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## Life History Strategies of Some Nearctic Agabini (Coleoptera, Dytiscidae)

by W.L. Hilsenhoff

**Abstract:** All species of *Ilybius* in Wisconsin overwintered as third instar larvae in aquatic sites and to a lesser degree as adults in terrestrial sites, with pupation and emergence in late spring. Two lotic and one lentic *Agabus* species had life cycles similar to *Ilybius*. The remaining species of lentic *Agabus* all overwintered as adults and mated and oviposited in the spring, some very early while ice still covered the ponds and others much later in the season. Two lotic species, *Agabus seriatus* and *semivittatus* had a life cycle similar to most lentic *Agabus* but did not pupate and emerge until late summer or autumn. *Agabus erichsoni* overwintered as an egg as well as an adult, a phenomenon that may also occur in some other *Agabus*.

**Key words:** Coleoptera Dytiscidae – *Agabus*, *Ilybius* – life cycles – biology – overwintering – emergence – habitats.

I will confine my remarks to *Agabus* and *Ilybius*, the only genera of Agabini that occur in Wisconsin and the western Great Lakes region. At least 8 of the 17 known nearctic *Ilybius* occur in this region along with at least 25 of the 80 or more species of *Agabus* described from North America. Most species of *Agabus* and *Ilybius* are arctic, subarctic or boreal, with only a few occurring south to the southern United States.

A revision of *Ilybius* in North America would be welcome. In 1939, WALLIS attempted to clarify the identification of *Ilybius* by providing a new key and for the first time including females in the key. He also provided notes on identification in an effort to eliminate some of the confusion that resulted from FALL's 1927 paper, but a revision with detailed descriptions and distributional data is needed. Except for larvae of holarctic species described in Europe, the larvae remain unknown, with no published description of any species from North America.

The *Agabus* of North America were last revised in 1922 by FALL, but due to the work of Hugh B. Leech the species in this genus seem to be better known than those of *Ilybius*. In 1938 LEECH developed a key to nearctic *Agabus* as part of his M. S. Thesis, and he has generously provided updated copies of this key to entomologists who have expressed an interest in the genus. Since then he has also published descriptions of several new species and clarified the status of others. Larvae of

*Agabus* in North America remain almost unknown with only 6 of the species having been described (WATTS, 1970; JAMES, 1970, HILSENHOFF, 1974) in addition to larvae of holarctic species described from Europe.

LARSON's study of the Dytiscidae of Alberta (1975) is the most significant recent contribution to our knowledge of North American *Agabus* and *Ilybius*. In addition to providing detailed descriptions of several species, he also included valuable notes on habitat and life history.

I became interested in life histories of Agabini after Bryn Tracy and I had studied beetle populations in McKenna Pond for several years. In this 0.8 ha pond west of Madison, Wisconsin we found that almost all Dytiscidae overwintered as adults, either in the pond or in alternative aquatic or terrestrial sites. Almost all species that used the pond as a breeding site mated, laid eggs in April or May, and died, with larvae of many dytiscid species present from April to July. Life histories of many of the Agabini did not seem to conform to this general pattern, and I decided to investigate further.

Because the larvae of most North American Agabini are unknown I have had to base my studies of life histories mostly on the occurrence of adults and teneral adults (Tab. 1). I did, however, develop a key to larvae I have collected in Wisconsin, and although I was able to distinguish 15 species of *Agabus* and 5 species of *Ilybius*, I can be certain of the identity of only those species that have been reared.

Life histories of all the *Ilybius* in Wisconsin appear to be the same. They overwinter as third instar larvae, pupate mostly in May, and emerge in very late May or June. Adults apparently mate and oviposit in July and August. Adults of the most common species, *angustior*, *biguttulus*, *denikei*, *discedens*, *fraterculus* and *pleuriticus*, were collected mostly in June, July and August, with 97% of the teneral adults being found in June. A few adults were collected in May (1.1%) and as late as early October (0.5%), but by September populations had always declined greatly. Larvae of 5 species were found from September into the first few days of May, and the larva is apparently the primary overwintering stage in all of our species. Although most adults probably die after mating and oviposition, some do overwinter in terrestrial sites as reported by GALEWSKI (1964) and fly back to ponds in May. LARSON (1975) collected mature adults in spring and I have collected mature adults of 6 species in early May. Do these overwintering adults mate and oviposit, and if so did they also mate and oviposit the previous summer? Or, is it possible that all beetles that emerge in early summer do not mate that year but wait until the following year?

All of the *Ilybius* breed in lentic habitats, but larvae of at least two species have also been collected from streams and spring ponds. I believe that these are the larvae of *biguttulus* and *pleuriticus* because adults of these species also frequented lotic habitats.

Adults of all species of *Agabus* in Wisconsin apparently overwinter in aquatic habitats. Three of the species, *confusus*, *semivittatus*, and *seriatus*, are strictly lotic as larvae and adults, inhabiting streams, springs and spring ponds. In *Agabus confusus* the larvae as well as the adults overwinter, and the life cycle appears to be identical to that described for *Ilybius*. The evidence indicates that *Agabus seriatus* and *semivittatus*, however, overwinter only as an adult and mate and oviposit in the spring or summer. Larvae of *seriatus* were present from May through August, and I collected newly emerged adults from August through October. Most *semivittatus* adults were collected in early spring and the only teneral adult was collected November 8. A fourth species, *Agabus ambiguus*, also apparently develops in streams, springs, and especially in spring ponds, but the adults may be found in a variety of lentic habitats as well as in the lotic habitats in which they breed. Some larvae of *ambiguus* overwinter and apparently pupate in April or May, while others that were collected throughout the summer into early August are probably the progeny of overwintering adults. Teneral adults were collected in April, June, August and September.

