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FIRST NORTH AMERICAN RECORDS OF *AMPHIAREUS OBSCURICEPS* (POPPIUS) (HEMIPTERA: HETEROPTERA: ANTHOCORIDAE), WITH A DISCUSSION OF DEAD-LEAF MICROHABITATS

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Abstract.—The anthocorid *Amphiareus obscuriceps* (Poppius) is reported for the first time from North America based on records from one Canadian province (Ontario), 14 U.S. states (Connecticut, Georgia, Illinois, Maryland, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, West Virginia), and the District of Columbia. A diagnosis, description, adult photographs, and scanning electron photomicrographs are furnished to facilitate recognition, and the dead-leaf microhabitat, associated plants, and psocids and other potential prey of this species are discussed.

Key Words: Heteroptera: Anthocoridae, *Amphiareus obscuriceps*, description, new records, North America, hosts, habitat, dead leaves

Members of the anthocorid genus *Amphiareus* Distant are similar in appearance to many species of the large cosmopolitan genus *Cardiastethus* Fieber. As a consequence of this close resemblance, several species now included in *Amphiareus* were originally described in *Cardiastethus*, including the type species of the genus, *A. constrictus* (Stål), and the adventive *A. obscuriceps* (Poppius) reported in this paper. Early efforts to identify our specimens of *A. obscuriceps*, using North American keys such as Blatchley (1926) and Kelton (1978), guided us to a conclusion that we probably had a species of *Cardiastethus*. Eventual use of Herring's (1976) generic key to North American anthocorids enabled us to identify the genus and determine that our material represented the exotic and widespread *A. obscuriceps*. Péricart (1996) recently catalogued information on this species in the Palearctic, and Yamada and Hirowatari (2003) revised *Amphiareus* and provided a key to the five known species.

In this paper, we give the first records of *A. obscuriceps* in North America based on specimens from 14 eastern U.S. states, the District of Columbia, and one Canadian province. To facilitate recognition, we provide a diagnosis, description, adult photographs, and scanning electron photomicrographs of selected structures. The poorly known dead-leaf microhabitat, associated plants, and potential prey of this adventive anthocorid are discussed.

Amphiareus obscuriceps (Poppius)
(Figs. 1–13)

Cardiastethus obscuriceps Poppius 1909: 19 (orig. descrip.).
Amphiareus obscuriceps: Hiura 1960: 48 (n. comb.); Herring 1965: 203 (note); Péricart 1996: 129 (cat.); Bu and Zheng 2001: 90 (descrip., distr., figs., key); Yamada and Hirowatari 2003: 297 (descrip., distr., figs., key).

Diagnosis.—*Amphiareus obscuriceps* is distinguished from all other North American anthocorids by the yellowish-brown hemelytra and contrastingly darker brown to fuscous head and pronotum (Figs. 1, 3), the distinctly raised trilobed setal bases on the clavus (Fig. 9a) and multilobed setal bases on the apical half of the scutellum (Fig. 9b), smooth impunctate corium, the posteriorly directed ostiolar scent channel and prolonged anteriorly curved carina (Fig. 10), and the sickle-shaped paramere (Fig. 12).

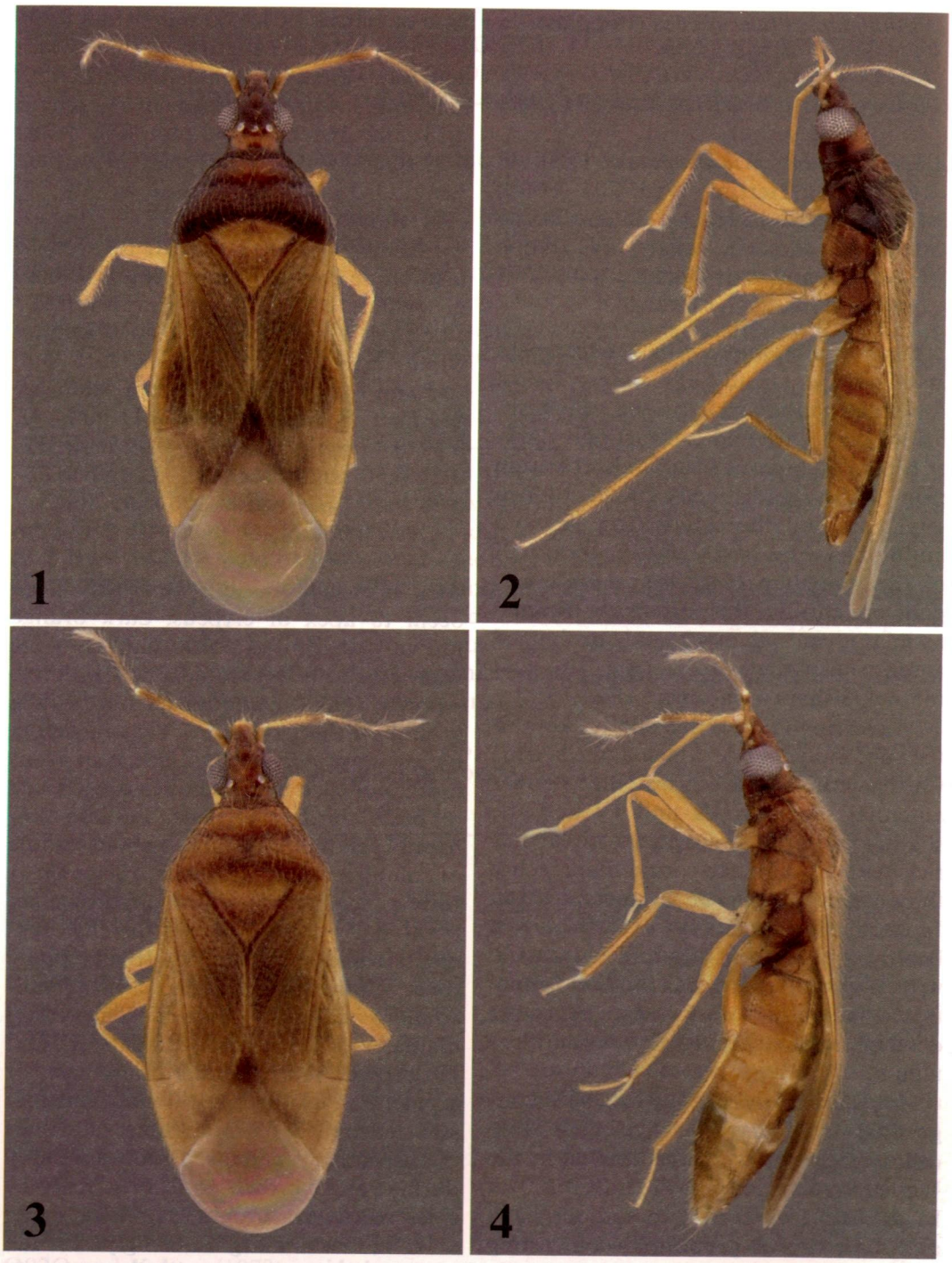
In Herring (1976), this species keys to the subfamily Lyctocorinae and the tribe Cardiastethini, based on the slender antennal segments III and IV and the slightly posteriorly directed ostiolar auricle with a prolonged carina that reaches the anterior margin of the metapleuron. In Cardiastethini, it keys to *Amphiareus*, based on the posteriorly directed auricle with a prolonged carina and a "punctate" [actually lobed setal bases–see description and Fig. 9] clavus and scutellum.

