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The Distribution of Three Broadly Sympatric Species of *Symmerista* Moths (Lepidoptera: Notodontidae) in the Great Lakes and Midwest Regions of the United States.

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THE DISTRIBUTION OF THREE BROADLY SYMPATRIC SPECIES OF *SYMMERISTA* MOTHS (LEPIDOPTERA: NOTODONTIDAE) IN THE GREAT LAKES AND MIDWEST REGIONS OF THE UNITED STATES.

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ABSTRACT

All three superficially inseparable species of *Symmerista* known to occur in eastern North America are sympatric in, and reach their western limit of distribution in, the southern Great Lakes and Midwest Regions of the United States. In this region two of the species also reach their southern limit of distribution (*S. canicosta* reaches its southwestern limit in North Dakota, South Dakota, Missouri, Kentucky, and North Carolina; *S. leucitys* reaches its southwestern limit in North Dakota, Missouri and Kentucky). The third species (*S. albifrons*) reaches its northwestern limit in Michigan and Wisconsin. All three species are here documented from well beyond their previously reported ranges, and distribution maps are provided for them. Diagnostic male abdominal structures are figured. Larvae of *Symmerista* are frequently reported as defoliators of oak (*Quercus*), maple (*Acer*), and other hardwoods.

What began as a simple report on the distribution of *Symmerista* in Michigan and Wisconsin assumed much greater proportions when it became clear that the species are much more widely distributed than previously suspected. Of the five species of *Symmerista* Hübner known to occur in America north of Mexico (Franclemont 1983), two are restricted to the Southwest and are not considered further in this paper; the remaining three species occur only in eastern North America. One or more species may be found virtually anywhere in the eastern United States or southeastern Canada wherever oak (*Quercus*) and/or maple (*Acer*) occurs. All three species are broadly sympatric in the northwestern portion of this region which, although imprecise, for brevity I shall refer to here as the Midwest, comprising (as shown on the accompanying maps) eastern North Dakota and South Dakota, Minnesota south to Arkansas, east through the Great Lakes Region to western Pennsylvania and North Carolina (no specimens have been seen or reported from Iowa or Tennessee). As a genus, the adult moths are easily recognized and commonly figured (Holland 1903: pl. 39, fig. 7; Covell, 1984: pl. 43, fig. 2). However, adults are so similar in appearance that they can not be reliably identified without examination of genitalia, although the diagnostic characters can frequently be observed without completely dissecting the abdomen. Franclemont (1948) has provided a key for distinguishing the larvae.

Judging from number of publications, interest in *Symmerista* seems to be greater than for most other notodontids, perhaps because their larvae can be

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conspicuous defoliators of deciduous forest trees, particularly during outbreaks; all three species feed on oak, and two of the species (*S. albifrons*, *S. canicosta*) are jointly referred to as the "redhumped oakworm." The larva of the third species, *S. leucitys*, called the "orangehumped mapleworm," is the only one of the three whose common name is "official" (Stoetzel 1989). In Minnesota, and doubtless elsewhere, *S. canicosta* and *S. leucitys* are members of a caterpillar guild (the "fall defoliator group") that favors oak in most areas of that state, but which are reported to a lesser extent on a variety of other hardwoods (Anonymous 1971, Anonymous 1972: 17–20). Other members of this oak-feeding guild are reported to be a saturniid, the orangestriped oakworm, *Anisota senatoria* (J. E. Smith), and three other notodontids: variable oakleaf caterpillar, *Lochmaeus manteo* Doubleday; yellownecked caterpillar, *Datana ministra* (Drury); and *Oligocentria lignicolor* (Walker). *Symmerista* larvae have been the subject of numerous economic bulletins, pamphlets, and reports, including those by Erickson et al. (1972), Hitchcock (1961), Millers and Erickson (1970), and Millers and Wallner (1975)—the larval "feculae" (frass) have even been the object of scrutiny (Hodson and Brooks 1956, Weiss and Boyd 1950)!

Identification of eastern *Symmerista* posed no difficulty for 150 years—only *S. albifrons* was known. But differences in the larvae led Franclemont (1946) to review the genus, resulting in the discovery that what had been called *S. albifrons* actually consisted of three species, two of which he described as new (*S. canicosta*, *S. leucitys*). Since two, or all three, of the species can be sympatric in a given area, most records of adult *S. albifrons* published before 1946 are necessarily suspect, as are subsequent identifications made without examination of the genitalia. Without adequate comparative material, even genitalic examination has led to misidentifications, partly due to variability in the shape of the last sternite of the male abdomen, and perhaps partly because of an unfortunate error in labeling the figures of the male genitalia in the most widely-used identification manual for the genus (Franclemont, 1948), where the captions for the aedeagi of *S. canicosta* and *S. leucitys* are transposed: the bottom row of figures labeled 222a-g as *canicosta* are actually *leucitys*, while those in the second row labeled 221a-c as *leucitys* belong to *canicosta*, a mistake that has only recently been noted by Riotte (1992). I re-illustrate these diagnostic structures here (Figs. 4–20).

