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BRUMOIDES SEPTENTRIONIS DAVISI (LENG) (COLEOPTERA: COCCINELLIDAE): DISTRIBUTION, HOST-PLANT ASSOCIATIONS, AND HABITATS OF A SELDOM-COLLECTED LADY BEETLE

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Abstract.—The chilocorine coccinellid *Brumoides septentrionis davisi* (Leng) is an infrequently collected lady beetle whose broad distribution in eastern North America has been mapped; few specific localities, however, have been published. Despite a known association with pines, the *Pinus* species on which it is found have not been recorded. Historical locality data are provided based on specimens in five museum collections, and new records from recent field work are presented. This coccinellid's plant and habitat associations are discussed. Its populations apparently have declined in the Northeast in recent years. Certain scale insects probably serve as prey.

Key Words: *Brumoides septentrionis davisi*, coccinellids, insect distribution, pine barrens

The most frequently encountered of all predacious beetles (Clausen 1940), coccinellids are associated with biological control more than any other group of predators (Obrycki and Kring 1998). Coccidophagous lady beetles have proved more effective as classical biological control agents than those that are aphidophages (Dixon 2000). The establishment, either from biocontrol introductions or accidentally from commerce, of several Old World coccinellids that are generalist aphid predators has led to more stringent regulations for their importation and has prompted interest in native lady beetles whose densities have declined as those of adventive coccinellids have increased (e.g., Schaefer et al. 1987, Wheeler and Hoebeke 1995, Colunga-Garcia and Gage 1998, Cottrell and Yeargan 1998, Obrycki et al. 1998, Evans 2000).

I provide distributional records of the Nearctic *Brumoides septentrionis davisi* (Leng) and notes on its plant associations and habitats to call attention to this infrequently collected lady beetle. I also suggest possible prey associations and a recent decline in its numbers. The availability of this background information might prove useful if studies on the bionomics of this coccinellid are initiated.

Brumoides septentrionis davisi (Leng)

The chilocorine *Brumoides septentrionis davisi* (*sensu* Gordon 1985) is the eastern North American subspecies of *B. septentrionis* (Weise), whose other subspecies are found farther west in Canada (McNamara 1991) and the United States (Gordon 1985). Leng (1908) described the eastern subspecies as *Exochomus* (*Brumus*) *septentrionis* var. *davisi* from Alabama, District of Columbia, "Lake Superior," Massachusetts, Michigan, New Jersey, Pennsylvania, and Virginia; except for Lakehurst, N.J., specific localities were not mentioned. The sub-

genera of *Exochomus* that Leng (1908) recognized—*Arawana*, *Brumus*, and *Exochomus*—were later considered valid genera (see Gordon 1985).

Chapin (1965) proposed the new genus *Brumoides*, with the Old World *Coccinella suturalis* Fabricius designated as type, and included both *B. davisi* (Leng) and *B. septentrionis* as valid species. I am retaining the generic name *Brumoides* for *septentrionis davisi*, although Kovář (1995) restricted this genus to the Old World; he did not, however, propose a new generic name to accommodate the New World species.

Brumoides septentrionis davisi is broadly oval, convex, 3.5 to 4.5 mm long, with the upper surface glabrous. The head and pronotum are black and the elytra yellowish brown to red and coarsely punctured. Each elytron typically has two large black discal spots with the sutural area broadly black; the black areas often are confluent. Gordon (1985) illustrated the adult habitus and male and female genitalia.

Distribution

Historical (Table 1).—State and provincial records that have been added since Leng's (1908) original description are New York (Leonard 1928), Minnesota and Wisconsin ("Lake Superior" was cited by Leng 1908) (Wingo 1952), South Carolina (Kirk 1970), and Ontario and Quebec (McNamara 1991). In his key to species of *Brumoides*, Gordon (1985) gave the general range of *B. septentrionis davisi* as "eastern United States, New York and New Jersey west to Wisconsin," but under its distribution he stated that the subspecies ranges from "southeastern Canada to Virginia, west to Minnesota." Gordon (1985) did not include Alabama, listed by Leng (1908), in the known distribution. The distribution given by Belicek (1976) for *B. septentrionis* included Illinois and Indiana, and his map appears also to include Tennessee; he did not recognize subspecies, but his records for these three states might apply to *B. septentrionis davisi*. Neither Belicek (1976) nor Gordon (1985) listed locality data for the specimens they examined. Downie and Arnett's (1996) inclusion of Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, Ohio, Pennsylvania, Rhode Island, Vermont, and Virginia in the known distribution apparently is based on their interpretation of the stippled area on Gordon's (1985) map.