Amphiareus obscuriceps can be distinguished from *A. constrictus*, the only other species of the genus known in the United States (Henry 1988; Lattin 2007a, b), by the dark brown to fuscous head and dark brown pronotum, contrasting with the more yellowish-brown hemelytra (versus the uniformly yellowish-brown body of *A. constrictus*).

Description.—Male (n = 10): Length to apex of membrane 2.52–2.72 mm, length to base of cuneus 1.64–1.80 mm, width 0.99–1.07 mm. *Head*: Length 0.40 mm, width 0.38 mm, vertex 0.18 mm. *Labium*: Length 0.80 mm. *Antenna*: Segment I, length 0.13 mm; II, 0.46–0.48 mm; III, 0.30–0.32 mm; IV, 0.29–0.30 mm. *Pronotum*: Length 0.35–0.37 mm, basal width 0.83–0.84 mm.

Female (n = 10): Length to apex of membrane 2.48–2.76 mm, length to base of cuneus 1.76–1.84 mm, width 0.98–1.06 mm. *Head*: Length 0.40–0.42 mm, width 0.38–0.40 mm, vertex 0.18 mm. *Labium*: Length 0.86–0.88 mm. *Antenna*: Segment I, length 0.10–0.11 mm; II, 0.42–0.45 mm; III, 0.27–0.29 mm; IV, 0.27–0.30 mm. *Pronotum*: Length 0.35–0.38 mm, basal width 0.80–0.93 mm.

Overall coloration yellowish brown to darker orange brown. Head (Figs. 5–8) dark brown to fuscous anteriorly from ocelli to apex of clypeus; dark orange brown posterior to ocelli; uniformly set with long, semierect setae; and with three pairs of long trichobothria, one with a trichobothrium on either side of vertex between eye and ocellus, one near front margin of each eye, and one on each side of basal third of clypeus. Labium uniformly yellow, extending to about middle of mesosternum. Antenna: Segment I brown, segment II yellowish brown on basal half, darker brown distally, segments I and apical half of II subequally thick, clothed with semierect setae subequal to or slightly greater in length than diameter of segments; segments III and IV brown, more slender than base of segment II, clothed with long, semierect setae, length 3 or more times diameter of respective segments. Pronotum shiny dark orange brown to nearly fuscous; sides relatively straight, slightly bulging at calli, basal margin strongly sinuate; collar distinct, rugose, with short, evenly spaced, parallel carinae across posterior half, forming a necklacelike pattern (Fig. 7); calli convex, undivided at middle, impunctate; posterior lobe behind



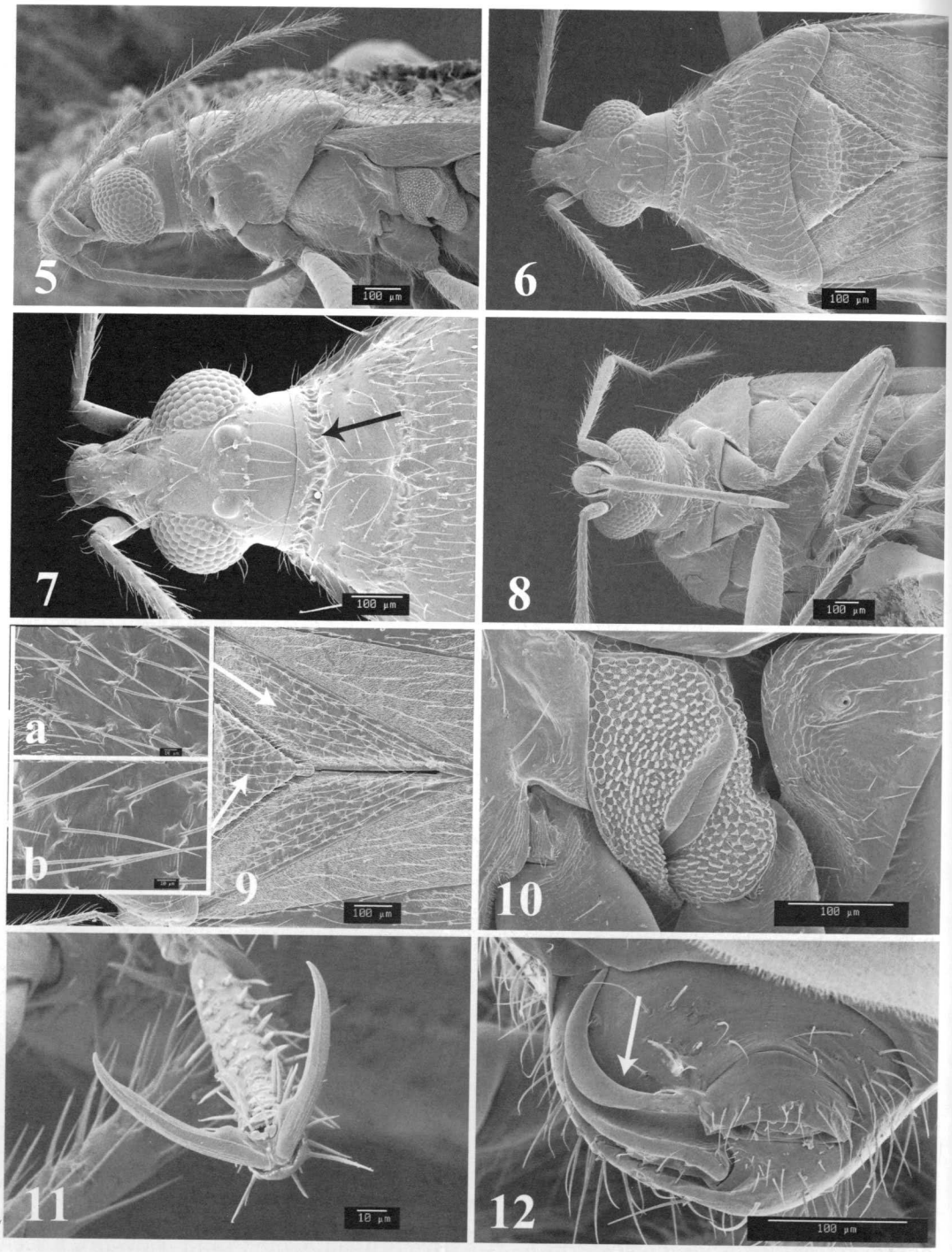
Figs. 1–4. *Amphiareus obscuriceps*. 1, 2, Adult male. 1, Dorsal aspect. 2, Lateral aspect. 3, 4, Adult female. 3, Dorsal aspect. 4, Lateral aspect.