This study began in the late 1960s, when I began compiling distributional data for Michigan *Symmerista* after a genitalic survey disclosed that all three species occur in that State. A recent paper on the Lepidoptera of Michigan's Beaver Island Archipelago (Profant 1991), which reported only one species of *Symmerista* from a region where Voss (1983) and I had found all three, prompted the resumption and expansion of this study.

As an example of the confused documentation of the distribution of this genus, Moore (1955) reported two species of *Symmerista* in Michigan but overlooked *S. leucitys*, the most widely distributed species in the state. Newman and Nielsen (1973) partly rectified this by publishing the data for specimens of the two Franclemont species I had identified in the Michigan State University collection, leaving unresolved the proper identity of specimens that Moore had treated as *S. albifrons* (mostly in the University of Michigan Museum of Zoology). The present study is based solely on the more than 500 specimens whose genitalia I personally examined (with three exceptions noted below), most of which were males, because they are usually more readily identified than females. In some cases, records are based on females from disjunct or peripheral localities from which no males were available, and these are noted in the text. Males (especially *leucitys*) may usually be reliably identified by the shape of the last abdominal sternite (Figs. 4–6); in *canicosta* and *albifrons* the supposed differences are frequently inconclusive, and in all such

doubtful instances I examined the aedeagus, which is diagnostic (Figs. 7–20). Females (except *canicosta*) require a complete dissection for accurate identification. The only records included in this study that I did not personally confirm (open circles on maps) are identifications based on genitalic examination from Ohio (Eric Metzler, pers. comm.), Illinois (Cashatt and Godfrey 1990), and paratype localities cited by Franclemont (1946). Sources of material examined include the Harold M. Bower collection of Wisconsin Lepidoptera in LACM, and a number of public and private collections cited in Acknowledgments, where an explanation of abbreviations will be found.

In the species accounts below, all counties mentioned are represented on the distribution maps (with one exception); for the sake of brevity, complete specimen data are given only for species that are at or near the periphery of their range as understood and reported here. Unless noted otherwise, the "General Distribution" and "Larval Hostplant" data for each species are from Franclemont (1946, 1948). States, and counties within states (in capital letters), are arranged alphabetically.

SYMMERISTA ALBIFRONS (J.E. Smith, 1797) (Figs. 1, 4, 7–10)

General Distribution: the most widely distributed species, previously reported from Nova Scotia to Florida, west to Illinois, Kansas, and Texas; new records reported here extend this range north and west.

Larval Hostplant: oak (*Quercus* spp.).

Midwestern Distribution. In the Midwest this is a southern species that reaches its northern limit in Ohio, Michigan, Wisconsin, and Missouri.

ARKANSAS (JRH): MADISON, WASHINGTON.

ILLINOIS (INHS): ADAMS, CHAMPAIGN, COOK, DOUGLAS, DU PAGE, HANCOCK, JACKSON, JERSEY, MARSHALL, MCDONOUGH, MCHENRY, MCLEAN, PEORIA, POPE, PUTNAM, SHELBY, WINNEBAGO.

INDIANA: PARKE: Turkey Run State Park, 31 May 1951, R.H. Leuschner (1 male, RHL; flying with *S. leucitys*).

KENTUCKY (ULK, UMSP): BELL, CARTER, HARLAN, JEFFERSON, MEADE, MENIFEE, MORGAN, OLDHAM, PERRY, POWELL, WHITLEY.

MICHIGAN: Northern Lower Peninsula: CHARLEVOIX: Beaver Island, 8–30 July, 1925–1926, S. Moore (4 males, 2 females, UMMZ). CHEBOYGAN: Burt Lake, 26 June 1936, Max Peet (1 male, UMMZ). NEWAYGO: Ramona, 28 June 1927, Carl F. Krueger collection (1 male, LACM). Southern Lower Peninsula: BERRIEN: Harbert, 3 June 1918, W.W. Newcomb (1 male, MSUE). LENAWEE: Morenci-Mulberry Rd., 18 Aug. 1961, M.C. Nielsen (1 male, MCN). ST. JOSEPH: T7S, R12W, Sec. 8, 13 Aug. 1971, M.C. Nielsen (1 male, MCN); T7S, R12W, Sec. 18, 11 Aug. 1972, M.C. Nielsen (1 male, MCN). This is the least common species in the state (only these 12 specimens examined). Recent collections of Michigan *Symmerista* should be carefully examined to determine if *S. albifrons* is a permanent resident of the State, or whether these old records represent extirpated populations.

