An Introduced Flatworm, *Bipalium adventitium* (Tricladida: Terricola), in Wisconsin and Its Potential Impacts

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Miscellaneous Publication PUB-SS-1041 2008

Contents

Cover Photo: A *Bipalium adventitium* specimen from southeastern Wisconsin. Photograph by Patricia Fojut, University of Wisconsin-Extension.

An Introduced Flatworm, *Bipalium adventitium* (Tricladida: Terricola), in Wisconsin and Its Potential Impacts

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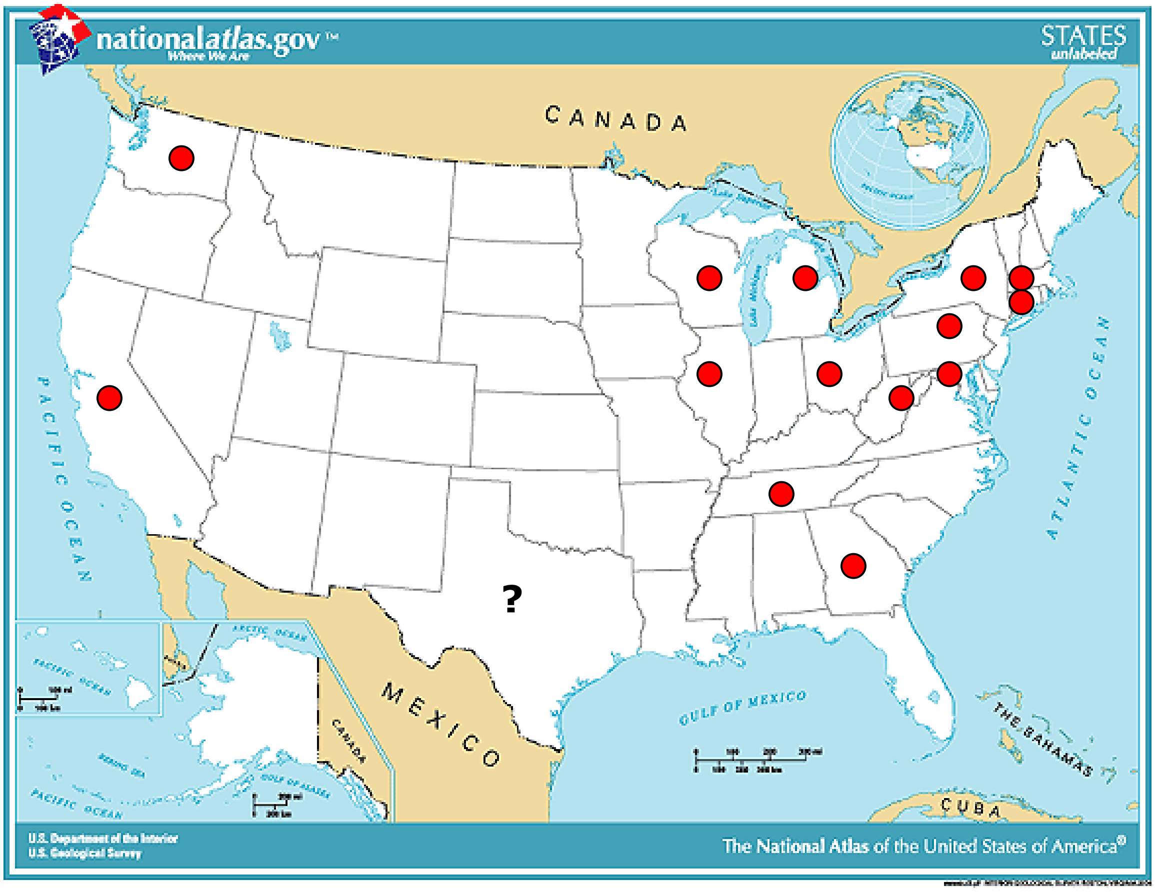
Abstract: *Bipalium adventitium* Hyman 1943, a terrestrial planarian that was first identified in the United States about a half century ago, is confirmed from Wisconsin for the first time. *B. adventitium* is an obligate predator on earthworms that potentially poses a threat to horticultural and agricultural settings. Its impact on native ecosystems remains unknown.

