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LIGHT TRAP RECORDS OF *PHYLLOPHAGA* (COLEOPTERA: SCARABAEIDAE) IN WISCONSIN, 1984-1987Robert A. Dahl and Daniel L. Mahr¹**ABSTRACT**

Phyllophaga adults (June beetles) were surveyed from 1984 through 1987 at five locations in Wisconsin using blacklight traps. Data were collected at each location for three consecutive years. A total of 9,259 specimens representing 13 species were collected during the survey. Species captured, sex ratios, and flight periods for abundant species were recorded for each location. Species abundance differed from previous surveys of *Phyllophaga* in Wisconsin. Possible reasons for observed shifts in species abundance are discussed.

Phyllophaga larvae (white grubs) feed upon the roots of turfgrasses and other desirable plants, whereas adults (June beetles) feed on the foliage of trees and shrubs. In Wisconsin, most *Phyllophaga* are thought to have a three year life cycle, spending most of it as larvae in the soil (Luginbill and Painter 1953). Much is known about adult host plant preferences (Forbes 1916, Travis 1933, Ritcher 1940, Chamberlin et al. 1943), but although Ritcher (1940) made some general observations on white grub hosts in Kentucky, the host relationships of *Phyllophaga* larvae are poorly understood.

Since the last study of Wisconsin *Phyllophaga* (Chamberlin et al. 1943), agricultural practices and land use patterns have changed considerably. Major differences include increased use of persistent and non-persistent soil insecticides, modified weed control practices, increased irrigation in some areas, adoption of crop rotation, shifts in pasture forage species, adjustments in fertilization practices, and escalating suburbanization. These and other alterations in land use could seriously impact the species composition of the soil insect fauna, including white grubs.

Changes in the species complex of *Phyllophaga* within a region may be a reflection of modifications in larval and/or adult habitats. Proximity to adult host plants and soil moisture are two major factors influencing *Phyllophaga* populations (Forbes 1916, Sweetman 1931).

Light traps are commonly used to survey or monitor *Phyllophaga* adults (Sanders and Fracker 1916, Forbes 1916, Travis 1933, Henry and Heit 1940, Neiswander 1963, Lim et al. 1979). This paper reports a light trap study in Wisconsin which surveyed the species of *Phyllophaga* and their relative abundance at five different locations in the state. Goals of the study were to: (1) examine for species shifts since earlier studies and (2) analyze for possible periodicity in adult emergence. Additionally, we review the brood theory concept as it relates to *Phyllophaga* yearly abundance.

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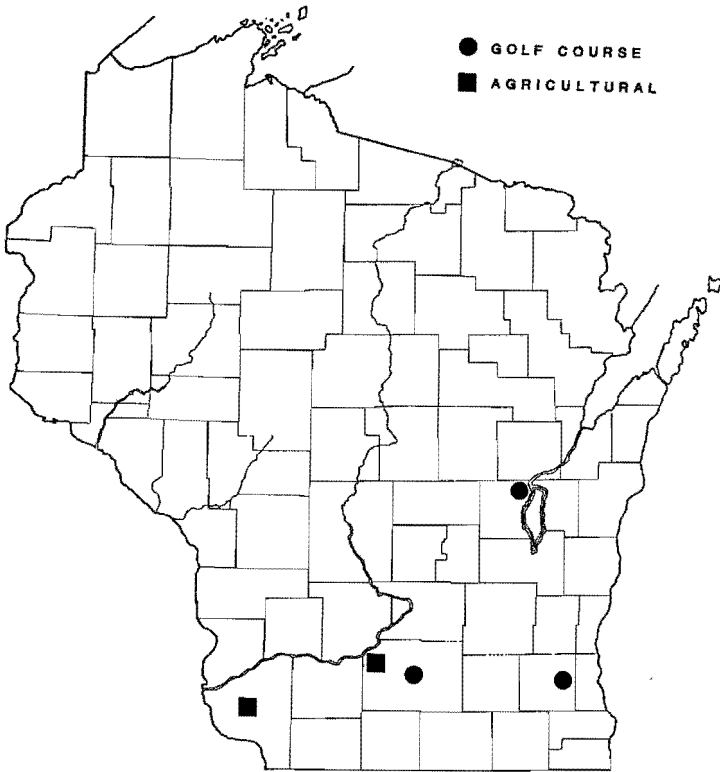


Figure 1. Location of blacklight traps for surveying *Phyllophaga* spp. adults in Wisconsin (1984-87).