MISSOURI (JRH): ATCHISON, BARRY, BENTON, CAPE GIRARDEAU, CEDAR, CLINTON, FRANKLIN, JACKSON, JOHNSON, LACLEDE, LAWRENCE, RANDOLPH, WASHINGTON, WAYNE.

OHIO (OSL): ASHTABULA, ATHENS, COLUMBIANA, CUYAHOGA/LAKE, FRANKLIN, GEAUGA, LICKING, MAHONING, MEIGS, MONTGOMERY, PORTAGE, SCIOTO, VINTON.

WISCONSIN: DOOR: Bailey's Harbor, 3 July 1958, Wm. E. Sieker (1

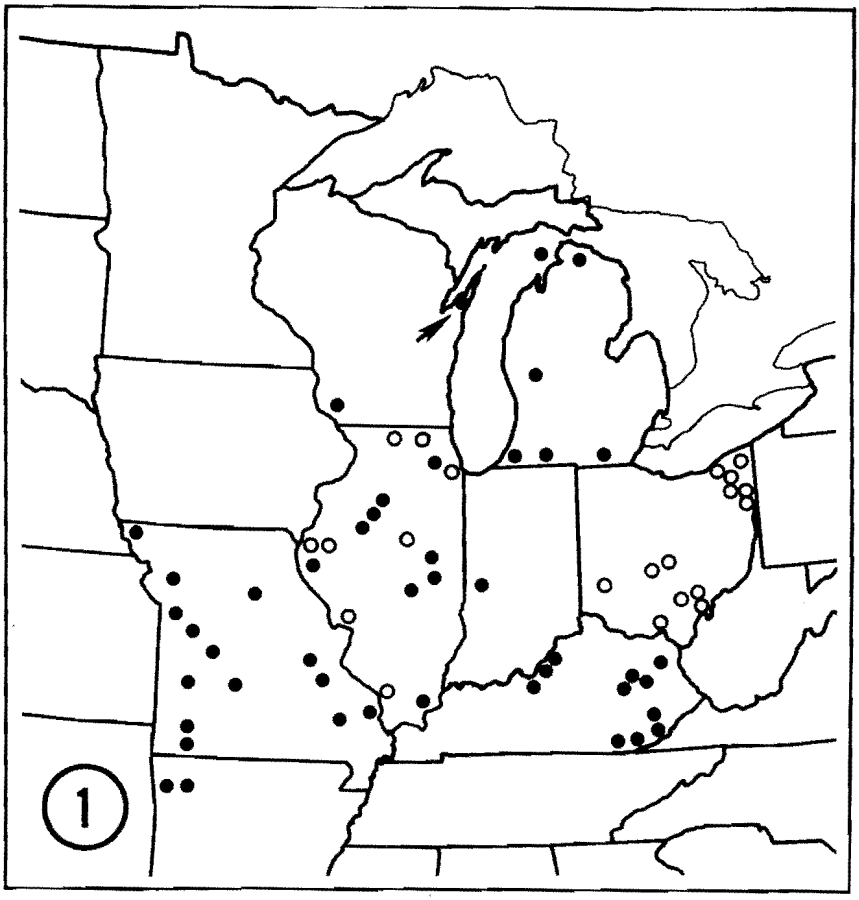


Figure 1. Distribution of *Symmerista albifrons* in the Midwest; solid circles represent specific county records based on specimens examined for this study, open circles are records from published or unpublished sources believed to be reliable.

male, LACM). GRANT: 7 Aug. 1987, Les Ferge (1 male, LAF). These are the northwesternmost localities for the species; the single Door Co. specimen was among a series of 16 male *S leucitys* bearing the same data.

SYMMERISTA CANICOSTA Franclemont, 1946 (Figs. 2, 5, 11–13)

General Distribution: Previously known from Nova Scotia to Virginia, west to Manitoba and Minnesota; new records reported here extend this range considerably to the southwest.

Larval Hostplants ("redhumped oakworm"): oak (*Quercus* spp.), maple (*Acer* spp.), rarely beech (*Fagus grandifolia*). Occasional outbreaks cause