New records.—*Brumoides septentrionis davisi* was collected mainly during studies on mirids (Wheeler 1991; A.G.W., unpublished data) and other hemipterans found in northeastern pitch pine-scrub oak barrens (Wheeler 1996, 1999a, b; Wheeler and Wilson 1996). Voucher specimens have been deposited in the Clemson University Arthropod Collection; Pennsylvania Department of Agriculture Collection, Harrisburg (PADA); and the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

CONNECTICUT: Hartford Co., Shaker Pines, Enfield, 28 Sept. 1991; Windham Co., Windham Airport, 1 Sept. 1991. MASSACHUSETTS: Barnstable Co., North Falmouth, 29 May 1988; Franklin Co., Montague Sand Plain, 15 June 1991. NEW HAMPSHIRE: Merrimack Co., Concord barrens, 14 Sept. 1991. NEW YORK: Suffolk Co., Yaphank, 29 May 1982; Ulster Co., Sam's Point Dwarf Pine Ridge Preserve NE of Cragsmoor, 1 & 14 June and 29 Sept. 1991. NORTH CAROLINA: Rockingham Co., Rt. 220, 5.6 km S of Virginia state line, 3.3. km NNW of Stoneville, 9 Apr. 1979; Guilford Co., Rt. 68, 6.4 km S of Rt. 421, 5 km SE of Sandy Ridge, 10 April 1983. PENNSYLVANIA: Chester Co., Goat Hill Serpentine Barrens, SW of Nottingham, 8 July 1990; Lancaster Co., New Texas Serpentine Barrens, 7 July 1988; Luzerne Co., Milnesville, 17 Sept. 2001; Schuylkill Co., jct. Rt. 81 & Rt. 61, S of Frackville, 20 June & 6 Oct. 1991. SOUTH CAROLINA: Oconee Co., Rt. 76, 10.5 km NW of Westminster, 11 Nov. 2001. VIRGINIA: Botetourt Co., Eagle Rock, 8 May 1999; Rt. 81 Rest Area, 2.4 km N of

jct. Rt. 640, SE of Fincastle, 26 May & 29 July 1978, 23 May 1981, 9 June 1982, 4 Mar. & 8 Apr. 1983; Henry Co., Rt. 220, 4.4 km SW of Ridgeway, 14 Mar. 1982. WEST VIRGINIA: Mercer Co., Rt. 77, 0.6 km N of Bluestone River SE of Camp Creek, 8 May 1999.

Plant Associations and Habitats

Brumoides septentrionis davisi is a conifer inhabitant found almost exclusively on pines. Leng (1908) noted its occurrence on pines [likely pitch pine, *Pinus rigida* Mill.] at Lakehurst, N.J. Few specimens from the localities listed in Table 1 bear host-plant data, but those from Berlin, Framingham, and Sherborn, Mass., are labeled as found on pitch pine. At least historically, pitch pine was present at nearly all the northeastern localities from which this coccinellid is known (e.g., Bromley 1935, Cryan 1985, Motzkin et al. 1999). The specimen from near Gordon, Wisc., was taken on jack pine (*P. banksiana* Lamb.).

The adults that I collected from the New England states, New York, and Pennsylvania were from pitch pine except for a specimen from eastern red-cedar (*Juniperus virginiana* L.) in Lancaster County, Pennsylvania. Specimens from North Carolina, South Carolina, and Virginia were from Virginia pine (*P. virginiana* Mill.); the West Virginia record is based on an adult from table mountain pine (*P. pungens* Lamb.).

In the Northeast, *B. septentrionis davisi* was found in pitch pine-scrub oak barrens and similar communities. It was collected in the dwarf pine plains (ridges) near Lake Maratanza in Ulster County, New York; the Montague Sand Plain in Franklin County, Massachusetts; a pitch pine community in Schuylkill County, Pennsylvania; and remnant pine barrens such as Concord, N.H.; Shaker Pines near Enfield, Conn.; and Yaphank (Long Island), N.Y. It also was found on pitch pine in serpentine barrens in Chester and Lancaster counties, Pennsylvania. In Luzerne County, Pennsylvania, it was found on pitch pine in a ruderal site, a coal spoilbank. Collections from table mountain pine and Virginia pine in North Carolina, South Carolina, Virginia, and West Virginia also did not involve specialized communities but were from disturbed sites, such as roadsides, in the Piedmont and in the Valley and Ridge ecoregions.