calli finely and sparsely punctate, with numerous long, semierect setae; and three pairs of long erect trichobothria, one at anterior angle of each callus, one at each lateral margin near callar bulge, and one at each posterior angle. Scutellum orange brown, nearly equilateral, slightly wider at base than long, deeply depressed through middle; basal third shiny, finely punctate, apical third strongly rugose, with raised, multilobed setal bases (Fig. 9b) of long, semierect setae. Hemelytron (Fig. 9) yellowish brown, thickly clothed with long, semierect setae; setae on clavus with raised, trilobed bases (Fig. 9a), corium and cuneus impunctate; membrane uniformly smoky brown. Ventral surface shiny yellowish brown to dark orange brown; abdomen often darker brown to fuscous. Ostiolar area (Fig. 10) orange brown; auricle and scent channel narrow, shiny, extending dorsally as a carinate line, angling forward to anterior margin of metapleuron. Legs uniformly yellowish brown; front tibia in males with a row of short, stout spines on distal three fourths of ventral side; front tibia in females unarmed; claws slender, weakly curved (Fig. 11). Male genital capsule (Fig. 12) broadly cone-shaped, somewhat flattened, with single sickle-shaped paramere arising dorsocaudally and curving anteriorly over top left edge of capsule.

Plant associations and habits.—Adults were associated consistently with dead-plant material such as leaves of tree branches still attached, detached and suspended in trees, or fallen. Leaf condition ranged from partly green, brown but moist (sometimes moldy), to dry and brittle. For several collections, the anthocorid was estimated to have colonized within a week of storm damage to trees or creation of brush piles. Taxonomic relatedness of "host" deciduous trees seemed unimportant. The majority of collections, however, were from maple (*Acer* spp.), oak (*Quercus* spp.), sweet-gum (*Liquidambar styraciflua* L.), and tulip tree (*Liriodendron tulipifera* L.) in suburban and urban landscapes, in woodlands, and at edges of second-growth forests. Another common habitat was brush piles of oaks and other hardwoods. Less frequently, *A. obscuriceps* was beaten from dead leaves of conifers (e.g., *Juniperus virginiana* L., *Pinus* spp.) and conifer brush piles, shrubs, vines, weeds (e.g., *Ambrosia artemisiifolia* L.), and grasses (e.g., *Panicum virgatum* L.). Several adults and nymphs were taken in old nests of the eastern tent caterpillar (*Malacosoma americanum* (F.), Lepidoptera: Lasiocampidae). One series of adults was shaken from a nest of the eastern grey squirrel (*Sciurus carolinensis* Gmelin, Rodentia: Sciuridae), which was a dense mass of dead dry leaves of *Vitis* sp. built among vine tangles in a wild cherry tree (*Prunus serotina* Ehrh.) about 3 m above ground. Specimens also were collected at light and in Malaise traps. The reddish nymphs were found on hardwood trees (in dead-leaf clusters on trees or fallen branches, in moldy frass in tent caterpillar nests, or in brush piles).

Amphiareus obscuriceps was collected throughout the year, suggesting that it is multivoltine. Adults apparently overwintered. Although nymphs were found in early January at a site in Maryland, we do not know if they survived the winter. Psocids generally were beaten from dead leaves that yielded the anthocorid. Other potential prey included thrips, beetle larvae, and eggs of the various arthropod species that colonize dead leaves.

Distribution.—In the Old World, *A. obscuriceps* is known from Bulgaria, Byelorussia, China (and Taiwan), Czech Republic, Georgia, Germany, Hungary, Iran, Italy, Japan, Kazakhstan, Kirgizia, Korea, The Netherlands, Nepal, Russia (European and Far-Eastern), and the Ukraine (Péricart 1996; Péricart and



Figs. 5–12. Scanning electron photomicrographs of *Amphiarieus obscuriceps*. 5, Head and pronotum, lateral aspect. 6, Head and pronotum, dorsal aspect. 7, Head and collar (arrow indicates necklacelike carinae around collar). 8, Head, ventral aspect. 9, Scutellum and clavus (inset "a" shows magnified trilobed setal bases on clavus; inset "b" shows magnified multilobed setal bases and transverse rugae in between on scutellum). 10, Ostiolar evaporative area, auricle, and extended carina. 11, Claw. 12, Male genital capsule and paramere (arrow indicates paramere).

Stehlík 1998; Bacchi and Rizzotti-Vlach 2000; Simon 2002; Yamada and Hirowatari 2003; Aukema et al. 2005).

The first New World records (Fig. 13) are here reported from Canada (Ontario) and the United States (Connecticut, District of Columbia [Washington, D. C.], Georgia, Illinois, Maryland, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, West Virginia).

All specimens are deposited in the National Museum of Natural History (Smithsonian Institution, Washington, D. C.) collection, except for those from University of Guelph, Guelph, Ontario (UG).

Specimens examined.—CANADA: ONTARIO: 1 ♀, Halton Reg., Milton, Derry Rd. & 4th Line, nr. grass field, light, 20 Aug.–9 Sept. 2001, S. Paiero, debu00172314 (UG);1 ♀, Essex Co., Point Pelee Natl. Pk, wooded area by W beach, Malaise/pan traps, 10–23 Sept. 1999, O. Lonsdale, debu00013117 (UG); 1 ♀, Essex Co., Point Pelee Natl. Pk., Visitor Centre, Malaise & pan traps, O. Lonsdale, 5–26 Sept. 2000, debu 01007046 (UG); 1 ♀, Essex Co., Windsor, ~1.5 km S Ojibway Prairie, forest-prairie edge, Malaise trap, 22 Sept.–13 Oct. 2001, S. Paiero, debu01108328 (UG); 1 ♀, Lamton Co., Port Frans, Richmond Subdivision, 2-Sept.-1995, merc[ury] vap[or] light, J. Skevington (UG).