MATERIALS AND METHODS

Four-baffled blacklight traps (Ellisco Inc. cat. no. 110103-2) equipped with ultra-violet fluorescent bulbs (18" Norelco 15 watt bulb F15 T8/BL) were used to monitor *Phyllophaga* adults at five locations in Wisconsin from 1984 to 1987. Three consecutive years of trapping were conducted at each location. From 1984 through 1986, single traps were operated continuously from mid-April to mid-July on each of three suburban golf courses in Madison, Brookfield, and Menasha (Figure 1). From 1985 through 1987, two traps were operated in Mazomanie and Lancaster, agricultural locations in the southern part of the state. A dichlorvos-impregnated strip in the collecting pan of each trap killed the trapped insects.

Trap catches were collected weekly, placed in labeled paper bags and stored in a refrigerator until processed. *Phyllophaga* were sorted according to species, sexed and counted. Identification of species was according to the keys of Luginbill and Painter (1953). Voucher specimens from this study are deposited in the Insect Research Collection, Department of Entomology, University of Wisconsin, Madison.

RESULTS AND DISCUSSION

Species Collected

Thirteen species and 9,259 specimens of *Phyllophaga* were collected during the four years of the study (Table 1). All 13 species had been previously recorded for Wisconsin although previous studies recorded greater diversity of *Phyllophaga* than our study. For example, Sanders and Fracker (1916) collected 17 species at five Wisconsin collection sites with light traps whereas Chamberlin et al. (1943) collected 19 species at 39 different locations in Wisconsin by handpicking beetles from host plants at night. Data from Iowa (Travis 1933) and northern Illinois (Forbes 1916) also showed greater diversity of *Phyllophaga* than our study. The lower species diversity observed in our study may have been due in part to the restricted number of habitats associated with our survey locations.

The most commonly collected species in our study was *P. futilis* LeConte, which accounted for 71% of the total. The Madison sites surveyed previously (Sanders and Fracker 1916) and during our study show differences in species abundance. *P. rugosa* Melsheimer and *P. fusca* Froelich comprised 99% of the June beetles collected by Sanders and Fracker (1916) at Madison but in our study, *P. futilis* and *P. anxia* LeConte collectively accounted for 87% of the June beetles captured in Madison. Conversely, *P. rugosa* and *P. fusca* represented only 5.9% of our total and *P. futilis* and *P. anxia* constituted <1% of the total caught by Sanders and Fracker (1916). Several reasons may explain the difference in species abundance between our study and that of Sanders and Fracker (1916). First, it is highly probable that our light trap locations within Madison differed from those of the 1916 study. Second, the type of adult host trees and their proximity to light traps may have influenced the array of *Phyllophaga* species caught (e.g. Forbes 1916). Most importantly, significant changes in land use patterns have occurred in Madison over the 70 years between studies and it is likely that habitats of larvae and/or adults were altered during this time. Our Madison location was on a golf course adjacent to the University of Wisconsin Arboretum, a vegetationally diverse area where many native Wisconsin plant communities are recreated on one tract of land. However, data from a light trap on another golf course in the Madison area showed the same two most abundant *Phyllophaga* species (*P. futilis* and *P. anxia*) for a two year period (1985 and 1986) (unpublished). The most abundant species at each location in our study, except Mazomanie, was *P. futilis* (Table 1). The most abundant species at the Mazomanie location was *P. implicita* Horn. Each location had a different species complex and only three species were common to all five trap locations. Shenefelt and Simkover (1951) found that the *Phyllophaga* species composition differed greatly between localities and concluded that these differences were a manifestation of the environmental conditions under which the insects exist (e.g. edaphic factors).

Sex Ratios of *Phyllophaga* Taken at Light Traps

Sex ratios for the most abundant species in the present study, given as the fraction of males, are as follows: *P. anxia* 0.88 (n = 75); *P. crenulata* Froelich 0.97 (n = 62); *P. fusca* 0.76 (n = 71); *P. futilis* 0.94 (n = 6214); *P. gracilis* Burmeister 0.75 (n = 16); *P. hirticula* 0.89 (n = 28); *P. implicita* 0.52 (n = 1423); *P. rugosa* 0.90 (n = 919). Generally, light traps capture more male *Phyllophaga* than females (e.g. Travis 1933, Lim et al. 1979) although some studies report differing results concerning sex ratios for certain species. For example, in three light trap studies involving *P. anxia*, Morofsky (1933) collected more females than males while Neiswander (1963) and Sanders and Fracker (1916) collected more males than females. In our study *P. anxia* captures were male biased. Only *P. implicita* had a nearly equal sex ratio and reasons for this were not apparent. Several factors could contribute to differences in sex ratios using light traps. For example, differences in flight habits and differential phototaxis (wavelength of light used in trap) among the sexes are two factors which could affect sex ratios.