Introduction

The wandering broadhead planarian, *Bipalium adventitium,* was first described by Hyman (1943) from specimens collected in California. Thought to be native to Southeast Asia, *B. adventitium* was probably introduced to North America accidentally during the early 1900s in soil on the roots of horticultural plants. Since its original description, reports of its discovery have been published in New York (Hyman 1954, Klots 1960, Dindal 1970, Ducey and Noce 1998), Massachusetts (Klots 1960), Pennsylvania (Ogren 1981, 1984, 1985), Tennessee (Curtis et al. 1983, Ogren 1984), Washington (Ogren and Kohn 1989), Connecticut and Maryland (Ogren and Kawakatsu 1998), Georgia (Bechler 1998), Illinois (Zaborski 2000, 2002), and Michigan, Ohio, and West Virginia (Ducey et al. 2005) (see Figure 1). Anecdotal evidence also suggested its presence in Texas (Taylor 2007).

Watermolen (2005) tabulated records of Wisconsin flatworms. He found no valid records of *Bipalium* from the state, but did mention an unidentified specimen collected in a horticultural facility in Milwaukee. Shortly after, Draney (2007) described several flatworms that he believed might be *B. adventitium* that he encountered in Green Bay in September and October 2007. Although photographed, these specimens were not identified with certainty. Identification of specimens collected recently (April 2008) at two sites in southern Wisconsin (Dane and Milwaukee counties) confirmed the presence of *B. adventitium* in the state, the northern most records for this species in the Midwestern U.S. (Figure 1).

Figure 1. The reported distribution of *Bipalium adventitium* in the United States. Records indicated by symbols (●) plotted in the center of the state. See text for citations.



Methods

On 11 April 2008, one of us (PF) encountered two specimens of an unidentified flatworm crawling in the forest leaf litter at Greenfield Park in west-central Milwaukee County (43° 01’ N, 88° 04’ W; T-7-N, R-21-E). The worms were crawling on the surface under wet leaves. When first encountered, they were contracted to about 12-15 mm. Both worms were collected by hand and observed and photographed in a Petri dish. The worms stretched out to about 30-35 mm as they explored their new surroundings.

One of the 11 April specimens and an additional specimen collected by hand from the same location on 15 April were shipped to the Wisconsin DNR (DW) for identification. Specimens were maintained in the laboratory for several days in plastic Petri dishes with a piece of dampened paper toweling and leaves and soil from the collection site. Living and preserved specimens were examined microscopically in various ways.

Two additional specimens were collected by hand from a residential flower bed in Madison, Dane County (43° 08′ N, 89° 23′ W; T-8-N, R-9-E) on 21 April 2008. The collector brought the specimens to the Wisconsin DNR (DW) for identification. As with the others, specimens were maintained in the laboratory for several days in plastic dishes with a piece of dampened paper toweling and leaves from the collection site.

One living specimen from the Milwaukee County collection was anesthetized in 10% ethanol and then fixed in 80% ethanol. Serial sections of the region behind the pharynx containing the copulatory apparatus were prepared generally following procedures outlined in Cooper (1988) and Winsor (1998). The other specimens were preserved whole in ethanol and deposited as vouchers in the invertebrate zoology collection at the Milwaukee Public Museum and the author's (DW) reference collection.