UNITED STATES: CONNECTICUT: 1 ♂, Hartford Co., Shaker Pines, Enfield, 41°46′N, 72°46W, 28 Sept. 1991, A. G. Wheeler, Jr., in dead leaves in a brush pile; 3 ♂, 1 ♀, New Haven Co., Middlebury, 29 July 1990, W. E. Steiner & J. M. Swearingen, beaten from dead leaves of wind-blown *Quercus rubra* L. [Fagaceae]. DISTRICT OF COLUMBIA: 14 ♂, 3 ♀, NW Washington, Rock Creek Park, 2 Jan. 1989, W. E. Steiner & J. M. Swearingen, shaken from dead leaves on fallen branches of *Quercus rubra* L. GEORGIA: 4 ♂, 4 ♀, Oconee Co., 10 km E Watkinsville, 33°51′N, 83°18′W, 21 Mar. 2001 & 23 Nov. 1998, W. E. Steiner, J. M. Swearingen, W. A. Dix, and C. Wells, shaken from dry dead oak leaves in mixed forest. ILLINOIS: 2 ♂, 1 ♀, Monroe Co., Columbia, 24 Apr. 1993, 38°26 N, 90°12 W, A. G. Wheeler, Jr., taken on dried leaves of *Quercus* sp. MARYLAND: 1 ♀, Anne Arundel Co., 3 km WSW Bristol at Jug Bay, 19 Sept. 1988, W. E. Steiner & S. F. Larcher, in moldy leaf cluster on fallen branch of *Liriodendron tulipifera* L. [Magnoliaceae]; 2 ♂, 1 ♀, Anne Arundel Co., Camp Letts, 8 km S Edgewater, 1–2 Apr. 1989, W. E. Steiner & J. M. Swearingen, shaken from dead leaves on fallen branches of *Liquidambar styraciflua* L. [Hamamelidaceae]; 1 ♂ with nymphal exuviae, Anne Arundel Co., 6 km ESE Laurel (North Tract Patuxent Res. Ref.), 39°05′N, 76°48′W, 28 June 2007, W. E. Steiner, J. Hulcr, J. Prena, nymph shaken from frass in old nest of *Malacosoma americanum* (F.) on *Prunus serotina* Ehrh. [Rosaceae]; molt to adult 5 July 2007; 2 ♂, 6 km ESE Laurel (North Tract Patuxent Res. Ref.), 39°04′N, 76°46′W, 12 July 2007, beaten from hanging dead leaf clusters on fallen branch of *Fagus grandifolia* Ehrh. [Fagaceae], W. E. Steiner; 1 ♂, 1 ♀, 6 km ESE Laurel (North Tract Patuxent Res. Ref.), 39°04′N, 76°46′W, 7 Aug. 2007, beaten from hanging dead leaf clusters on fallen branch of *Asimina triloba* (L.) Dunal [Annonaceae], W. E. Steiner; 6 ♂, 1 ♀, Baltimore Co., 3 km SE Edgemere near Swan Point, 1 Nov. 1986, W. E. Steiner & J. M. Swearingen, shaken from dead leaves on fallen branch of red oak; 2 ♂, 3 ♀, Baltimore Co., Miami Beach, 10 May 1987, W. E. Steiner & J. M. Swearingen, shaken from dead leaves on cut *Sassafras albidum* (Nutt.) Nees [Lauraceae]; 4 ♂, Baltimore Co., Oregon, 5 Sept. 1992, W.

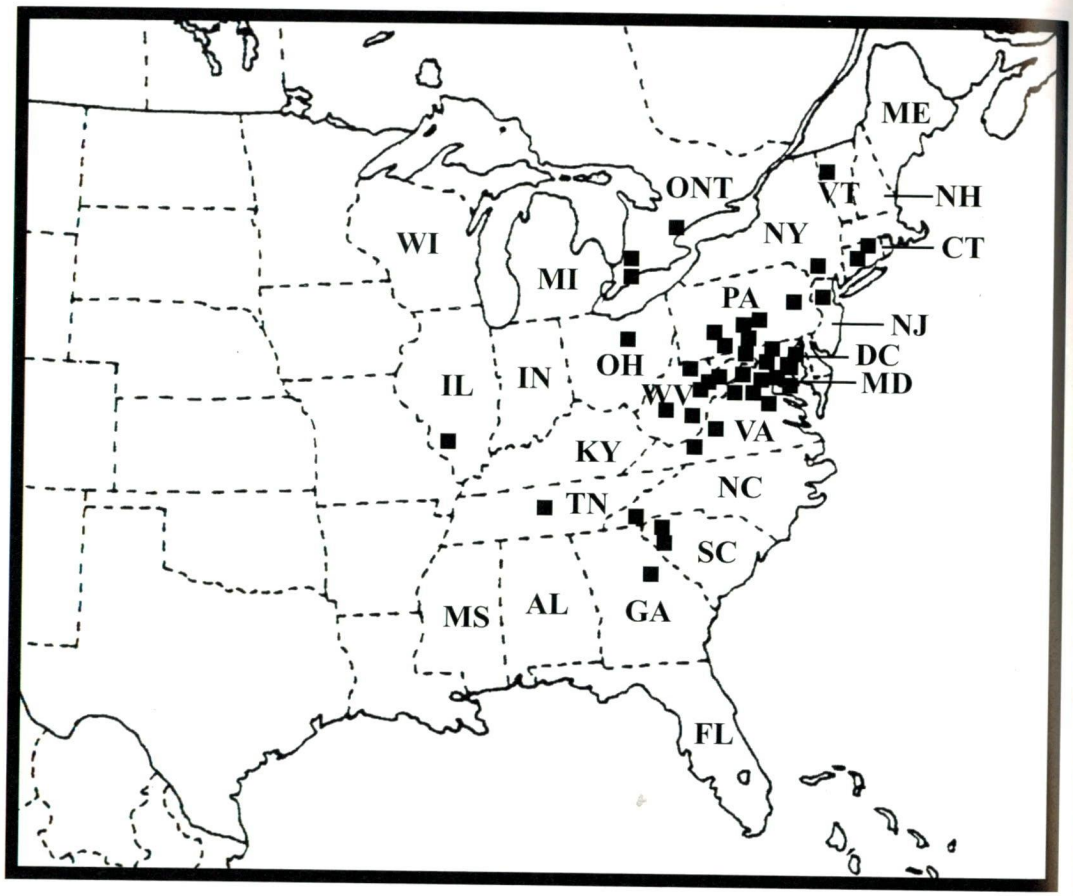


Fig. 13. Distribution of *Amphiareus obscuriceps* in eastern North America (Canada Ontario [ONT]) and the United States: Connecticut [CT], District of Columbia [DC], Georgia [GA], Illinois [IL], Maryland [MD], New Jersey [NJ], New York [NY], North Carolina [NC], Ohio [OH], Pennsylvania [PA], South Carolina [SC], Tennessee [TN], Vermont [VT], Virginia [VA], West Virginia [WV]).