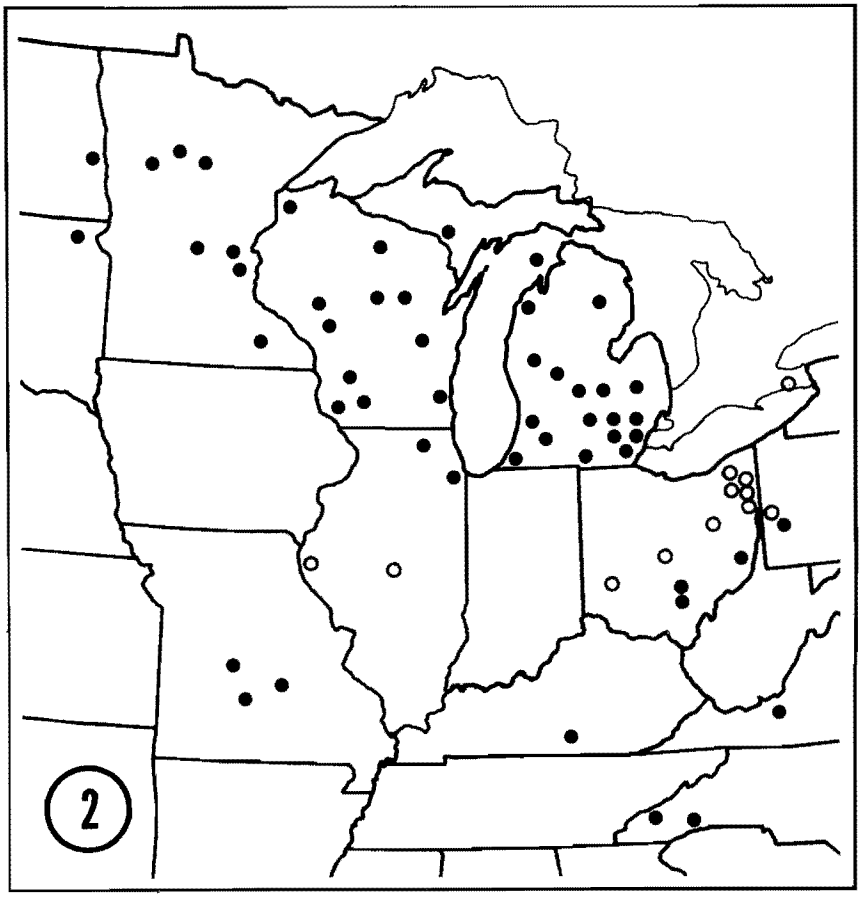


Figure 2. Distribution of *Symmerista canicosta* in the Midwest; solid circles represent specific county records based on specimens examined for this study, open circles are records from published or unpublished sources believed to be reliable.

severe defoliation of bur oak (*Quercus macrocarpa*) in Manitoba (Ives & Wong, 1988: 132–133; figs 64c (larva), h (adult), & j (defoliation)).

Midwest Distribution: a northern species that reaches its southwestern limits in North Dakota, South Dakota, Missouri, Kentucky, and North Carolina.

ILLINOIS (INHS): ADAMS, COOK, MACON (paratypes), MCHENRY.

KENTUCKY: RUSSELL: Lake Cumberland State Park, 9 & 11 June 1980, Carl C. Cornett (2 males, ULK).

MICHIGAN (MCN, MSUE, UMMZ): Upper Peninsula: DICKINSON. Northern Lower Peninsula: BENZIE, CHARLEVOIX (Beaver Island), OSCODA. Southern Lower Peninsula: ALLEGAN, BERRIEN, CLINTON, HILLSDALE, INGHAM, KALAMAZOO, LAPEER, LIVINGSTON, MON-

ROE, MONTCALM, NEWAYGO, OAKLAND, OTTAWA [not mapped], SHIAWASSEE, WASHTENAW, WAYNE. This is the most frequently collected *Symmerista* in Michigan.

MINNESOTA (NDSU, UMSP): ANOKA, BECKER, CASS, CLEARWATER, OLMSTED, RAMSEY, STEARNS.

MISSOURI: LACLEDE: 3 mi [4.8 km] SE of Stoutland, north of county road T, mixed deciduous forest, 31 July 1976, taken at UV light, J.R. Heitzman (1 female, JRH). MORGAN: on Lake of the Ozarks south of Stover on 112, 24 July 1982, coll. at blacklight, J.R. Heitzman (1 female, JRH). PHELPS: Lane Spring Rec. site, deciduous forest along Little Piney River, 21 July 1987, at blacklight, J.R. Heitzman (1 female, JRH).

NORTH CAROLINA: HENDERSON: Bat Cave, 9 June 1969, C.V. Covell, Jr. (1 male, ULK). SWAIN: Cherokee, Cherokee Shopping Center, 31 July 1973, L. Koehn (2 males, ULK). These are the southernmost specimens of the species ever reported.

NORTH DAKOTA: CASS: Fargo, 22 June 1900 (1 female, UMSP).

OHIO (OSL, MPM, MSUE, RHL): BELMONT, COLUMBIANA, FRANKLIN, GEAUGA, HOCKING, HOLMES, MAHONING, MONTGOMERY, PORTAGE, TRUMBULL, VINTON.

