) wrote that when in tropical countries the entomologist would often "be compelled to bring home the remainder of his game stuck both on the inside and outside of his hat" when other containers were filled, but by mid-century, collecting dress was rapidly changing, partially due to growing popular participation. There would always be those like Otto Dientz who aimed for well-tailored ideals wherever he went, and many European collectors wear coat and tie in the field today. Most of us have lesser sartorial standards, but perhaps we are at least more comfortable.

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