E. Steiner & J. M. Swearingen; 1 ♂, 2 ♀, Calvert Co., Flag Ponds area, 3 km SE Long Beach, 9 Sept. 1990, W. E. Steiner & J. M. Hill, in moldy leaf clusters on fallen branch of *Liriodendron tulipifera* L.; 5 ♂, 1 ♀, Caroline Co., 5 km S Denton, 25 Mar. 1989, W. E. Steiner, shaken from dead leaves of fallen *Quercus alba* L.; 1 ♂, 12 ♂, 5 ♀, Carroll Co., Piney Run Lake, 6 km W Eldersburg, 6 Aug. 1989, W. E. Steiner, J. M. Swearingen, & C. D. Hackman, shaken from dead leaves of fallen *Quercus rubra* L.; 1 ♂, Carroll Co., Finksburg, 16 Aug. 1989, W. E. Steiner & J. M. Swearingen, at black light in mixed deciduous forest, and 4 ♂, 1 ♀, 15 Aug. 1990, W. E. Steiner & J. M. Swearingen, in moldy leaf clusters on fallen branch of *Liriodendron tulipifera* L.; 8 ♂, 3 ♀, Carroll Co., 6 km S of Hampstead, 8 Aug. 1990, W. E. Steiner & J. M. Swearingen, in moldy leaf clusters of cut branches of *Juglans nigra* L. [Juglandaceae]; 14 ♂, 12 ♀, Cecil Co., Pleasant Hill, 14–16 July 1989, W. E. Steiner & J. M. Swearingen, shaken from dead leaves on fallen *Quercus rubra* L.; 4 ♂, Charles Co., 6 km SW of Nanjemoy, 1 Jan. 1991, W. E. Steiner & J. M. Swearingen; 5 ♂, 3 ♀,

Frederick Co., Catoctin Mountains, W of Thurmont, 27 Oct. 1990, W. E. Steiner, J. M. Swearingen, M. J. & R. Molineaux; 15 ♂, 5 ♀ (4 nymphs), Harford Co., Fallstson, Camp Millstad, 1 Oct. 1988, W. E. Steiner & J. M. Swearingen, in moldy leaf clusters on fallen branch of *Liriodendron tulipifera* L.; 2 ♂, Howard Co., Savage, 3 July 1990, W. E. Steiner, J. M. Swearingen, & A. & L. Landvoigt; 2 ♂, 6 ♀, Howard Co., Columbia, 39°12′N, 76°52′, 12 July 1992, W. E. Steiner, J. M. Swearingen, J. B. Stribling, & S. Rockey, shaken from dead leaves on fallen branches of *Liriodendron tulipifera* L.; 7 ♂, 4 ♀, Montgomery Co., 4 mi. SW of Ashton, 19 May–23 June 1985, G. F. & J. F. Hevel; 1 ♂, Montgomery Co., 5 km. N. Clarksburg, 28 Aug. 2006, W. E. Steiner, J. M. Swearingen, P. & C. Bergmann, at black light in mixed patchy forest near farmed fields and cut logs (USNM); 5 ♂, 1 ♀, Montgomery Co., 3 km. N Clarksburg at Little Bennett Cr., 4 Feb. 2007, W. E. Steiner, J. M. Swearingen, C. & P. Bergmann, beaten from hanging dead leaf clusters and cones on fallen branch of tuliptree; 5 ♂, 6 ♀, Montgomery Co., S. of Dickerson along Potomac River, 21 Aug. 1983, T. J. Henry & A. G. Wheeler, Jr., taken in dead leaves of *Lonicera* sp. [Caprifoliaceae] and other shrubs; 18 ♂, 7 ♀, Montgomery Co., Hyattstown, 12 Nov. 1988, W. E. Steiner, shaken from dead leaves on fallen branches of *Quercus rubra* L.; 1 ♂, Montgomery Co., 3 km SE Seneca, Blockhouse Point, 15 Jan. 1989, W. E. Steiner, J. M. Swearingen, J. M. Hill, & C. & L. Davis, from moldy leaves of fallen branch of *Liriodendron tulipifera* L.; 4 ♂, 7 ♀, Montgomery Co., Plummers Island, 16 Aug. 1985, T. J. Henry & A. G. Wheeler, Jr., beaten from dead *Acer negundo* L. [Aceraceae] leaves; 3 ♂, 2 ♀, Montgomery Co., Plummers Island, 17 Aug. 1989, A. Freidberg & W. E. Steiner, in moldy leaf clusters on branches of silver maple; 4 ♂, Montgomery Co., Plummers Island, nr Cabin John, 11 Aug. 1988, T. J. Henry, beaten from dead *Acer negundo* L. leaves; 2 ♂, 7 ♀, Montgomery Co., C & O Canal near Plummers Island, 14 Sept. 1989, pyrethrin fogging of dead leaves of fallen *Acer negundo* L., flood plain forest; 7 ♂, 9 ♀, Montgomery Co., Rockville, 19, 26 & 27 June 1989, 6 July 1989, 3 Aug. 1989, 6, 18 & 31 July 1990, 4 Oct. 1992, W. E. Steiner & J. M. Swearingen, at black light in mixed deciduous forest, and 1 ♂, 1 ♀, 21 July 1989, shaken from dead leaves on fallen branches of *Quercus rubra* L., and 1 ♂, 2 ♀, in moldy leaf clusters on fallen branches of *Liriodendron tulipifera* L.; 1 ♂, 1 ♀, Montgomery Co., Sandy Spring, 26 June 1993, W. E. Steiner & J. M. Swearingen; 1 ♀, Montgomery Co., Silver Spring, 14 Jan. 1989, W. E. Steiner, in moldy leaf clusters on fallen branches of *Liriodendron tulipifera* L.; 1 ♂, 1 ♀, Montgomery Co., 2 km SW Unity, 20 Jan. 1989, W. E. Steiner, J. M. Hill, & J. J. Marshall, shaken from dead leaves on fallen branches of *Quercus rubra* L.; 3 ♂, 2 ♀, Prince George's Co., 6 km NW Bowie (PWRC), 39°03′N, 76°49′W, 1 Jan. 1995, W. E. Steiner, M. J. & R. Molineaux, shaken from hanging dead leaf clusters on fallen branch of *Quercus falcata* Michx. [Fagaceae] in mixed forest; 8 ♂, 13 ♀, Prince George's Co., Cheverly, 38°56′N, 76°55′W, various dates from 14 Mar. to 14 Sept. 1992 to 2006, W. E. Steiner & J. M. Swearingen, at black light [either "at ground level" or "in tree canopy, mixed broken forest and residential area"] and 1 ♀, 11 June 2006, in old nest of *Malacosoma* on *Prunus serotina*, and 2 ♀ (2 nymphs), 21 July 2007, shaken from frass in old nest of *Malacosoma* on *Prunus serotina*, and 6 ♂, 6 ♀, 25 July 2007, shaken from dry leaf (*Vitis* sp.) [Vitaceae] nest of *Sciurus carolinensis* in vine tangle ca. 3 m above ground; 3 ♂, Prince George's Co., College Park,