Results

We identified all four specimens as *Bipalium adventitium* Hyman 1943, initially with Ball and Sluys' (1990) key and subsequently by comparison to the descriptions provided by Hyman (1943), Kawakatsu (1982, 1983), and Ogren (1984). The bodies were elongate, ribbon-shaped, tapered at the rear, and flattened in cross section. Specimens measured 37-72 mm (mean=51.5 mm) long when fully extended and 3.5-5.2 mm wide at their widest point. The worms' heads were fan-shaped (semi-lunar), rounded in front, tapered to the neck, and lacked recurved auricles (Figures 2 and 3). The pharynx and mouth were situated near the body's mid-point. Body color was pale orange-brown, with the ventral surface slightly paler than the dorsal surface. The anterior margin of head was darkly pigmented and a single, dorsal median stripe extended from the neck to the posterior tip of the body (Figures 2 and 3). Eyes were present in two rows along the anterior dorsal margin of the head, in a broad band on the neck, and scattered along the entire length of the sides of the body. General features and reproductive anatomy matched descriptions of the species by Hyman (1943: Fig. 25), Kawakatsu (1982; 1983: Fig. 7), and Ogren (1984: Fig. 5). These specimens confirm the presence of *B. adventitium* in Wisconsin.

Movements of living specimens were consistent with previous descriptions of behavior. During movements, the head and part of the neck were lifted above the substrate and moved form side to side, with the minute sensory projections of the head occasionally being touched to the substrate. When not moving about the plastic dish, flatworms generally sought refuge under leaves or the moistened paper toweling.

Figure 2. Dorsal view of *Bipalium adventitium* (from Hyman 1943)

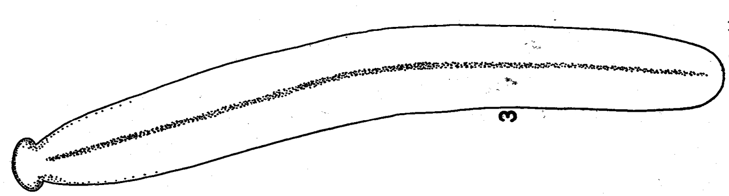


Figure 3. Photograph of southeastern Wisconsin *Bipalium adventitium* specimen.

Photo: P. Fojut

Discussion

B. adventitium is one of four non-native bipalid flatworms documented in the United States (Ogren and Kawakatsu 1987, Ogren and Sheldon 1991, Ducey et al. 2007, Broadwell et al. 2008). *B. adventitium*'s origin and mode of introduction to North America, however, remain unknown. Some authors speculate that Japan may be the source since several similar *Bipalium* species occur there[1]. Because these flatworms appear most commonly in urban and suburban settings—often in gardens, their dispersal appears to be passive, with most authors suggesting transport in soil associated with the roots of trees, bushes, grasses, or horticultural plantings being the initial mode of introduction. Subsequent dispersal may be active, however, with these planarians eventually being found in some wooded and agricultural habitats (Ducey and Noce 1999, Zaborski 2000).

The extent of the distribution of *B. adventitium* in Wisconsin and its population structure remain unknown. The only confirmed records are those

[1] *B. adventitium*, however, differs morphologically from the other four Japanese *Bipalium* species that have a single dorsal line; see Kaburaki (1922).

reported here[2], although the photographs accompanying Draney's (2007) short note strongly suggest the presence of *B. adventitium* in the Green Bay area as well. These records and observations do not necessarily indicate recent range expansions. Instead, they probably reflect the first times anyone has noticed and reported this species. In other states where *B. adventitium* has invaded, it occurs in locally high densities (e.g., Ducey and Noce 1998, Ducey et al. 2005). Anecdotal evidence noted at the time of the 2008 collections suggests this may be the case in southern Wisconsin as well. Further work, however, will be necessary to delineate *B. adventitium*'s Wisconsin distribution and fully assess its population characteristics.

The effects of *B. adventitium*'s presence in the state remain unknown. *B. adventitium* feeds on a wide range of earthworm species and sizes (Table 1)[3] and has an ability to locate and kill these worms in a wide spectrum of microhabitats (Fiore et al. 1994). Dindal (1970) and Ducey et al. (1999) provide general descriptions of *B. adventitium*'s predatory behavior when it encounters an earthworm, including behaviors that significantly reduce earthworm escape responses. All published studies thus far report that *B. adventitium* attacks all species of earthworms presented to it (Zaborski 2000), including those many times its size—up to 80-100 times its own mass (Dindal 1970, Ducey and Noce 1998, Ducey et al. 1999).