Table 1. *Phyllophaga* spp. beetles collected at light traps in Wisconsin, 1984-1987.

<i>Phyllophaga</i> species	BROOKFIELD			MADISON			MENASHA			MAZOMANIE			LANCASTER		
	1984	1985	1986	1984	1985	1986	1984	1985	1986	1985	1986	1987	1985	1986	1987
<i>futilis</i>	196	129	119	98	306	30	487	1046	345	358	3	0	1291	220	1944
<i>rugosa</i>	4	9	8	0	27	1	3	30	40	79	1	9	640	2	145
<i>anxia</i>	0	1	1	9	20	22	0	7	1	11	2	1	0	0	0
<i>fusca</i>	0	1	0	5	0	0	0	0	0	8	0	3	26	5	25
<i>implicita</i>	0	0	1	1	5	0	0	0	1	103	271	977	15	5	44
<i>crenulata</i>	0	0	0	14	4	6	0	0	0	8	11	15	0	0	4
<i>tristis</i>	0	0	1	1	2	1	0	0	0	0	0	0	0	0	0
<i>hirticula</i>	0	0	0	0	0	0	0	0	0	0	0	0	10	0	18
<i>balia</i>	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0
<i>gracilis</i>	0	0	0	0	0	0	0	0	0	2	0	14	0	0	0
<i>inversa</i>	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
<i>forsteri</i>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>prunina</i>	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
total	200	140	130	130	365	60	490	1083	387	571	288	1020	1983	232	2180

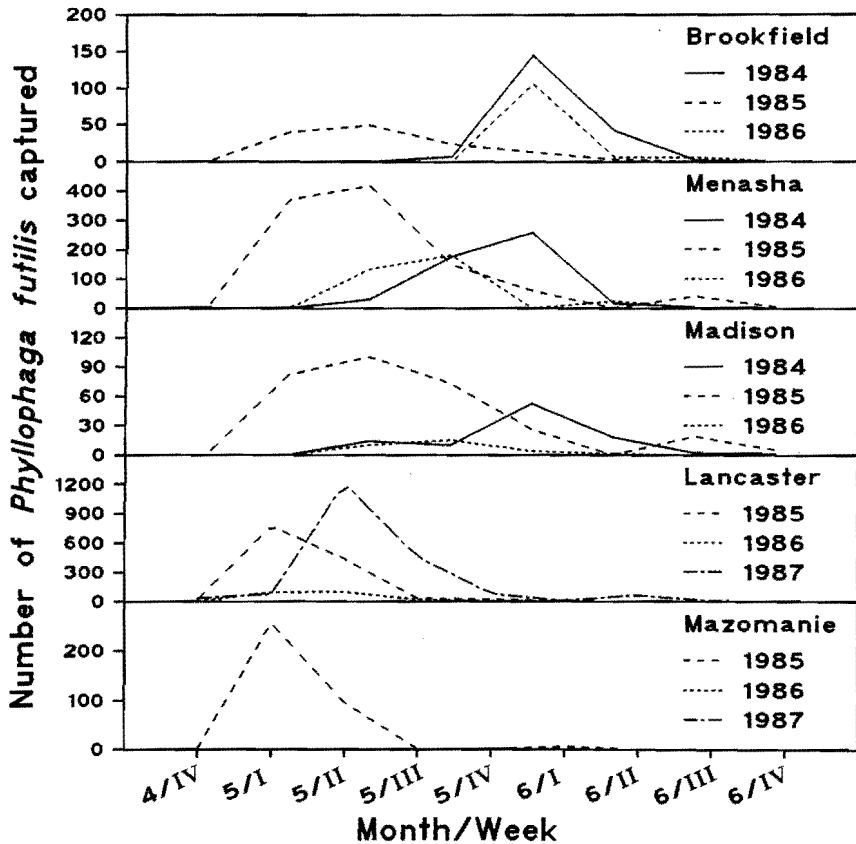


Figure 2. Number of *Phyllophaga futilis* beetles caught per week at light trap locations in Wisconsin, 1985-1987.