39°00′N, 76°56′W, 19 Aug. 1995, W. E. Steiner, J. M. Swearingen et al., beaten from dead leaves on wind-blown *Quercus rubra*; 6 ♂, 2 ♀, Talbot Co., St. Michaels, 38°47′N, 76°13′W, mixed forest, 24 Dec. 2006, W. E. Steiner & J. M. Swearingen, beaten from hanging dead-leaf clusters on fallen branch of *Quercus alba* L. [Fagaceae] and *Liquidambar styraciflua*; 12 ♂, 18 ♀, Talbot Co., Wittman, 3–5 Sept. & 25–27 Dec. 1986 & 1988, 6 Sept. 1992, 17 Dec. 2006, W. E. Steiner & J. M. Swearingen, shaken from dead leaves of fallen branches of *Liquidambar styraciflua* L., *Prunus serotina* Ehrh., & *Quercus* sp.; 27 ♂, 4 ♀ (19 nymphs), Talbot Co., McDaniel (Wades Point), 25 Sept. 1988, shaken from dead leaves on branches of fallen *Populus deltoides* Marsh. [Salicaceae]; 1 ♀, Wicomico Co., 1 km SW Sharptown at Plum Creek, sandhill, 38°18′N, 75°07′W, 7 Aug. 1999, W. E. Steiner & J. M. Swearingen, at black light in open mixed forest. NEW JERSEY: 1 ♂, Morris Co., Rt. 206, 2 mi. S of Chester, 22 July 1988, A. G. Wheeler, Jr., taken on *Fraxinus* sp. [Oleaceae]. NEW YORK: 1 ♀, Ulster Co., Mohonk Preserve, Overcliff Road, 3 Aug. 1990, A. G. Wheeler, Jr., taken from dead leaves in brush pile; Ulster Co., Mohonk Preserve, 20 Aug. 1993, A. G. Wheeler, Jr., taken on dead leaves of *Quercus* sp. NORTH CAROLINA: 2 ♀, Buncombe Co., Rt. 25, Asheville, 11 July 1988, T. J. Henry & A. G. Wheeler, Jr., taken on *Juniperus chinensis* L. [Cupressaceae] & *Alnus serrulata* (Aiton) Willd. [Betulaceae]. OHIO: 2 ♀, Wayne Co., Clear Creek at bridge on Smithville Western Road, ca 2 km W of St. Rd. 83, ca 7 km NNW of Wooster, N40.8582°, W81.9740°, 5 Sept. 1999, Eric Chapman, taken at black light. PENNSYLVANIA: 6 ♂, 3 ♀, Adams Co., 6 km S Fairfield, 21 August 1988, W. E. Steiner & J. M. Swearingen, shaken from dead leaves on fallen branch of *Fraxinus* sp. [Oleaceae]; 6 ♂, 2 ♀, Blair Co., Williamsburg, 28 June 1990, A. G. Wheeler, Jr., on dead leaves of *Quercus* sp.; 1 ♀, Dauphin Co., Weiser St. For., Greenland Tract, nr. Schuylkill Co. line, 6 July 1990, A. G. Wheeler, Jr., on dead leaves of *Quercus* sp.; 1 ♂, 4 ♀, Cumberland Co., Michaux St. Forest, W of Pine Grove Furnace, 18 July 1990, A. G. Wheeler, Jr., on dead leaves of *Quercus* sp.; 1 ♂, Fulton Co., Harrisonville, 29 July 1990, A. G. Wheeler, Jr., in dead *Quercus* leaves; 1 ♂, 1 ♀, Northhampton Co., Moravian College, Bethlehem, 8 Aug. 1989, A. G. Wheeler, Jr., taken on *Fagus sylvatica* L. [Fagaceae]; 12 ♂, 4 ♀, York Co., Rt. 851, W of New Freedom, 6 Sept. 1983, A. G. Wheeler, Jr., taken on dead leaves of shrubs with psocids; 2 ♀, Westmoreland Co., Powdermill Nature Preserve near Rector, 40°10′N, 79°16′W, 10 June 2006, W. E. Steiner & J. M. Swearingen, beaten from hanging dead-leaf clusters on fallen branches of *Quercus rubra* L. SOUTH CAROLINA: 1 ♂, 1 ♀, Anderson Co., I-85S rest area, nr Anderson, 3 May 1991, A. G. Wheeler, Jr., in dead leaves of *Liquidambar styraciflua* L. in brush pile; 2 ♀, Pickens Co., SC Botanical Garden, Clemson, 31 July 2005, A. G. Wheeler, Jr., on *Panicum virgatum* L. [Poaceae];1 ♀, Pickens Co., Glassy Mtn., 4 May 1991, A. G. Wheeler, Jr., in dead leaves of *Photinia* sp. [Rosaceae] in brush pile; 1 ♀, Pickens Co., Rt. 11, nr. Eastatoe Creek, 1 Nov. 2001, A. G. Wheeler, Jr., ex dead needles of *Pinus echinata* Mill. [Pinaceae]; 1 ♂, 1 ♀, Pickens Co., Eastatoe Creek, N of Rt. 11, nr. S-39-143, 5 Oct. 2001, A. G. Wheeler, Jr., ex dead leaves of fallen *Quercus alba* L. TENNESSEE: 1 ♀, Davidson Co., Long Hunter State Recreation Area, 19 Apr. 1991, A. G. Wheeler, Jr., on dead leaves of *Bignonia capreolata* L. [Bignoniaceae]. VERMONT: 1 ♂, 3 ♀, Chittenden Co., Camp Johnson, Colchester, 44°27′N, 7°03′W, 19 Aug. 1992, A. G. Wheeler, Jr., in dead leaves in brush pile. VIRGIN-