Extensive predation on earthworms raises several potential conservation issues. First, populations of native earthworms, which evolved in the absence of these flatworm predators and may have minimal defenses against them, could be significantly reduced or eliminated. Second, where earthworms comprise a major component of the soil fauna, they function as "ecological engineers" by distributing organic matter throughout the soil column, aiding decomposition, boosting soil aeration, altering water flow/infiltration and soil drainage, and improving root penetration (Lee 1985, Hendrix 1995, Edwards 1998, and references cited therein), particularly important functions in agricultural settings. Depletion of earthworm populations could alter these ecosystem processes. On the other hand, the soil disturbing activities of exotic earthworms can adversely affect the variety and abundance of herbaceous layer plants, creating a concern in native ecosystems (Gundale 2002, Hale et al. 2006, Frelich et al. 2006). In these latter cases, *B. adventitium* might serve as a biological control for these other non-native species. Finally, earthworms are "keystone" species, whose populations affect multiple other species. For example, various wildlife species feed on earthworms (MacDonald 1983). Earthworm population reductions could impact adversely these other trophic levels.

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[2] The unidentified *Bipalium* mentioned by Watermolen (2005) is probably not *B. adventitium*. It is more likely *Bipalium kewense* Moseley 1878, as that specimen had a darkly pigmented head and multiple dorsal lines.

[3] Some early studies (e.g., Hyman 1954, Klots 1960) suggest that *B. adventitium* may also prey on slugs, as do some other bipalids, and insect larvae, but we find no evidence to support these suggestions.

Table 1. Earthworms reported as prey of *Bipalium adventitium*. Asterisks following species names indicate earthworms recorded from Wisconsin.

Earthworm Species	Reference(s)
Family Megascolecidae	
Amynthas sp.	Ducey et al. 2005
Family Lumbricidae	
Allolobophora chlorotica *	Zaborski 2002
Aporrectodea rosea *	Zaborski 2002
Aporrectodea trapezoides *	Ducey and Noce 1998, Ducey et al. 1999
Aporrectodea tuberculata *	Ducey and Noce 1998, Ducey et al. 1999
Aporrectodea turgida *	Ducey and Noce 1998, Zaborski 2002
Aporrectodea spp.	Ducey et al. 2005
Bimastos sp.	Ducey and Noce 1998, Ducey et al. 2005
Bimastos tenuis	Dindal 1970
Eisenia foetida *	Zaborski 2002, Ducey et al. 2005
Lumbricus rubellus *	Ducey and Noce 1998, Ducey et al. 1999. Ducey et al. 2005
Lumbricus terrestris *	Dindal 1970, Ducey and Noce 1998, Ducey et al. 1999, Ducey et al. 2005
Octolasion tyrtaeum *	Ducey and Noce 1998, Zaborski 2002, Ducey et al. 2005

Although sixteen earthworm species have been reported from Wisconsin (Table 2), biologists have not surveyed systematically the state's annelid fauna and there is much that remains to be learned. Nonetheless, this total is comparable to the earthworm faunas documented in neighboring states where more thorough surveys have been conducted (Murchie 1956, Snider 1991, Reynolds et al. 2002). It is also clear that virtually all earthworm species found in the state are nonindigenous species (Table 2: Reynolds and Wetzel 2004; Hale 2007). Little is known regarding the abundance and distribution of North America's native earthworms (James 1995), including those that occur in Wisconsin. Finally, it is possible that a few other unreported earthworm species occur here and that others also may be introduced into the state.