Possible Prey Associations

Predation on scale insects is well known among chilocorine coccinellids (e.g., Balduf 1935, Majerus 1994, Hodek and Honěk 1996, Dixon 2000). Within *Brumoides*, the Old World *B. suturalis* preys mainly on armored scales (Diaspididae), mealybugs (Pseudococcidae), and soft scales (Coccidae) (e.g., Gautam 1990, Williams and Greathead 1990, Carnegie 1997, Ponsonby and Copland 1997), with aphids and other insects serving as alternative prey (e.g., Gautam 1990). In addition, Gordon (1985) stated that members of this genus (species unspecified) feed on cochineal or dactylopiid scales (Dactylopiidae) and mealybugs. For *B. septentrionis*, Belicek (1976) reported that the balsam woolly adelgid, *Adelges piceae* Ratzeburg, serves as prey, apparently referring to predation by one of the western subspecies of this lady beetle. No prey records for the easternmost subspecies, *B. septentrionis davisi*, are available, although Leng (1908) noted its occurrence at Lakehurst, N.J., on aphid-infested pines.

No definite prey records were obtained during my field work. Aphids of several genera (mainly *Cinara*) were observed at all sites where the coccinellid was found and might serve at least as alternative prey. All 10 adults of *B. septentrionis davisi* that were observed in Luzerne County, Pennsylvania, in September 2001 were on a single pitch pine growing on a coal spoilbank with 8–10 other pitch pines; the coccinellid was beaten only from branches infested with a pine needle scale, *Chionaspis heterophyllae* Cooley. In Franklin County, Massachusetts, and Schuylkill County, Pennsylvania, this lady beetle also was found on pitch pines that harbored a mar-

garodid scale, *Matsucoccus gallicolus* Morrison. The frequent co-occurrence (ca. 5 additional sites) of the coccinellid with a more or less specialized predator of *Matsucoccus* scales (e.g., Lussier 1965), the anthocorid *Elatophilus inimicus* (Drake and Harris), suggests that *M. gallicolus* also was present at other collection sites for the coccinellid.

Discussion

Brumoides septentrionis davisi is about as large as many of our familiar and well-studied coccinelline lady beetles. Moreover, its coloration—black and yellowish brown to red—is only slightly more subdued than that of our readily recognized reddish, black-spotted coccinellids. Its restriction to pines, a consistent association with specialized communities such as pitch pine-scrub oak barrens, and an apparent absence (northeastern states) on pines in Christmas tree plantations and landscape plantings might partly explain the infrequency of its collection and lack of attention given to its bionomics.

Brumoides septentrionis davisi was collected from New Hampshire to South Carolina at elevations from near sea level on Long Island, New York (17 m), to about 685 m in Ulster County, New York. Adults were found in all months from March to November (range: 4 Mar.–11 Nov.), suggesting that this coccinellid is multivoltine like most other Chilocorini (e.g., Iperti 1999).

In the Northeast, this lady beetle has been collected in several well-known pine barrens, including the New Jersey Pine Barrens and those on Cape Cod, Massachusetts, and Long Island, New York. Despite intensive collecting on pitch pines, it was not observed in New York's Albany Pine Bush or in pine barrens such as Fryeburg, Shapleigh, and Waterboro in Maine and Ossipee in New Hampshire.

In addition to the need for more field work in those northeastern pine barrens in which *B. septentrionis davisi* has yet to be found, the southern extent of its distribution requires greater resolution. Specifically, the Alabama record, listed by Leng (1908) in describing this coccinellid but not mentioned by Gordon (1985), requires verification. It was not found in the survey of the Alabama Coccinellidae by Grimes (1965). Attempts to collect it in Alabama (and Georgia) might focus on pines in upland areas, including the Appalachian Plateau.

