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THE TERRESTRIAL ISOPOD *HYLONISCUS RIPARIUS* (ISOPODA: ONISCIDEA: TRICHONISCIDAE) IN WISCONSIN

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ABSTRACT

We examined seasonal reproductive patterns for the terrestrial isopod *Hyloniscus riparius* in Wisconsin. Samples collected from habitats in three Wisconsin regions were compared with regard to the reproductive status of population members. We also recorded differences in sex ratio and stage of female gravidity in all samples. Males were a minority in all samples. Southern samples showed the greatest reproductive capacity based on the proportion of females that were found to be gravid.

Hyloniscus riparius (Koch 1838), a European species not native to the Nearctic, has been reported from Michigan, Newfoundland, New York, North Carolina and Pennsylvania (Jass and Klausmeier 2000), as well as Wisconsin. The first report of *H. riparius* from Wisconsin was from a survey of the terrestrial isopods at the University of Wisconsin-Milwaukee Field Station in Ozaukee County (Jass and Klausmeier 1987). In the Field Station Upland Woods, *H. riparius* was found in association with *Trachelipus rathkii* (Brandt 1833). Along the boardwalk in the adjacent Cedarburg Bog, it was found with *T. rathkii* and *Trichoniscus pusillus* Brandt 1833.

Our collections of *H. riparius* from Wisconsin between 1987 and 1998 showed that its habitats can be grouped into three categories: shorelines, damp woodland soils, and quarries. Common to all Wisconsin collection sites for *H. riparius* is the high moisture content of the ground. *Hyloniscus riparius* has been found in damp sites such as lakeshores and river banks, and in damp microhabitats such as the water seeps from rocks in a quarry.

This isopod quickly desiccates and expires when removed from its habitat and placed in an empty collecting container. Two factors account for this susceptibility in *H. riparius*. One is its exceptionally small size and the other is that it lacks pseudotracheae ("humidity chambers" for oxygen exchange) on its abdominal pleopods, which in other terrestrial isopods act to conserve body moisture. Thus it is more strictly confined to moist habitats than some other terrestrial isopod species.

Few studies exist documenting the seasonal cycles of terrestrial isopods in North America. Hatchett (1947) studied the life histories of four Michigan species under laboratory conditions and also recorded size frequencies, sex ratios and gravidity for a population of one of them, *Cylisticus convexus* (DeGeer 1778), in the field from June through August. In Wisconsin, we have previously conducted field studies of the seasonal cycles for populations of *Porcellio spinicornis* Say 1818 (Jass et al. 1991) and *T. rathkii* (Jass and Klausmeier 1996). For terrestrial isopods in temperate climates, the majority of individuals have been found to live slightly longer than one year (as in McQueen's 1976 combined field and laboratory study of *P. spinicornis* in Ontario), with young adults from the prior season mating and giving birth to the next generation during their second summer. In this study we collected samples of *H. riparius* in order to describe its seasonal cycle in Wisconsin.

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MATERIALS AND METHODS

Between 1987 and 1998 we collected *H. riparius* from 37 Wisconsin counties (Fig. 1), indicating that the range for this species in the state includes portions each of the three ecological regions of Curtis (1959). We used our general collection data from Wisconsin to select sites for a more intensive study of the life cycle of *H. riparius*, choosing for further study those locations that had yielded larger numbers of specimens in the past (Table 1).

We gathered 18 samples from 13 June through 7 November 1997, 6 from each of the three ecological regions: the northern, the southern, and the intervening tension zone as defined by Curtis (1959) (Fig. 1). At least 30 individuals of *H. riparius* were gathered at each sampling. Samples were collected with aspirators, preserved in the field in 70% ethanol, and taken to the laboratory for sorting under a dissecting microscope. Adult males were identified as individuals having pleopods modified for transfer of sperm and females as those having a marsupium. All collections are maintained at the Milwaukee Public Museum.

A series of samples taken throughout the growing season can be analyzed to describe the annual reproductive pattern for a particular isopod species. This is done by noting the percent of gravid females in the samples and following the timing of development of embryos from eggs to young. The developmental process takes place inside the female's marsupium and can be seen through the oostegites (transparent overlapping body flaps) that form the marsupial cavity on the ventral surface of the thorax. This allows further classification of gravid females into two subgroups, those whose broods are still at the egg/embryo stage and those whose broods have developed to the manca stage. When the embryo develops to the stage in which it closely resembles a miniature adult, it has been termed a "manca" (Holdich et al. 1984). Mancas are active inside the marsupium for at least several days before they become independent. Immatures are whitish immediately after exiting the marsupium and undergo several molts in the process of gradually maturing to display the external sexual characters and wine-red coloration of adults (Heeley 1942). Because of the impossibility of accurately identifying and sexing such individuals, the results of our field studies refer to adults only.