Table 2. Earthworms reported from Wisconsin and their reported ecotypes (ecotypes based on Fraser and Boag [1998], Reynolds [1977], and Simonson et al. [2008]). Asterisks following species names indicate nonindigenous species (based on Reynolds and Wetzel [2004]).

Earthworm Species	**Reference(s)**
Family Enchytraeidae	
species indeterminate	M.J. Wetzel, pers. comm.
Family Lumbricidae	
Epigeic	
Dendrobaena octaedra (Savigny, 1826) *	Gates 1972b, Reynolds 1976
Dendrodrilus rubidus (Savigny, 1826) *	Beyer and Stafford 1993
Eisenia foetida Savigny, 1826 *	Reynolds and Wetzel 2004
Eiseniella tetraedra (Savigny, 1826) *	Gates 1972b
Endogeic	
Allolobophora chlorotica (Savigny, 1826) *	Gates 1972b, Beyer and Stafford 1993
Aporrectodea rosea (Savigny, 1826) *	Simonson et al. 2008
Aporrectodea trapezoides (Duges, 1828) *	Gates 1942, 1972b; Beyer and Stafford 1993; Reynolds 1995
Aporrectodea tuberculata (Eisen, 1874) *	Gates 1972a, 1972b; Brown and Posner 1991; Beyer and Stafford 1993; Reynolds 1976, 1995
Aporrectodea turgida (Eisen, 1873) *	Reynolds 1977, Brown and Posner 1991, Reynolds 1995
Lumbricus rubellus Hoffmeister, 1843 *	Reynolds 1976, Beyer and Stafford 1993, Hale et al. 2005
Octolasion cyaneum (Savigny, 1826) *	Reynolds and Wetzel 2004
Octolasion tyrtaeum (Savigny, 1826 *	Reynolds 1977, 1995; Simonson et al. 2008
Anecic	
Lumbricus terrestris Linnaeus, 1758 *	Nielson and Hole 1963, Gates 1972b, Brown and Posner 1991, Simonson et al. 2008
Family Acanthodrilidae	
Diplocardia verrucosa Ude, 1895	Reynolds and Wetzel 2004
Family Sparganophilidae	
Sparganophilus eiseni Smith, 1895	Muttkowski 1918; Hauge 1923; Gates 1972b; Reynolds 1977, 1980

The impact of *B. adventitium* on Wisconsin's earthworms will, in part, be affected by how successful it is at preying on the various species found here. Previous investigators (Bouche 1971, 1972; Fraser and Boag 1998; Hendrix and Bohlen 2002) have divided earthworms into three "ecotypes" or functional groups based on their principle location in the soil horizons and feeding habits:

> Epigeic species – live on the soil surface or in the very upper reaches of the mineral soil beneath the litter layer; tend not to burrow very far into the soil; feed on decaying organic matter; have relatively high reproductive rates and grow rapidly, perhaps an adaptation to high predation rates.
>
> Endogeic species – inhabit the mineral soil horizons, generally in horizontal burrows; derive nourishment from humified organic matter (some feed at the soil surface); consume more soil than the epigeic or anecic species; play important role in top soil mixing through burrowing and casting activity.
>
> Anecic species – form permanent/semi-permanent vertical burrows that open at the soil surface and descend deep (up to 8 feet) into the mineral subsoil horizons; feed nocturnally by pulling surface litter into burrows; play important role in burying surface litter.

Ecotypes have been identified for all lumbricid earthworms reported from Wisconsin (Table 2): four are epigeic, eight are endogeic, and one is anecic. Predation pressure from other predators (i.e. birds, mammals, and centipedes) is estimated as very high for epigeic earthworms since they live at or near the soil surface and are easily encountered (Lee 1985). Most predation by ecologically similar planarians has been recorded close to the soil surface (Blackshaw and Stewart 1992, Blackshaw 1997). The four epigeic earthworms found in Wisconsin may be the most susceptible to predation by *B. adventitium,* which is known to feed on at least one of these, *Eisenia foetida* (Zaborski 2002, Ducey et al. 2005). Yet, this may not create a significant biodiversity conservation concern as all four of these epigeic earthworm species are nonindigenous.