Seasonal Flight Periods and Yearly Trap Results

The three most abundant *Phyllophaga* species in our study were *P. futilis*, *P. implicita*, and *P. rugosa*. Other *Phyllophaga* species (Table 1) were not well represented and are not discussed. The three most abundant species have similar adult seasonal activity periods. The fourth week of April through the end of June brackets the period of highest activity of adult *Phyllophaga* species. Many environmental factors (such as soil moisture and temperature, air temperature, and local rain fall patterns) potentially influence developmental rate or flight activity. Such factors could result in different flight periods for a species in areas of close proximity. For example, in 1985 Mazomanie and Lancaster had similar flight activity periods for *P. futilis* (Fig. 2) while the activity periods for *P. implicita* in 1987 at the same two locations were quite different (Fig. 3).

Peak captures of *P. futilis* in 1984 occurred during the same time period for the three golf course locations (Fig. 2). In 1985 all trap locations had earlier flight activity of *P. futilis* than other years; the two agricultural locations had earlier peak flights than the three golf course sites (Fig. 2). Flight activity of *P. futilis* in 1986 was

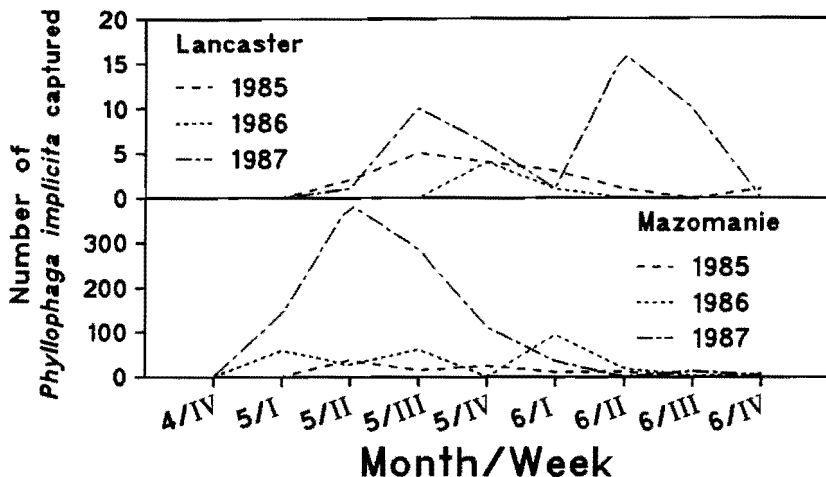


Figure 3. Number of *Phyllophaga implicita* beetles caught per week at light trap locations in Wisconsin, 1985–1987.

more variable temporally than the previous two years. Both agricultural locations had low numbers of *P. futilis* captured in 1986. Total *P. futilis* collected at all sites was lowest in 1986, except at Mazomanie (Table 1). In 1987, Lancaster had the largest capture of *P. futilis* for any year or location, whereas Mazomanie had no *P. futilis* captured in 1987, the lowest for any year at any location during the study.

Abundance of *P. rugosa* was greatest in 1985 at all sites except Menasha (Table 1). Captures were very small in 1984 and 1986 at all locations, Menasha excluded. Captures differed substantially in 1987 between Mazomanie and Lancaster. The total capture of *P. rugosa* at Lancaster in 1987 was substantially greater than at Mazomanie (Fig. 4).

Seasonal flight periods were similar for *P. rugosa* at Brookfield and Menasha in 1984 (Fig. 4). In 1985, seasonal flight periods were earlier than 1984 (for Brookfield and Menasha) and similar for all locations except Mazomanie which peaked later (Fig. 4). Peak flight periods in 1986 were similar among the golf course locations and 1987 peak flight periods were similar between the two agricultural locations (Fig. 4).

P. implicita was collected at all five sites but was well represented only at the two agricultural locations (Table 1). More *P. implicita* were captured yearly at Mazomanie than at Lancaster, and Mazomanie trap catches increased with each year of trapping (Table 1). Peak captures of *P. implicita* were generally earlier at Mazomanie for a given year (Fig. 3). Although *P. implicita* was captured mainly at the agricultural locations, the total number captured represented >15% of the 9,259 beetles collected.