The taxonomic status of *B. septentrionis davisi* might also be reevaluated. Gordon (1985) indicated that he was not satisfied with his arrangement of species and subspecies of *Brumoides*. Following Leng's (1908) description of *B. septentrionis* var. *davisi*, Casey (1908) reduced this variety to a synonym of *Brumus septentrionis* Weise. According to Leng (1911), Casey, in reconsidering the status of *davisi*, thought it represented a new species that "should be called *Brumus davisi* Leng." Most subsequent authors also listed *davisi* as a valid species, including Leonard (1928) (as *Exochomus davisi*), Stehr (1930) (as *E. [Brumus] davisi*), Wingo (1952) (as *Brumus davisi*), Chapin (1965) (as *Brumoides davisi*), and Kirk (1970) (as *Brumoides davisi*). Following Gordon's (1985) monographic treatment of North American Coccinellidae, however, subsequent authors (e.g., McNamara 1991, Downie and Arnett 1996) have continued to list *davisi* as a subspecies of *B. septentrionis*.

Another gap in our knowledge of North American *Brumoides* is the lack of larval descriptions. The larval key to genera (and selected species) of Nearctic coccinellids (Rees et al. 1994) excluded this genus because larvae were unavailable for study.

The determination of this chilocorine's trophic habits also is needed. My suggestion that the diaspidid *Chionaspis heterophyllae* serves as acceptable prey is based only on the beating of 10 adults of the lady beetle from scale-infested branches of a pitch pine. The suggestion that *B. septentrionis davisi* might prey on the margarodid scale *Matsucoccus gallicolus* is offered because of the co-occurrence of these species

Table 1. Locality data for *Brumoides septentrionis davisi* from five museum collections and previously published localities (minimum of county level).

Locality	Year of Collection	Museum[a] or Reference
	United States	
District of Columbia		
Washington (Rock Creek)	1901	USNM
Maryland		
Glen Echo	1992	USNM
Massachusetts		
Berkley	1936	MCZ
Berlin	1937	MCZ
Dover	1900	MCZ
Fall River	NA[b]	MCZ
Framingham	1944	MCZ
Marion	1902–1904	MCZ, USNM
Sherborn	1934	MCZ
Springfield	NA	MCZ
Tyngsboro	1893, 1908	MCZ
Michigan		
Whitefish Point	NA	USNM
Minnesota		
Duluth	1918	Stehr 1930
Hubbard County	1929	Stehr 1930
New Hampshire		
Durham	1899	UNH
New Jersey		
Browns Mill	1911	USNM
Clementon	1906	USNM
Jamesburg	NA	Smith 1910
Lakehurst	1903–1943	Leng 1908, Smith 1910; CUIC, USNM
Manchester	NA	USNM
Milltown	NA	Smith 1910
New York		
Keeseville	1952	CNC
Lake Ronkonkoma	1922	CUIC
Melville	1924	CUIC
Mt. Whiteface	1922	USNM
Riverhead	1950, 1953	CUIC
Rockaway Beach	NA	USNM
Southold	1941, 1942	CUIC
Wyandanch	1911	Davis 1911, Leonard 1928; USNM
Yaphank	NA	Davis 1911, Leonard 1928
Pennsylvania		
Hazleton	NA	MCZ
Rhode Island		
Lonsdale	1920	MCZ
Watch Hill	1909	MCZ
South Carolina		
Long Creek	NA	Kirk 1970

Table 1. Continued.

Locality	Year of Collection	Museum[a] or Reference
Virginia		
Mt. Vernon	1911, 1960	CNC, USNM
Wisconsin		
Gordon (4 mi. east)	1952	USNM
	Canada	
Ontario		
Constance Bay	1892	CNC
Sudbury	1932, 1935	CNC

[a] CNC: Canadian National Collection, Ottawa, Ont.; CUIC: Cornell University Insect Collection, Ithaca, N.Y.; MCZ: Museum of Comparative Zoology, Harvard University, Cambridge, Mass.; UNH: University of New Hampshire, Durham; USNM: National Museum of Natural History, Smithsonian Institution, Washington, D.C.
[b] NA = Not Available.

and the known coccidophagous habits of other chilocorine coccinellids. Trophic relationships of a coccinellid species should not be assumed merely from its syntopy with potential prey species, and experimental studies on *B. septentrionis davisi* are needed to identify both its essential and accepted or alternative prey (*sensu* Hodek and Honěk 1996).

