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Star-of-Bethlehem, *Ornithogalum umbellatum* L. (Liliaceae): An Invasive, Naturalized Plant in Woodlands of Ohio

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Ornithogalum umbellatum (star-of-Bethlehem) is a liliaceous perennial with long grasslike leaves and a fleshy bulb that possesses toxic cardiac glycosides or glycosylflavones (Azzioui et al. 1989); it is lethal to livestock (Cox 1985). *Ornithogalum umbellatum* is native to the Mediterranean region and has been planted as an ornamental in North America, Europe, and Australia, where it has become naturalized and invasive. In fact, in portions of Australia, *O. umbellatum* has become such a problematic weed that control measures are under consideration (Wallwork et al. 1992) because it serves as a vector for fungal rust transmission. In contrast, *O. umbellatum* is considered endangered and near extinction within its native range (Mezev-Krichfalushii et al. 1989), presumably owing to anthropogenic disturbances (Mezev-Krichfalushii 1991).

Throughout the United States *O. umbellatum* has escaped from gardens and become established in a variety of habitats including roadsides, fields, and woodlands (Deam 1940, Braun 1967, Mohlenbrock 1970, Voss 1972). Naturalized populations are known to occur in at least 35 states and the District of Columbia (determined from a survey of published floras and herbaria). The species has a primarily eastern distribution in the United States, as naturalized populations have not been reported from Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Washington, or Wyoming. However, several populations in Utah have been reported (Welsh et al. 1987).

In portions of the Midwest, *O. umbellatum* appears to be a weed or pest that spreads rapidly. Deam (1940) reported patches of an acre or more in Indiana forests and noted a tendency for the plant to grow in high densities and displace native plant species. Mohlenbrock (1970) reported its occurrence in a nearly virgin forest in Illinois and suggested that "the species may run rampant and completely invade an area." In addition, Braun (1967) indicated its invasive potential and stated that it is "often a troublesome weed difficult to eradicate." In other regions of the United States, the plant may be less invasive. Voss (1972) and Ownbey and Morley (1991) indicated that it rarely escapes from cultivation in Michigan and Minnesota, respectively. Duncan and Foote (1975) reported it as occasional in the southeastern United States, while Van Bruggen (1985) described it as rare in South Dakota.

In Ohio woodlands, *O. umbellatum* initiates growth in late February to early March. During this time, the bulbs produced during the previous year sprout roots, which grow quickly and push the bulb upward and outward through the soil surface. I have measured movements of bulbs through this process of up to 14 cm. *Ornithogalum umbellatum* functions as a true spring ephemeral: all of its foliar tissue senesces prior to full canopy leaf out. The plant appears to spread exclusively by vegetative means in woodlands. I have observed only several flowers within forested sites. Individuals in nearby fields and forest edges, however, do flower in mid- to late-May (after foliar senescence and canopy closure) and may serve as an important seed source for dispersal, particularly to interior portions of woodlands and along adjacent fields, forest borders, and edges.

Observations of *O. umbellatum* were made in the Wright State University woods in Greene County, Ohio. The site is an 80-ha oak-maple forest comprising both older growth and successional stands. In this woods, the greatest density of *O. umbellatum* occurs in a moderately disturbed, 3-ha, older growth stand and a 4-ha, approximately 45-year-old stand. A previous study conducted in 1987 (DeMars and Runkle 1992) recorded the presence or absence of *O. umbellatum* in 100 randomly placed 1-m^2 quadrats in both stands. To compare

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changes in occurrence from 1987 to 1994, I randomly established quadrats in the same areas described by DeMars and Runkle (1992) and recorded the presence or absence of the plant within each quadrat and computed its frequency and stem density.

In the older growth stand, *O. umbellatum* was obviously dispersing along the confines of what appeared to have been a path used by motor vehicles. In 1991, I marked the leading front of plants along this path with flagging. Subsequent measurements of front dispersal were made in April of 1992, 1993, and 1994 by measuring the distance between the five most distant, newly established individuals and the previous year's front.

To examine the contribution of *O. umbellatum* to overall groundlayer community composition within the older growth stand, detrended correspondence analysis (Gauch 1982) was performed on the 1993 data using the relative frequency of individual groundlayer species within each quadrat.

In the older growth stand, the presence of *O. umbellatum* in quadrats increased from 7% to 19% from 1987 to 1994, while in the approximately 45-year-old stand, it decreased from 23% to 11%. In the younger stand, most of *O. umbellatum* occurrences in 1994 were along a wide path that transects the stand or on the east edge of the stand, whereas in 1987 they were scattered throughout the interior as well.

In 1994 *O. umbellatum* density averaged 35.1 stems/m^2 in the older growth stand and 3.1 stems/m^2 in the 45-year-old stand. The higher average density in the older growth stand reflects several quadrats where density was extremely high. For instance, one quadrat located on the abandoned path contained 532 individuals.

Movement of the dispersing front of *O. umbellatum* along the abandoned path in the older growth stand ranged from 6 cm in 1992 to 32 cm in 1994 and averaged 0.2 m/year. In addition, more distant patches of plants have been observed farther down the path each year. These new patches may have resulted from seed dispersal from forest edges, water dispersal of bulbs (observed following a rainstorm), or accidental dispersal during sampling.

Detrended correspondence analysis (DCA) ordinated *O. umbellatum* as the lower pole of axis 2. Sample quadrats ordinated along the axis with decreasing *O. umbellatum* importance. Quadrats with *O. umbellatum* relative frequencies greater than 25% grouped toward the lower pole, while quadrats with no *O. umbellatum* grouped toward the upper pole. Quadrats with intermediate levels of *O. umbellatum* were scattered between the poles. The grouping of quadrats based on the relative frequency of *O. umbellatum* in quadrats suggests that the plant is a major factor affecting groundlayer community composition (as determined by DCA) in this stand.

The results of this study suggest that *O. umbellatum* is an actively invading species in the older growth stand within the Wright State University woods. Results from the approximately 45-year-old stand, however, suggest that *O. umbellatum*'s invasiveness is lowered as forest succession occurs. This may be because there is a lower rate of disturbance as the younger stand matures. Data from both stands indirectly indicate that the plant is disturbance adapted, as are many invading plants (Drake 1988). I have also observed *O. umbellatum* in Neotoma Valley (Hocking County), Buckeye Lake State Park (Fairfield County), and Gahanna Woods (Franklin County). At these three sites, the plant was restricted to disturbed areas, including the borders of wooded streams and paths.

From these observations it is apparent that *O. umbellatum* has the ability to invade the interior of woodlands. However, the plant appears to be restricted to disturbed sites and, hence, may be an opportunistic species representing only a moderate threat to native species. Further observations and experiments are needed to assess future potential threats to this species, its effect on species diversity, and its relationship to disturbance phenomena.

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