IA: 3 ♀, Alleghany Co., Falling Spring overlook, Rt. 220, 25 Aug. 1990, A. G. Wheeler, Jr., in dead leaves of *Ulmus* sp. [Ulmaceae] in brush pile; 2 ♂, 4 ♀, Clarke Co., Univ. Virginia Blandy Exp. Farm., 2 mi. S Boyce, 4 June 1993, T. J. Henry, beaten from *Ilex opaca* Aiton [Aquifoliaceae]; 1 ♂, Essex Co., 1 mi. SE Dunnsville, 12–31 Mar. 1993, D. R. Smith, Malaise trap; 1♀, Fairfax Co., Great Falls, swamp trail, 38°58′N, 77°8.9W, 30 June–13 July 2006, D. Smith, Malaise trap; 1 ♂, Fairfax Co., Great Falls N. P., near Lock 1, 38°59′N, 77°14′W, 6 Aug. 2007, at black light in mixed forest gap near river, W. E. Steiner & J. M. Swearingen; 1 ♀, Fairfax Co., Turkey Run, headqtrs, 38°57.7′N, 77°8.9′W, 7–20 July 2006, D. Smith, Malaise trap; 1 ♂, 4 ♀, Fairfax Co., Turkey Run Park, bluff above river, 38°57′N, 77°09′W, 15 Dec. 2006, W. E. Steiner & J. M. Swearingen, beaten from hanging dead-leaf clusters on fallen branch of *Quercus falcata* Michx.; 1 ♀, Giles Co., vic. Mtn. Lake Biol. Stn., 13 May 1998, J. Daley, sweeping (UG); 10 ♂, 3 ♀, Montgomery Co., Brush Mtn., NW of Blacksburg, 15 May 1993, 37°13 N, 080°24 W, A. G. Wheeler, Jr., on dead leaves of *Quercus* in brush pile; 1 ♂, City of Newport News, SW of Yorktown, 25 Feb. 2007, W. E. Steiner & J. M. Swearingen, beaten from hanging dead-leaf clusters and dry fruits on fallen branch of *Liquidambar styraciflua*; 1 ♂, Rappahannock Co., 2 mi. S Washington, 24 Aug. 1986, G. F. & J. Hevel; 2 ♂, Shenandoah Co., Short Mtn. barrens, 3 mi. SE of Mt. Jackson, 17 May 1992, A. G. Wheeler, Jr., on *Phlox subulata* L. [Polemoniaceae]. WEST VIRGINIA: 8 ♂, 4 ♀, Grant Co., Rt. 28 & 55, E of Smoke Hole, 24 June 1990, A. G. Wheeler, Jr., taken on dead leaves of *Acer* sp.; 3 ♂, 1 ♀, Greenbrier Co., Kates Mtn., White Sulphur Springs, 25 Aug. 1990, A. G. Wheeler, Jr., in dead leaves of *Acer saccharum* Marsh [Aceraceae]; 12 ♂, 10 ♀, Hardy Co., 2 mi. N of Mathias, 20–21 July 1995 & 16 July 1999, T. J. Henry, at UV light; 26 ♂, 12 ♀ (10 nymphs), Jefferson Co., Shepherdstown, 10–11 Sept. 1988, W. E. Steiner, shaken from dead leaves of *Quercus bicolor* Willd. [Fagaceae]; 1 ♀, Kanawha Co., Charleston, 22-Sept.-1986, M. C. Thomas; 2 ♂, 1 ♀, Monongalia Co., Morgantown, W. Va. Univ., 5 Aug. 1989, A. G. Wheeler, Jr., on dead leaves of *Lonicera sempervirens* L. [Caprifoliaceae]; 1 ♀, Pocahontas Co., 9 km W Frost, 38°16′N, 79°57′W, 22–23 May 1999, W. E. Steiner, J. M. Swearingen, J. & B. Bullard; 34 ♂, 3 ♀ (2 nymphs), Randolph Co., Elkins, 23–29 July 1989, W. E. Steiner & J. M. Swearingen, shaken from dead leaves of fallen *Quercus alba* L.

Discussion

The Eurasian *A. obscuriceps* is established in eastern North America from southern Ontario in Canada, and Vermont south to Georgia and west to Ohio and Illinois in the United States. A collection from Maryland in 1983 is the earliest known for North America. Although common and apparently widespread at the time of its detection, this anthocorid probably remained uncollected in the Nearctic Region because of its cryptic habits—living in dead-leaf clusters and other dead-plant material. This microhabitat has received relatively little attention from entomologists; one exception is Steiner's (1984) comment that dead-leaf clusters "create a unique microhabitat for a wide variety of insects." In addition, Mockford (1993) noted that certain psocids colonize dead leaves of deciduous trees. Psocids serve as prey for certain Anthocoridae (e.g., Carayon 1957; Péricart 1972).

We consider *A. obscuriceps* an immigrant species in North America. Previous records from Asia, Europe, Iran, and North Africa (Péricart 1996; Yamada

and Hirowatari 2003), including recent ones from the Czech Republic, Finland, Italy, and The Netherlands (Péricart and Stehlík 1998; Bacchi and Rizzotti-Vlach 2000; Albrecht et al. 2003; Aukema et al. 2005), suggest that the species readily moves in commerce. A congener, *A. constrictus* (Stål), was described from Brazil and has been considered native to South America (Lattin and Lewis 2001). But species now considered synonyms of *A. constrictus*—*Xylocoris fulvescens* Walker, 1872; *Lasiochilus sladeni* Distant, 1913; and *Cardiastethus macilentus* Hiura 1958—were described from Sri Lanka (as Ceylon), Seychelles, and Japan, respectively (Cassis and Gross 1995; Péricart 1996). Because the genus is mostly Asian (Yamada and Hirowatari 2003), the essentially cosmopolitan *A. constrictus* might have become established in Brazil via commerce. It has been reported from the Afrotropical, Australian, Nearctic (Florida), Neotropical, Oriental, and Palearctic regions (Henry 1988; Cassis and Gross 1995; Péricart 1996; Yamada and Hirowatari 2003); has been intercepted at the port of San Francisco, California, in a shipment of orchids from Colombia (Lattin and Lewis 2001); and is now established in Hawaii (Zimmerman 1948; Brenner and Lattin 2001; Lattin 2007a). About 16 other immigrant anthocorid species—that is, unintentionally introduced (sensu Frank and McCoy 1990)—have become established in North America (Lattin 1999a, 2005, 2007b).