PENNSYLVANIA: ALLEGHENY, BEAVER (paratypes).

SOUTH DAKOTA: MARSHALL-ROBERTS County line: Sieche Hollow State Park, 12 mi [19 km] NW Sisseton, elev. 1750 ft [533 m.], 16 June 1969, George L. Godfrey (2 females, INHS); Godfrey (pers. comm.) offers that this record "...may be from the absolute, westernmost limit of the species' distribution, unless the species has managed to locate the population of bur oak [*Quercus macrocarpa*] that grows in Aberdeen, about 80 miles [130 km] to the west."

VIRGINIA: MONTGOMERY: Blacksburg, 17 June 1963, C.V. Covell, Jr. (1 male, ULK).

WISCONSIN (LACM, LAF, MPM): CLAIRE, DOUGLAS, GRANT, IOWA, JACKSON, MARATHON, MILWAUKEE, ONEIDA, RICHLAND, SHAWANO, WINNEBAGO. W.E. Miller (unpublished notes) adds WASHBURN County (not mapped) to the preceding, based on the examination of male genitalia of specimens in the University of Wisconsin collection.

SYMMERISTA LEUCITYS Franclemont, 1946 (Figs. 3, 6, 14–20)

General Distribution: Previously reported from Maine, New York, Pennsylvania, southern Quebec, southern Ontario, and Minnesota; the most limited distribution of the three species, but reported here from much farther south than previously known.

Larval Hostplants ("orangehumped mapleworm"): principally sugar maple (*Acer saccharum*), but also reported on several other deciduous trees (Allen, 1979), including oak.

Midwest Distribution: a northern species that reaches its western limit in North Dakota, and its southwestern limit in Missouri, Illinois, Kentucky, and West Virginia.

ILLINOIS: PUTNAM: 4 July 1952, M.O. Glenn (1 female, INHS); VERMILION: Forest Glen Co. Pres., T18N, R11W, Sec. 24, ex larva on *Fagus grandifolia* coll. 9 Aug. 1987, emgd. 19 June 1988, S. Passoa (1 male, INHS); same data, emgd. 11 June 1988 (2 females, INHS).

INDIANA: PARKE: Turkey Run State Park, 31 May 1951, R.H. Leuschner (1 male, RHL; flying with *S. albifrons*).

KENTUCKY: BARREN: Barren River State Park, 17 May 1977, Carl C.