Predation pressure is thought to be minimal for endogeic species as they rarely leave their temporary burrows and backfill them with their castings. In addition, these planarians apparently do not actively burrow. Although unlikely to encounter the endogeic species regularly, *B. adventitium* will prey on at least seven of the eight species reported from Wisconsin (Table 1). Other terrestrial flatworms have been observed following endogeic earthworms or their slime trails into their burrows, where they successfully preyed on the earthworms. *B. adventitium* may do the same. As with the epigeic species, successful predation on this suite of species may not create significant ecological concerns as all eight are nonindigenous invaders.

Predation pressure is believed to be lower for the anecic species than it is for the epigeic species, but greater than that for the endogeic species. Although they feed at the soil surface, anecic species may be able to escape by retreating into their burrows. Wisconsin's only anecic species, the widespread night crawler, *Lumbricus terrestris,* commonly dominates earthworm populations and because of its relatively large size also often dominates the earthworm biomass in the areas in which it occurs. Even though *B. adventitium* has been reported to consume *L. terrestris* previously (Table 1), one might surmise that because *L. terrestris* is anecic, *B. adventitium* will not likely have a major impact on this introduced lumbricid. Furthering this suggestion are Ducey et al.'s (1999) laboratory studies, which found that 52% of *L. terrestris* that came into contact with *B. adventitium* escaped predation. On the other hand, *L. terrestris* does feed nocturnally at the surface, during a period when *B. adventitium* is most likely to be active and therefore encounter it. *B. adventitium* also feeds on *L. terrestris* when both are forced from the soil following heavy rains (Dindal 1970). In addition, Zaborski's (2002) observations of injured and dead *L. terrestris* in proximity to foraging flatworms further suggest that *B. adventitium* may adversely affect this species. In New Zealand, where ecologically similar flatworms occur, anecic lumbricids are absent (Fraser and Boag 1998).

Experimental feeding trials have not been conducted with *B. adventitium* and our native earthworms, and we have found no anecdotal accounts of *B. adventitium* feeding on members of these genera. Given its known predatory behaviors and feeding habits, however, we have no reason to believe that *B. adventitium* will not feed on these native earthworms. *Sparganophilus eiseni*, a limicolous species (Muttkowski 1918), may be particularly vulnerable.

We cannot say what specific impact the establishment of *B. adventitium* may have on earthworm populations, the wildlife that feed on earthworms, or the soil processes that earthworms influence. But, because it is such an aggressive predator on earthworms (Dindal 1970, Ogren 1995) and several species of earthworm occurring in Wisconsin are likely to be subject to predation (Table 1), *B. adventitium* may pose a potential threat to horticultural and agricultural settings by impacting earthworm populations. In native ecosystems, *B. adventitium* might function as a biological control for expanding exotic earthworm populations or as a limiting factor for the few indigenous species that occur here.

Comparisons between invading species and their relatives can provide insights into their dispersal, colonization, population establishment, and potential ecological impacts. Unfortunately, ecological and life history traits have been investigated for only a handful of terrestrial flatworms; most that have been studied are exotic invaders. An ecologically similar flatworm invasion, however, is occurring in the British and Faroe Islands (Blackshaw 1990, Boag et al. 1994, Jones and Boag 1996, Cannon et al. 1999). In that case, the comparatively well studied New Zealand planarian, *Arthurdendyus triangulatus* (Dendy 1894) [formerly *Artioposthia triangulata*], was introduced accidentally into Ireland in the early 1960s and may now be having a significant impact on earthworm populations in areas it has invaded (Blackshaw and Stewart 1992, Mather and Christensen 1993, Boag et al. 1994, Blackshaw 1995, Christensen and Mather 1995, Jones et al. 2001).