Leng (1908) commented on the abundance of the coccinellid at Lakehurst in the New Jersey Pine Barrens. About 75–80% of the specimens in the USNM are from this locale (R.D. Gordon, pers. comm.). I have not found this coccinellid in the New Jersey Pine Barrens during my studies of mirids (Wheeler 1991; A.G.W., unpublished data) and other insects (Wheeler 1996; 1999a, b; Wheeler and Wilson 1996). In the absence of baseline data on population trends of this lady beetle, any evidence pointing to a recent decline in its densities is tenuous. My impression, though, is that it has become increasingly difficult to find in northeastern pine barrens. Since the early 1990s, my attempts to recollect this species have been unsuccessful at several northeastern sites where 10 or more adults had been observed one or more times in 1991. Recent collecting was most intensive at Sam's Point Dwarf Pine Ridge in New York (13 Aug. 2000, 5 Sept. 2001), but also included efforts to recollect *B. septentrionis davisi* in the pitch pine community near Frackville, Pa. (4, 6 Sept. 2001) and the Montague Sand Plain in Massachusetts (15 Aug. 1993, 6 Sept. 2001). In contrast, adults of another conifer-associated lady beetle, the coccinelline *Mulsantina picta* (Randall), were found at these and other sites during the 1990s and in 2000–2001.

The numbers of coccinellid species, especially those in crop fields, can fluctuate widely at a particular site from year to year (e.g., Foott 1974, Elliott and Kieckhefer 1990, Kieckhefer and Elliott 1990). If populations of *B. septentrionis davisi* actually have declined recently in pine barrens, hypotheses to account for its reduced densities might include competition from and intraguild predation by Old World coccinellids that have become established in North America (e.g., Evans 1991, 2000; Elliott et al. 1996; Obrycki et al. 1998). The most abundant and widespread of these adventive species are *Coccinella septempunctata* L. and *Harmonia axyridis* (Pallas). The former coccinelline spread rapidly during the 1980s (e.g., Hoebeke and Wheeler 1980, Schaefer et al. 1987, Staines et al. 1990, Gordon and Vandenberg 1991), whereas the latter species began to assume dominance in some natural and managed systems in the 1990s (e.g., Tedders and Schaefer 1994,

Brown and Miller 1998, Colunga-Garcia and Gage 1998, Hesler et al. 2001). Although the establishment of *H. axyridis* in the eastern United States might be the result of an accidental introduction (Day et al. 1994), this predator was intentionally released numerous times between 1916 and 1985, mainly to control arboreal homopteran pests, including margarodid scales (e.g., Gordon 1985, McClure 1987). Adults and larvae of *H. axyridis* were found in the majority of the stands of pitch pine and Virginia pine that I surveyed in the late 1990s and in 2000–2001. Adults of two other adventive coccinellids—*Hippodamia variegata* (Goeze) and *Propylea quatuordecimpunctata* (L.)—were observed less often on pines (A.G.W., unpublished data).

In apple orchards of eastern West Virginia, the Old World *H. axyridis* has become the dominant coccinelline, displacing another Old World species, *C. septempunctata* (Brown and Miller 1998). It is, however, the potential adverse effects of nonindigenous coccinellids on lady beetles (and other insects) native to North America that is a cause of concern (e.g., Ehler 1990, Evans 1991, Horn 1991, Elliott et al. 1993, Wheeler and Hoebeke 1995). A detrimental effect on native coccinellids such as *Adalia bipunctata* (L.), *Coccinella novemnotata* Herbst, *C. transversoguttata richardsoni* Brown, *Cycloneda munda* (Say), and *Hippodamia convergens* Guérin-Méneville already has been suggested (Wheeler and Hoebeke 1995, Elliott et al. 1996, Wheeler and Stoops 1996, Brown and Miller 1998, Colunga-Garcia and Gage 1998). Coccinellids that have more specialized habitat requirements than those associated with agroecosystems might be especially vulnerable to competitive displacement by adventive coccinellids, their numbers perhaps declining more rapidly than those of agriculturally important lady beetles (Elliott et al. 1996). Any long-term monitoring of our native coccinellid fauna, therefore, might include not only species associated with agroecosystems but also those such as *B. septentrionis davisi* that are found in specialized natural communities.

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