RESULTS

In each of six populations we sampled in 1997, males comprised less than 45% of the population (Table 2). The percentage of males from all 18 samples was low, averaging 27.2%. Our northern samples had a significantly higher proportion of males (mean = 34.7%) than did southern samples (mean = 24.5%) ($\chi^2 = 10.60$, $P < 0.001$, df = 1) (SAS 1985). The mean for tension zone males was 22.4%, intermediate in value but not statistically significantly different from means for the other zones.

All samples showed a reproductive cycle that displayed a definite pattern of differences across the season in Wisconsin. June through August was the period in which the highest frequency of gravid females was found in all three regions of Wisconsin. Reproductive activity was significantly less after September. No samples from October had any gravid females.

Our 1997 collections suggested that the reproductive period of *H. riparius* is shorter and more concentrated north of the tension zone in Wisconsin than it is in, or south of, the tension zone (Table 2). Females with mancas were found only in the August sample from one of the northern populations, whereas mancas were found from June through September in more southerly populations. Because the females in our samples from the Brown County population consisted almost entirely of non-reproductive individuals, this had a strong effect on the overall totals for the northern region.

Table 1. Collection sites for *Hyloniscus riparius* in 1997. Regions are as defined by Curtis (1959).

Collection dates	**County**	**Location**
Wisconsin Northern Hardwoods Province		
13 Jun, 1 Aug, 3 Oct	Ozaukee	UWM Field Station Upland Woods
11 Jul, 5 Sep, 7 Nov	Brown	Bayshore Park
Wisconsin Tension Zone		
20 Jun, 8 Aug, 3 Oct	Fond du Lac	Kettle Moraine Noyes Woods
18 Jul, 12 Sep, 07 Nov	Milwaukee	Saint Francis Seminary Woods
Wisconsin Southern Prairie-Forest Province		
27 Jun, 31 Aug, 17 Oct	Green	New Glarus State Park Woods
25 Jul, 12 Sep, 7 Nov	Racine	Karcher Marsh Wildlife Area

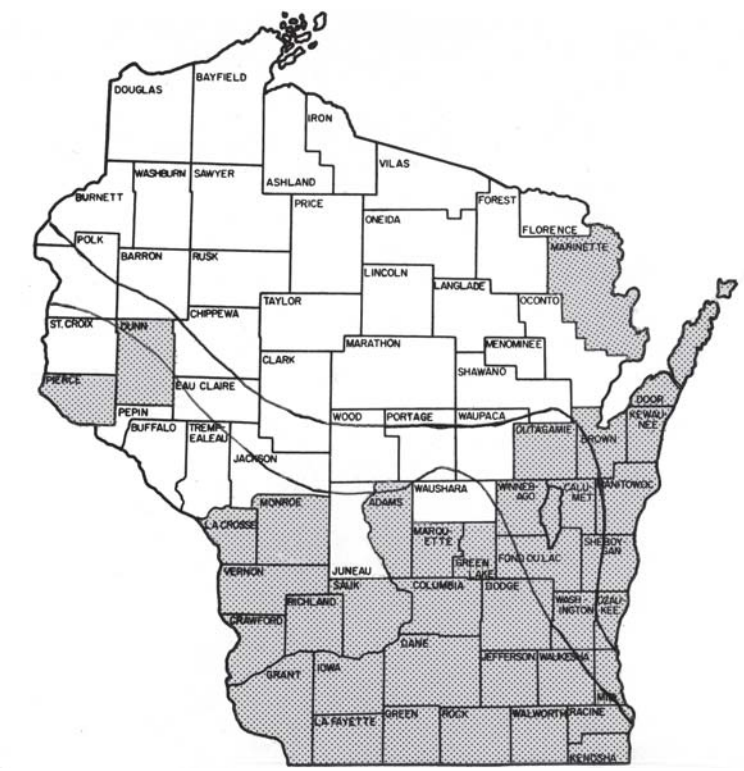

Figure 1. Shading indicates the Wisconsin counties from which *Hyloniscus riparius* was collected 1987 - 1998. The map depicts Curtis' (1959) northern and southern ecological regions and the tension zone between them.

Table 2. Collections of *Hyloniscus riparius* adults in 1997, with percent of the total that were male, percent of females that were gravid, and percent of gravid females that were carrying mancas rather than embryos.