Where *A. triangulatus* has become established, its populations have exploded and have reduced local earthworm populations to below detectable levels, possibly to extinction, in a relatively short time (Mather and Christensen 1993, Blackshaw 1995, Christensen and Mather 1995, 1998). In these affected areas, it appears that the invasive flatworm prevents earthworm recolonization after depletion (Christensen and Mather 1995). On the other hand, the flatworms do not appear to have affected [introduced] lumbricid populations in New Zealand, where they appear to live in equilibrium with the prey species (Fraser and Boag 1998).

The impact of *B. adventitium* in Wisconsin will be determined largely by how widespread and well established the species becomes in the state. There are two principal means for *B. adventitium* to colonize new sites: 1) it can disperse actively on its own through dispersal behaviors, or 2) someone or something can move it to new areas. As such, the life history traits of the species, as well as human behaviors, will influence how *B. adventitium*'s range develops in Wisconsin.

Unfavorable micro-climate conditions or local resource depletion may lead to active migration by *B. adventitium* and invasion of surrounding areas, as has been observed for the various ontogenetic stages of the New Zealand planarian (Mather and Christensen 1998). Competition for available resting places or food may also influence dispersal behaviors. Should *B. adventitium* impact local earthworm populations as *A. triangulatus* has, a lack of food resources may induce individuals to undertake migratory behaviors. As with other terrestrial flatworms, soil moisture and atmospheric humidity significantly influence where the soft-bodied *B. adventitium* can survive without being subject to desiccation. As a result, natural dispersal from its (likely) urban population centers may be restricted primarily to advances along river corridors, wetland drainages, moist forest floors, and similar damp habitats.

Ducey et al. (2005) studied the reproductive traits of *B. adventitium* in populations across its known U.S. range (summarized in Table 3). Factors that may aid in the dispersal of *B. adventitium* include its ability to reproduce sexually in a cool climate, hermaphroditism, sperm storage, tough egg capsules containing multiple offspring, and the ability of individuals to produce multiple egg capsules, all traits that are present in other terrestrial flatworms and likely allow a few individuals (propagules) to establish new populations. Like may flatworms, *B. adventitium* also can reproduce by fission (Hyman 1954). Ducey et al. (2005), however, found relatively low survival rates, at least in captivity, when individuals fragmented. They felt procreation in this mode was more likely a response to stress rather than a standard mode of reproduction. Nonetheless, its ability to reproduce by fission underscores the ability of single individuals to serve as propagules.

Table 3. Summary of reproductive characteristics of *B. adventitium* (from Ducey et al. 2005).

Capsules produced/worm	1-6 capsules; mean=1.9 [SD=1.19]
Litter size (#eggs/capsule)	1-8 offspring; mean=3.4 [SD=1.3]; similar to other terrestrial flatworms
Offspring/season	Total maximum/worm=18; mean=6.4 [SD=4.02] – note: this study was not designed to assess total reproductive output over the lifetime of the worms.
Incubation period	7-37 days; mean=23.1 days [SD=0.64 days], similar to other terrestrial flatworms
Reproductive effort/capsule	0.10-0.30 of parent pre-deposition mass
Offspring mass	mean=5.16 mg [SD=3.27 mg]; positively correlated with egg capsule mass; mean proportion of egg mass not converted into offspring mass=0.28 [SD=0.142]

The spread of *B. adventitium* may also depend in part on its ecological interactions with potential predator and parasite species. Ducey et al. (1999) investigated the predator-prey relations of *B. adventitium*, in an attempt to better understand factors that may affect the species' distribution in New York. There seems to be a paucity of predators against *B. adventitium*; of the herptiles tested, only the salamanders *Desmognathus ochrophaeus* and *Plethodon glutinosus* consumed *B. adventitium,* and in both cases, only in less than 10% of feeding trials (Ducey et al. 1999). Neither of these salamanders occurs in Wisconsin. In the same study, two other salamander species did pursue and strike *B. adventitium*, but did not eat them. The flatworm's sticky mucous and distasteful secretions appear to discourage predation. We found no other reports of predation in the literature.