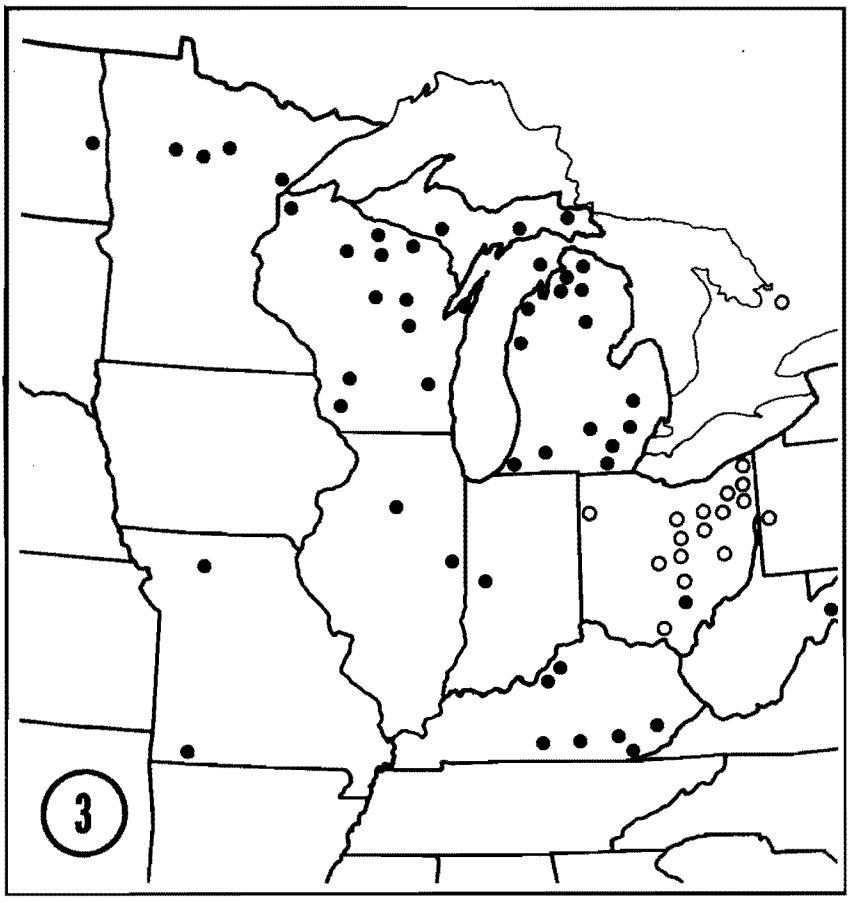
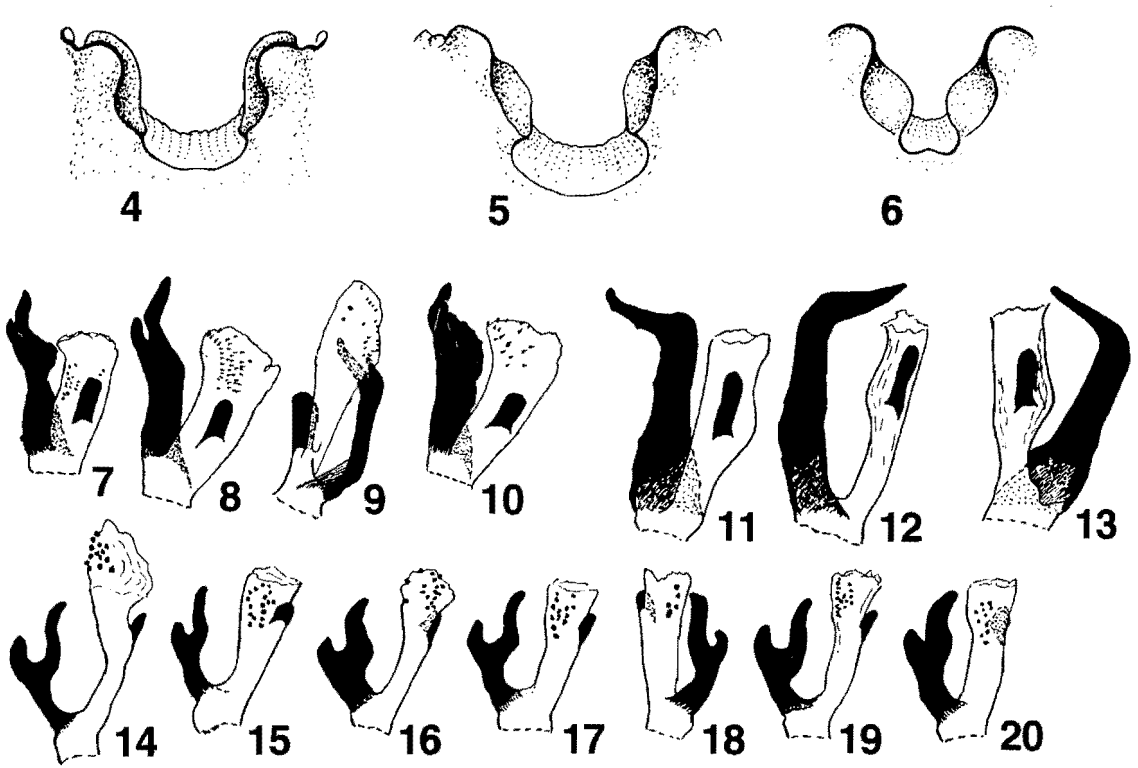


Figure 3. Distribution of *Symmerista leucitys* in the Midwest; solid circles represent specific county records based on specimens examined for this study, open circles are records from published or unpublished sources believed to be reliable.

Cornett (1 male, ULK). BELL: Pine Mountain State Park, 7 June 1979, Carl C. Cornett (1 male, ULK). LAUREL: Bald Rock, 11 June 1978, R.W. Meluch (1 male, MSUE). JEFFERSON: Valley Station, 20 & 26 April; 3, 10, & 18 June; 6 Oct. 1974–1975, Siegfried Scholz (8 males, ULK). OLDHAM: Cov. Br. Boy Scout Resv., 16 June 1976, C.V. Covell, Jr. (1 male, ULK). PERRY: Buckhorn State Park, 8 June 1972, Carl C. Cornett (1 male, ULK). RUSSELL: Lake Cumberland State Park, 10 June 1980, Carl C. Cornett (1 male, ULK).

MICHIGAN (MCN, MSUE, UMMZ): Upper Peninsula: CHIPPEWA, DICKINSON, SCHOOLCRAFT. Northern Lower Peninsula: ANTRIM, BENZIE, CHARLEVOIX (Beaver & High Islands), CHEBOYGAN, OTSEGO, ROSCOMMON. Southern Lower Peninsula: BERRIEN, INGHAM, KALAMAZOO, LAPEER, LENAWEE, MASON, OAKLAND,



Figures 4–20. Male abdominal structures of eastern *Symmerista* species. Figures 4–6: ventral view of last abdominal sternite: 4, *S. albifrons*; 5, *S. canicosta*; 6, *S. leucitys*. Figures 7–20: aedeagi, various orientations (large modified process is on ventral side, small simple process is on dorsal side): 7–10, *S. albifrons*; 11–13, *S. canicosta*; 14–20, *S. leucitys*. Note that in *S. albifrons* the apex of the large bilobed process greatly exceeds the apex of the small simple process; in *S. leucitys* the two apexes are subequal. Figures 4–6 drawn by Tina Ross, Figures 7–20 reproduced from Forbes (1948, Figs. 220a-d, 221a-c, 222 a-g).