	JUN	JUL	AUG	SEP	OCT	NOV
Northern Wisconsin						
Total number of individuals	56	70	37	68	64	81
% Male	26.8	32.9	29.7	38.2	43.8	37.0
% Females gravid	43.9	0	34.6	2.4	0	0
% Gravid females with mancas	0	0	11.1	0	0	0
Tension Zone						
Total number of individuals	59	32	50	123	104	73
% Male	27.1	15.6	18.0	28.5	29.8	15.1
% Females gravid	27.9	48.1	43.9	10.2	0	0
% Gravid females with mancas	0	7.7	5.6	11.1	0	0
Southern Wisconsin						
Total number of individuals	48	52	67	84	45	55
% Male	22.9	21.2	28.4	22.6	35.6	16.4
% Females gravid	40.5	9.8	35.4	9.2	0	6.5
% Gravid females with mancas	26.7	25.0	0	50.0	0	0

Four other terrestrial isopods were associated with *H. riparius* in our 1997 collections: *C. convexus*, *Miktoniscus medcofi* (Van Name 1940), *P. spinicornis* and *T. rathkii*.

DISCUSSION

We found *H. riparius* in a fairly wide range of sites, as defined either by features of the landscape (such as lakeshore, river bank, quarry, gravel pit, garden) or dominant vegetation (floodplain/upland forest, deciduous/mixed deciduous and coniferous forest, native plants/introduced species). The most important factor shared by all of these sites is high soil moisture. Vandel (1960) called *H. riparius* "epigean" to define its microhabitat among the loose soil beneath dead leaves, mosses, and woody debris. Using the Brower and Zar (1977) qualitative categorization of soil moisture content, we consistently found *H. riparius* at the moist to wet end of the scale, where the wetness can be felt and soil adheres to the hand during collecting.

Schultz (1965) discussed the North American distribution and general biology of *H. riparius*, and described a North Carolina population with data collected in June and September. In fall he found a large number of very small individuals, too immature for the development of external sexual traits. Schultz (1965) identified these as the members of the next generation, which would not mature until the following season, a size class distinctly separate from even the smallest members (body lengths of about 2 mm) of the current generation. While we did not count members of this very small size class, we did note a large number of tiny whitish immature isopods in our September sampling. Among the matures he measured, Schultz (1965) found that the smaller individuals were males and that females outnumbered males in all collections, the male-female ratio being 1:2.

Males were also a minority in all of our Wisconsin samples, averaging 27.2% of all the isopods collected. Our two northern populations had a higher proportion of males than the more southerly samples. Our studies of the terrestrial isopod *T. rathkii* (Jass and Klausmeier 1996) showed a similar statistically significant difference between the proportions of males in northern and southern Wisconsin, with females dominating southern populations to a greater degree than northern ones. In that species we were able to correlate the different sex ratios with a significantly decreased reproductive capacity in the north in terms of gravidity. Interestingly, the greatest percentage of *H. riparius* males occurred in October in both north and south samples.

An important difference between *T. rathkii* and a less surface-active species like *H. riparius* is the extension of the breeding season of the latter into autumn. For terrestrial isopods in temperate climates, Dangerfield and Telford (1990) hypothesized that the less surface-active the species, the weaker would be the tie between the timing of its reproductive cycle and environmental cues such as day length. The occurrence of a strong August-September increase in reproductive activity in *H. riparius* was described as typical by Schultz (1965) and was seen in the preliminary data reported for this species by Jass and Klausmeier (1996). In contrast, for *T. rathkii* we found that southern populations had their reproductive peak in June (76.9% of females gravid) and northern populations in July (91.9% of females gravid), followed by drastic reductions in the proportion of females gravid in both the north and south in August (<5%) and none after that. For *H. riparius* we found high percentages of females with embryos in all three August 1997 samples (Table 2).

There was a rather abrupt end to the *H. riparius* reproductive season after the release of the last maturing mancas in September. In only one sample, from the southernmost region, was there any reproductive activity at all later in the season (6.5% females gravid in November).

Sutton (1972) showed that increasing cold triggered a change in isopod behavior. He found that freezing temperatures in the field caused an increase in terrestrial isopod activity and resulted in migration away from the surface layers. Perhaps the only individuals that will survive to begin the reproductive cycle again the following spring are those that have descended far enough into the lower levels of the soil to find sufficient protection to withstand the extreme temperatures of winter. Our focus has been on the reproductive portion of the life history of *H. riparius*, and we recognize that many other aspects, such as over wintering, remain to be elucidated by further research.

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