Parasites have not been documented from *B. adventitium*. Three days after capture, a tiny (~12 mm long) nematode emerged from the dorsal surface of the caudal end of one of the Greenfield Park specimens observed in captivity. The flatworm thrashed its caudal end about as the nematode emerged, but appeared unaffected when observed several days later. Unfortunately, we were not able to preserve the nematode for identification and it was found desiccated in the Petri dish a few days later.

That *B. adventitium* was first discovered in Wisconsin's largest metropolitan areas in not surprising. In other states, it appears most commonly in urban and suburban settings, strong evidence that human activity mediates its dispersal into new habitats. In Northern Ireland, the number of public reports of the similarly invading New Zealand flatworm correlated positively with human population density (Moore et al. 1998). Like that species, *B. adventitium* is most often introduced by accident, being easily transported on various materials without the knowledge of those handling the material. The ability to withstand long periods without feeding and a propensity to seek shelter beneath surface objects, like greenhouse plant containers, may facilitate spread of the species into previously uninfested areas (also see Ogren [1985] for further discussion of the human factors that may affect dispersal).

Given its generally cryptic nature and the regular movement of horticultural and agricultural products and equipment throughout the state, *B. adventitium* almost certainly will be introduced into other areas of the state. In places where nonindigenous earthworms have become well established, *B. adventitium* could potentially serve as a biological control for their expanding populations. It remains unclear, however, what dispersal mechanisms might allow extension of its range from its urban points of introduction to environments where exotic earthworms seem to be most impacting native plant communities (e.g., around rural boat landings in northern Wisconsin forests). It is also possible that there may be some areas of the state where earthworm populations have not yet reached a sufficient density to support establishment of *B. adventitium* populations. In the absence of earthworm surveys, however, we are not able to predict where such areas might be.

Management Implications

The Wisconsin DNR and the Wisconsin Council on Invasive Species have been working to develop rules to classify and regulate invasive species to prevent their introduction and spread in the state. Due to a lack of information regarding their occurrence in the state, non-native flatworms have yet to be considered in the rule-making process. The recent discovery of *B. adventitium* and its potential impacts, as well as the likelihood that the more widespread and related *B. kewense* has been introduced (see Footnote 2), suggest a need to address these exotic species in the rule-making process.

Simply prohibiting the intentional introduction and transport of non-native flatworms will probably not be effective in addressing potential concerns because, as with the introductions of several other soil dwelling taxa, they or their eggs are often transported totally hidden from view (as in soil or plant debris). It would be difficult to control *B. adventitium*'s dispersal by even the best of legal means because of the extensive movement of horticultural and agricultural products and equipment throughout the state. An appropriate category for regulation of introduced terrestrial flatworms is the "watch list category" included in the draft rule—NR 40.06, *Wis. Admin. Code*. For species in this category, the extent of their presence in the state or their impact is not sufficiently documented. According to the draft rule, "watch list species may have shown evidence of invasiveness in similar environments in other states and could potentially spread in Wisconsin." *B. adventitium* and its relatives certainly have these characteristics. Additional information will be needed to determine if these terrestrial flatworms should more appropriately be included in some other category. In the meantime, systematic monitoring may be the best possible method of detecting and addressing potential problems from these species.

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Acknowledgments

M.E. Voss collected the Dane County specimens.

Afterword

With the spread and growth of *B. adventitium* populations in Wisconsin, the little children's song–

Nobody loves me!
Everybody hates me!
Goin' out the garden
to eat worms:
big, fat, juicy ones,
long, slim, slimy ones.
See how they wiggle and squirm!
Bite the head off.
Suck the juice out.
Throw away the skin.
Nobody hates me!
Everybody loves me!
See? I won again!

–could become obsolete if earthworms in fact disappear from our landscape.