WASHTENAW. This species is more frequently collected in the northern parts of the state.

MINNESOTA: CASS: Cass Lake, 18 June 1934, A.A. Granovsky (2 males, UMSP); Pillager (2 reared males, UMSP). CLEARWATER: Itasca Park (several specimens, including a series reared from basswood, elm, and birch by L.W. Orr in 1933-1934, UMSP). ITASCA: Wabana Lake, 15 & 22 June 1978, R. Bartelt (2 males, UMSP). ST. LOUIS: Duluth (no further data, 1 female, INHS).

MISSOURI: BARRY: Roaring River State Park, Ozark Plateau flora, 11 June 1980, J.R. Heitzman (1 female, JRH). GRUNDY: Crowder State Park, marsh & deciduous forest, 25 June 1980, field collected by J.R. Heitzman (2 males, JRH).

NORTH DAKOTA: CASS: Fargo, Red River of [the] North, 22 June 1961, Robert Poole Card No. 925 (1 female, NDSU).

OHIO (OSL, MSUE, RHL): ASHTABULA, FRANKLIN, GUERNSEY, HOCKING, HOLMES, KNOX, LICKING, MAHONING, PAULDING, PORTAGE, RICHLAND, SCIOTO, STARK, TRUMBULL, VINTON, WAYNE.

PENNSYLVANIA: BEAVER (paratypes).

WEST VIRGINIA: HARDY: Lost River State Park, 4-6 July 1980, S.E. Miller (1 male, LACM).

WISCONSIN (LACM, LAF, MPM): DOOR, DOUGLAS, FLORENCE, GRANT, MARATHON, ONEIDA, PRICE, RICHLAND, SHAWANO, WASHINGTON, WAUPACA. W.E. Miller (unpublished notes) adds WASHBURN County (not mapped) to the preceding, based on the examination of male genitalia of specimens in the University of Wisconsin collection.

ACKNOWLEDGMENTS

I am grateful to Eric H. Metzler and The Ohio Department of Natural Resources, Division of Wildlife, for generously providing records from the Ohio Survey of Lepidoptera database; these records are based on examination of male genitalia, and I have accepted them without question (all Ohio records indicated by open circles on the maps). George L. Godfrey kindly provided a copy of an unpublished report on Illinois Lepidoptera (Cashatt & Godfrey 1990), and subsequently allowed me to personally confirm the identity of most of the specimens on which that report was based. William E. Miller not only arranged for the loan and gift of specimens, but turned over to me a voluminous file that included the unpublished results of his own study of the genus as well as that of the late L.W. Orr; that file is now housed at LACM. Two of the private collections examined are especially noteworthy: Les Ferge's Wisconsin moth survey has documented for the first time the occurrence of all three species in that state, while Richard Heitzman's collection revealed the unexpected occurrence of two species far to the southwest of their previously known range. My thanks to Tina Ross for drawings of the sternites, Caryl Maloof and Jane Herwegh for graphics assistance, and Brian Harris for technical support. Eric Metzler, M.C. Nielsen, William E. Miller, and an anonymous reviewer made many valuable suggestions on various drafts of this paper. Early portions of this study were undertaken at Michigan State University where I was a National Science Foundation Graduate Fellow, which support is gratefully acknowledged.

To all who cooperated in this study, as listed below, my deepest gratitude (institutional abbreviations follow, for the most part, Heppner and Lamas, 1982): **INHS**—Illinois Natural History Survey (G.L. Godfrey, K.R. Methven);

JRH–J. R. Heitzman collection; **LACM**–Natural History Museum of Los Angeles County; **LAF**–Leslie A. Ferge collection; **MCN**–M.C. Nielsen collection; **MPM**–Milwaukee Public Museum (S.S. Borkin); **MSUE**–Michigan State University Entomology Museum (M.C. Nielsen and the late R.L. Fischer); **NDSU**–North Dakota State University (D. Cuthrell); **OSL**–Ohio Survey of Lepidoptera (E.H. Metzler and The Ohio Department of Natural Resources, Division of Wildlife); **RHL**–R.H. Leuschner collection; **ULK**–University of Louisville (C.V. Covell, Jr.); **UMMZ**–University of Michigan Museum of Zoology (T. E. Moore); **UMSP**–University of Minnesota Insect Collection (W.E. Miller, P.J. Clausen).