The other 17 species of *Agabus* that I have collected are strictly lentic and are only rarely encountered in lotic or semilotic situations. None of their larvae exhibit lotic tendencies. Only one of these species, *Agabus disintegratus*, has a life cycle similar to that of *Ilybius*, with overwintering larvae that pupate in spring. A second species, *Agabus erichsoni*, inhabits vernal ponds and overwinters primarily as an egg. This was documented by JAMES (1970) who described the larva and life history in detail. Overwintering adults oviposit in early June, but the eggs do not hatch until the bottom of the pond thaws the following spring. Development of larvae is completed in late May, with teneral adults present in late June and July. I have collected numerous adults in June and July, but none after August 10, which corroborates James' contention that the adults aestivate. Unanswered is the question of whether new adults mate and oviposit in July, or whether all of them wait until the following spring.

I suspect most of the remaining *Agabus* overwinter in Wisconsin only as adults, mating and laying eggs in spring. Some species overwinter in a variety of habitats and then fly to their breeding sites early

Species	March	April	May	June	July	August	September	October	November
<i>Agabus ambiguus</i>	48	57(1)	13	8(1)		6(1)	7(2)	10	22
<i>A. antennatus</i>	27	253	40	29(13)	6	1	68	31	11
<i>A. anthracinus</i>		187	30	56(8)	14(4)	6(1)	5	14	1
<i>A. bicolor</i>		1	1	10(2)	1(1)				
<i>A. bifarius</i>	1	41	7	30(4)	5(4)				
<i>A. discolor</i>				18		1	2	1	
<i>A. disintegratus</i>	1	4	1	14(1)			4	2	7
<i>A. erichsoni</i>		3	2	41(10)	17(6)	1			
<i>A. falli</i>	3	13							
<i>A. phaeopterus</i>		2	4	23(9)	2		1		
<i>A. punctulatus</i>	23	60	11	9(5)				1	2
<i>A. semipunctatus</i>	4	102	2	3	2				
<i>A. semivittatus</i>	18	13	2	5	1	1		1	4(3)
<i>A. seriatus</i>	24	56	34	25	3	13(3)	1	14(4)	46
<i>A. subfuscatus</i>		3	6	67(14)	6	1	5		1
<i>Ilybius angustior</i>			2	7(2)	9		3		
<i>I. biguttulus</i>			7	40(10)	24(1)	46(1)	59	4	
<i>I. discedens</i>			3	28(2)	3	2			
<i>I. fraterculus</i>			1	561(54)	157	37	27	9	
<i>I. pleuriticus</i>			1	6(5)	3	8	1		

Tab. 1: Numbers of most common *Agabus* and *Ilybius* species collected in Wisconsin, with number of teneral specimens in parenthesis.

in May. These species include *anthracinus*, *bifarius*, and *semipunctatus*. All of these species appear to breed mostly in swamps and bogs, with pupation and emergence in late June or July. Adults of all of them are most commonly collected in early spring before they fly to their breeding sites. After July I have only infrequently collected *anthracinus* and have never collected *bifarius* or *semipunctatus*, which suggests that they aestivate in late summer before flying to overwintering sites in September or early October.

Three other species, *antennatus*, *falli* and *punctulatus* overwinter and breed in open ponds that contain numerous sedges and grasses. They mate and oviposit very early in the spring, often when ice still covers most of the pond. LARSON (1975) recorded *punctulatus* copulating on the ice. All three of these species probably complete development and pupate in late May or early June, with several teneral *antennatus* and *punctulatus* having been found in June. I have collected larvae of *antennatus*, which were described by WATTS (1970), from late April into early June. The newly emerged adults apparently aestivate and do not become active again until September or October. I have collected adults of *falli* only between March 19 and April 7, and I have not collected *punctulatus*, a common species, in July, August or September.

Our inability to capture *falli*, except very early in the spring, is especially intriguing. We have collected intensively at one of its breeding sites with both nets and traps, and our failure to capture newly emerged adults suggests that they may aestivate in the pupal cell, a phenomenon that Dr James Matta told me he has observed in *Agabus gagates*. Adults of *falli* and other species could also aestivate in other terrestrial sites or in the bottom mud of cool ponds, seeps, or swamps. Larson (personal communication) has successfully collected many *Agabus* by diligently digging through the mud of seeps and swamps with a very sturdy net, and many of them may have been aestivating individuals.

Adults of *Agabus phaeopterus* and *subfuscatus* have been collected mostly from open ponds in June and early July. They are occasionally collected earlier in the spring, but are rarely found in late summer or autumn. This suggests that they may have a life cycle similar to that described for *erichsoni*, aestivating in late summer and overwintering as eggs and adults. Most of the rarer species in Wisconsin, *bicolor*, *canadensis*, *confinis*, *discolor* and *wasastjerna*, also seem to follow this pattern. But, without the ability to identify larvae, much of what I have presented is speculative. A program devoted to collecting and rearing larvae and associating them with the adults is needed before we can

fully understand the life cycles of Agabini. A study of the larvae will also help us to better understand the phylogenetic relationship of the various species in these two closely related but diverse genera.

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