Certain anthocorids *sensu lato*, such as *Lyctocoris campestris* (F.) (lyctocorines sometimes are placed in a separate family, Lyctocoridae; Schuh and Slater 1995) and *Xylocoris galactinus* (Fieber), long have been known to inhabit stored-plant products and vegetable refuse (Hicks 1959; Southwood and Leston 1959). Other anthocorid species also have been recorded from dead-plant material and harvested plants (e.g., Blatchley 1926; Usinger 1946; Zimmerman 1948; Hiura 1958, 1960; Hicks 1959). Lattin (1999a), in reviewing the bionomics of Anthocoridae, noted their often cryptic habitats in dead-plant material. Lattin (1999b) reported *Cardiastethus luridellus* (Fieber) (1 adult) and *Calliodis temnostethoides* (Reuter) (2 adults) from dead-leaf clusters of black oak (*Q. velutina* Lam.) windthrows in Michigan. Only adults were found and it was suggested that they might have dispersed from some other habitat, perhaps under bark. Psocids living in dead leaves with the anthocorids were considered likely prey (Lattin 1999b). *Amphiareus* species now are recognized as characteristic inhabitants of dead-plant material (Yamada and Hirowatari 2003). The habitats of *A. obscuriceps* in North America are similar to those that Yamada and Hirowatari (2003) reported in Japan: piles of dead trees and other types of dead-plant material. *Amphiareus obscuriceps*, a predator nearly restricted to such microhabitats, should benefit from physical disturbances to trees, such as wind storms, that result in extensive suspended litter and litterfall (e.g., Lodge et al. 1991).

Noting that all species of *Amphiareus* are predators, Yamada and Hirowatari (2003) suggested that the bugs feed on beetle larvae, psocids, thrips, and other small arthropods. We generally collected psocids, thrips, small beetles such as latridiids and phalacrids, and spiders with *A. obscuriceps* in dead leaves. Adult lacewings (*Chrysoperla rufilabris* (Burmeister) and *Micromus posticus* (Walker)) were frequently found with *A. obscuriceps* in hanging dead leaves throughout the year. Eggs of any of the arthropod inhabitants of dead leaves, as well as soft-bodied insects such as psocids, likely serve as prey.

Aerial leaf litter, consisting of curled dead leaves suspended in vegetation above the forest floor (Remsen and

Parker 1984), appears to have received more attention from ornithologists as a substrate for foraging birds than dead-leaf clusters have from entomologists as a microhabitat for insects. Dead leaves tend to harbor more (and larger) insects than do green leaves (Gradwohl and Greenberg 1982; Remsen and Parker 1984; Rosenberg 1990). Particularly in the Neotropics, numerous species of insectivorous birds forage on arthropods in dead leaves; certain species search dead leaves only occasionally, whereas others (typically slender-billed species that feed on larger prey, e.g., orthopterans) belong to specialized dead-leaf guilds (Gradwohl and Greenberg 1982; Remsen and Parker 1984; Greenberg 1987; Rosenberg 1990, 1993, 1997; Chapman and Rosenberg 1991; Leme 2001; Mallet-Rodrigues 2001). Birds' use of aerial leaf litter can involve exploration, innate bias, and learning, as well as visual orientation to dead, curled leaves (Greenberg 1987).

The use of dead-leaf clusters by insects undoubtedly involves quite different factors; plant volatile semiochemicals emitted by senescing tissues might provide location cues. Biotic and abiotic stresses can affect the emission rates and blend composition of volatile compounds in plants (Tollsten and Bergström 1988; Ebel et al. 1995), but the effects of abiotic stresses on emission rates of volatiles are little understood (Heiden et al. 1999). Chemistry can be altered when stems, leaves, and other plant parts are cut or detached (Turgeon et al. 1998; Agelopoulos et al. 1999). Moreover, certain cell-degradation compounds may be absent from whole-plant samples (Tollsten and Bergström 1988).

Anthocorids respond to plant volatiles (Aldrich 1988; Reid and Lampman 1989; Lattin 1999a), including herbivore-induced compounds (Drukker et al. 2000; James 2003; Sigsgaard 2005). Anthocorid species restricted to dead-plant material, as those of *Amphiareus* appear to be (Yamada and Hirowatari 2003), might discover dead leaves and similar microhabitats by using the altered profile of volatile organic carbon molecules emitted by senescing or necrotic plant tissues. We suggest that *A. obscuriceps* can rapidly colonize dead-leaf clusters (< 7 days, as leaves wither) by orienting to plant volatiles alone or, after death, perhaps with involvement by microbial invaders.

Volatiles (e.g., alcohols and aldehydes) providing cues for location of dead-plant material by *A. obscuriceps* are unlikely to be identified, or the bug's chemical ecology elucidated, in the near future. Volatile blends emitted by herbivore-damaged plants often comprise 20 to more than 200 compounds (Dicke and van Loon 2000), and the role that ethylene and other volatiles play in the attraction of scolytid beetles to broken or senescing tree branches needs clarification (Bonello et al. 2001). Fundamental aspects of the anthocorid's bionomics that could be more readily determined include voltinism and feeding habits. Psocids are likely prey (Carayon 1957; Lattin 1999b; Yamada and Hirowatari 2003), but this needs verification.

In addition to documenting prey preferences, we hope workers will study the life histories of anthocorids restricted to dead-plant material and will follow the further spread of *A. obscuriceps* in North America. The anthocorid can be detected by creating a dead-leaf microhabitat, a collecting technique Steiner (1984) suggested for certain phalacrid beetles. Tree branches can be cut and hung in bundles in the shade; after a week or more, the dead leaves can be tapped over a pan or shallow insect net to dislodge anthocorids and other arthropods.

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