The Brood Theory in *Phyllophaga*

Several authors have alluded to a three year synchronous life-cycle (“broods”) for *Phyllophaga* (Neiswander 1963, Hammond 1954, Ritcher 1940). The idea of synchronous and periodic emergence of June beetles may have originated from European work. For example, Forbes (1916) briefly mentioned a European origin for forecasting white grub outbreaks but lists no references. Unfortunately the notion of synchronicity with respect to *Phyllophaga* populations has been perpetuated without sound data. Neiswander (1963) claimed that entomologists have “essentially

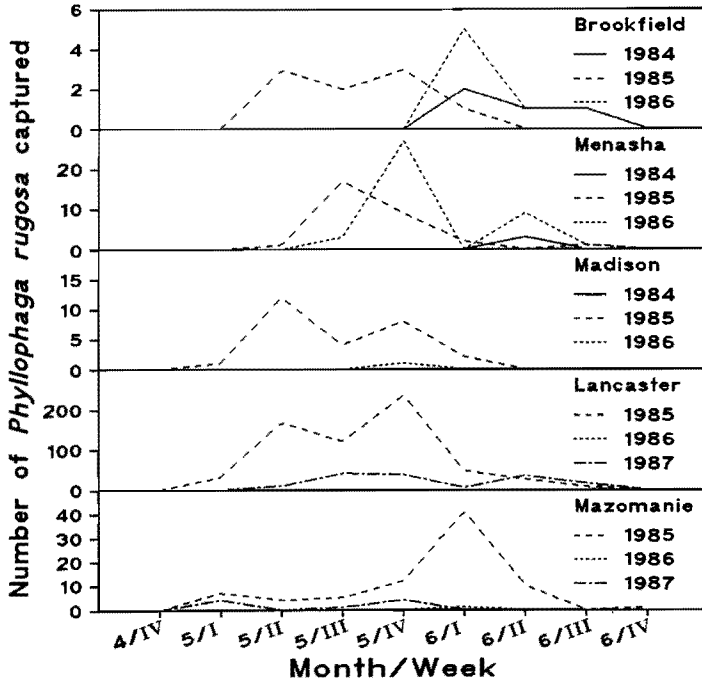


Figure 4. Number of *Phyllophaga rugosa* beetles caught per week at light trap locations in Wisconsin, 1984–1986.

accepted the early alignment of broods without subsequent study of populations." The life cycles of *Phyllophaga* species generally exhibit a periodicity of two to four years but individuals of the same species may differ greatly (e.g. Davis 1916). Determination of life cycle length in *Phyllophaga* is complex; the interplay of temperature, food quality and quantity, soil conditions and larval population density may all be involved. In particular, cumulative seasonal soil temperatures can have a strong influence on developmental time. For instance, Davis (1916) found *P. drakii* Kirby to have a three year life cycle at Lafayette, Indiana and a four year life cycle at Trout Lake, in northern Wisconsin. Furthermore, he pointed out that the combined seasonal temperatures in Lafayette for three years were approximately the same as for four years at Trout Lake. Additionally, Shenefelt and Simkover (1951) found *P. tristis* Fabricius to have a two year life cycle in central Wisconsin but a one year life cycle at the same latitude in Michigan. Michigan's more moderate climate may account for the shorter life cycle. The roles of food quality and larval density are more difficult to assess. These factors could, separately or together, account for differences in life cycle length for individuals of the same species in the same location. Lloyd and White (1976) proposed that *Magicicada* species might emerge four years early with crowding of early instar nymphs. These factors make prediction of destructive broods difficult except on a very local basis.

Mahr (1984) predicted that 1986 would be a major flight year for *P. rugosa* in Wisconsin. No trap location in this study supported that prediction. Although the Menasha location had the largest capture of *P. rugosa* in 1986, the total was fairly insignificant and *P. rugosa* was not the most abundant species in any year. The literature shows discrepancies in major flight years and relative abundance for a given

species in different areas (Forbes 1916, Sanders and Fracker 1916). It is therefore difficult, if not impossible, to compare results of different studies in predicting *Phyllophaga* outbreaks, even in the same locale. In some areas a shift in the most abundant brood can occur over several years (Neiswander 1963). The supposition that most June beetles have synchronous life cycles appears to be a dubious generality on a regional basis. In restricted geographical areas populations of *Phyllophaga* may be temporarily synchronous due to localized environmental conditions. However, it is likely that this synchronicity breaks down through time and the concept should not be extrapolated on a larger geographical or temporal scale.

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