LITERATURE CITED

Anonymous. 1971. Late season broadleaf defoliators. For. Pest Newsletter 8: 2 p. Minnesota Dept. Agric., Div. Plant Industry.

Anonymous. 1972. 1972 Forest Pest Report. 50 p. Minnesota Dept. Agric., Div. Plant Industry.

Allen, D. C. 1979. Observations on biology and natural control of the orangehumped mapleworm, *Symmerista leucitys* (Lepidoptera: Notodontidae), in New York. Canad. Entomol. 111:703–708.

Cashatt, E. D. and G. L. Godfrey. 1990. Database of Illinois Lepidoptera, Phase II. Ill. Nat. Hist. Survey Tech. Report 1990 (3): 239 p. [Project NGW895 Report prepared for Illinois Nongame Wildlife Conservation Fund, Division of Natural Heritage, Illinois Department of Conservation; unpublished.]

Covell, C. V., Jr. 1984. A Field Guide to the Moths of Eastern North America. Houghton Mifflin Co., Boston. xv + 496 p., 64 pls., 76 figs.

Erickson, G., A. Hastings and H. Toko. 1972. Oak defoliation on the Manistee N.F. and adjacent forest lands in lower Michigan–1972. U.S. Dept. Agric., For. Serv., Rept. S-72-7: 2 p., 3 maps.

Franclemont, J. G. 1946. A revision of the species of *Symmerista* Hübner known to occur north of the Mexican border (Lepidoptera, Notodontidae). Canad. Entomol. 78:96–103.

_____. 1948. *Symmerista*, pp. 222–224. *In*: W.T.M. Forbes, Lepidoptera of New York and Neighboring States, Part II: Cornell Univ. Agric. Exp. Sta. Memoir 274.

_____. 1983. Notodontidae, pp. 112–114. *In*: Hodges, Ronald W., et al., eds., Check List of the Lepidoptera of America North of Mexico. E.W. Classey Ltd. & Wedge Entomological Research Foundation.

Heppner, J. B. and G. Lamas. 1982. Acronyms for world museum collections of insects, with an emphasis on Neotropical Lepidoptera. Bull. Entomol. Soc. Amer. 28: 305–315.

Hitchcock, S. 1961. Caterpillars on oaks. Conn. Agric. Exp. Sta., Bull. 641: 15 p., 14 figs.

Hodson, A. C. and M. A. Brooks. 1956. The frass of certain defoliators of forest trees in the North Central United States and Canada. Canad. Entomol. 88:62–68.

Holland, W. J. 1903. The Moth Book, a popular guide to a knowledge of the moths of North America. Doubleday, Page & Company, New York. xxiv + 479 p., 48 pls., 263 figs.

Ives, W. G. H. and H. R. Wong. 1988. Tree and shrub insects of the prairie provinces. Canadian Forestry Service, Northern Forestry Centre, Information Report NOR-X-292: xi + 327 p., 117 figs.

Millers, I. and G. Erickson. 1970. Oak defoliation on the Manistee National Forest–1970. U.S. Dept. Agric., For. Serv., Rept. S-70-8: 2 p., 1 map.

Millers, I. and W. E. Wallner. 1975. The redhumped oakworm. U.S. Dept. Agric., For. Serv., Forest Pest Leaflet 153: 6 p., 3 figs.

Moore, S. 1955. An annotated list of the moths of Michigan exclusive of Tineoidea (Lepidoptera). Univ. Mich. Mus. Zool. Misc. Publ. 88:1–87.

Newman, J. H. and M. C. Nielsen. 1973. Moth species new to Michigan. Great Lakes Entomol. 6:33–45.

Profant, D. 1991. An annotated checklist of the Lepidoptera of the Beaver Island Archipelago, Lake Michigan. Great Lakes Entomol. 24:85–97.

Riotte, J. C. E. 1992. Annotated list of Ontario Lepidoptera. Roy. Ontario Mus. Misc. Publ. Life Sci.: viii + 208 p., 3 figs., 1 table.

Stoetzel, M. B. 1989. Common Names of Insects and Related Organisms 1989. Entomological Society of America, Lanham, MD. 199 p.

Voss, E. G. 1983. Moths of the Douglas Lake region (Emmet and Cheboygan Counties), Michigan: III. Thyatiridae, Drepanidae, Lasiocampidae, Notodontidae, Lymantriidae (Lepidoptera). Great Lakes Entomol. 16:131–137.

Weiss, H. B. and W. M. Boyd. 1950. Insect feculae. J. New York Entomol. Soc. 58:154–168, 54 figs.