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Maryland Collection Records of *Dioedus punctatus* LeConte (Coleoptera: Tenebrionidae: Phrenapatinae), a Small Darkling Beetle Found in Rotten Wood

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ABSTRACT: Known specimen records of *Dioedus punctatus* LeConte (Coleoptera: Tenebrionidae: Phrenapatinae) from Maryland are listed by county. Specimen data from the District of Columbia are also given. All life stages of the beetle are found in soft wood of "red-rotten" logs and fallen trunks in late stages of decay, usually in mature forest habitats.

INTRODUCTION

Dioedus punctatus LeConte (Coleoptera: Tenebrionidae) is the only member of the subfamily Phrenapatinae Solier, Tribe Penetini Lacordaire, known to occur in eastern North America (Aalbu et al. 2002). Most species of the subfamily are tropical and all inhabit rotten wood (Matthews et al. 2010). A widespread beetle of eastern North American forests, *D. punctatus* occurs from Ontario, Canada (Bousquet et al. 2013), south to Florida and Puerto Rico (Peck and Thomas 1998) and probably occurs in all states east of the Mississippi River. This small, saproxylic beetle (body length 2.5-3.3 mm) is often overlooked by collectors, and family identity is commonly questioned. It is not well known, nor mentioned in popular field guides, but can be found frequently if the habitat is recognized and carefully searched. BugGuide (2015) provides some images, distribution and habitat data. Triplehorn (1952) provided a detailed description of the beetle; the distinctive larva was described (Young 1976) from Michigan, "from a dead log, probably *Ulmus americana*, in the red-rotten stage of decay." Some pupal characters and habitats were described for it and a few relatives (Steiner 1995).

Specimens and/or literature records of *D. punctatus* have been seen for most of the eastern United States. In this study we present the known specimen data for Maryland and the District of Columbia and include descriptions of habitats and some life history observations not published elsewhere. These records substantiate the earlier listing of the species for the state (Steiner 2008; Maryland Biodiversity Project 2015).

METHODS

Specimens are deposited in the United States National Museum of Natural History, Smithsonian Institution, Washington, DC. Specimen label data below are quoted verbatim, with commas inserted for clarity; breaks between labels are separated by a forward slash. Inferred data and additional characters added in abbreviations are given in

brackets. Most of the specimen records were collected by the authors, with names spelled out on labels, but abbreviated here as "WES" and "JMS." The numbers of specimens bearing the same data follow in parentheses.

RESULTS

Maryland Records

Anne Arundel County: "MARYLAND: Anne Arundel County, Crofton, 38°59'33"N, 76°41'58"W, 27 March 2015, colls. WES & JMS / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (2 hind bodies + 1 small larva); "MARYLAND: A. Arundel Co., 6 km SE Laurel (North Tract Patuxent Res[earch]. Ref[uge].), 39°04'26"N, 76°46'51"W, 15 April 2015 / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest; Coll. WES" (3).

Baltimore County: "Towson, Md., Nov. 6.[19]13 / H L Parker" (1).

Howard County: "Ellicott City, Md., 9 Nov.'[19]15 / H L Parker Collector" (2).

Montgomery County: "MARYLAND: Montg. Co., Blockhouse Point area 2.8 km ESE Seneca, 39°04'10"N, 77°18'32"W, 1 January 2005 / WES, JMS et al. collectors / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (3); "MARYLAND: Montg. Co., Carderock area, 38°58'27"N, 77°12'10"W, 9 November 2002, coll. WES & JMS / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (5); same data except "11 April 2010 / In red-rotten barkless log, probably oak" (1); "Jacksons Isl. Md. [presumably near Plummer's Island on Potomac River], July 16.[19]13, HSBarber / In red-rotten oak with *Micromalthus*" (1, + 2 larvae in alcohol); same data except "Plummers Isl note #135' / Jacksons I. Md, 19.VI.[19]13 / HSBarber Collector (2); same data except "5.V.13 / in red rotten log" (2); same data except "in red rotten wood (oak), Aug. 5. 1913, Schwarz & Barber" (1, teneral with larval exuvia, + 1 larva in alcohol); same data except "in old oak, Aug. 24, 1913" (3 + 2 larvae in alcohol); same data except "20.VI.13 / Schwarz & Barber Coll" (1); same data except "5 Aug. 1913" (3) and "10 Aug. 1913" (1); same data except "In red-rotten oak with *Micromalthus*, bred July 1913, Schwarz & Barber" (1 teneral + 2 larvae in alcohol); "Pre-pupa ex. Pupal cell & young larva in rotten oak, June 21, 1914, H. S. Barber" (2 larvae in alcohol); "MARYLAND: Montg. Co., Plummers Island, west slope near summit, 38°58'11"N, 77°10'35"W, 1 January 2006 / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest / WES, JMS, J. M. Hill, C. & P. Bergmann collectors" (1); same data except "swale NW of summit, 38°58'12"N, 77°10'37"W, 11 April 2015 / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest / WES, JMS et al. collectors" (4); "MARYLAND: Montgomery Co., Potomac, May 1973, WES" (2); "MARYLAND: Montg. Co., Rachel Carson Consv. Park, 4 km SW Unity, 39°13'N, 77°05'W, 1 January 2008 / In soft damp wood of red-rotten oak log in mixed forest / WES, JMS, C. & P. Bergmann collectors" (1).

Prince George's County: "MD.; Bladensburg, V-8-1917" [no other data] (7); "Pr. Georges Co. Md., I.18-IV [19]48, George B. Vogt / under bark of advanced rotten log /

red or black oak" (1); MARYLAND: Pr. Geo. Co., Cheverly, 38°56'N, 76°55'W, 1 November 1992 / WES & JMS collectors / In red-rotten wood of fallen *Pinus virginiana*" (13); same data except "3 January 1993" (10), "31 Dec. 1993" (2); same data except "38°55'58"N, 76°54'58"W, 1 December 2008 / WES, JMS et al. collectors / In soft red-rotten wood of log *Pinus virginiana* in mixed forest slope" (11); same data except "18 March 2012" (4); same data except "near Town Park, 38°55'29"N, 76°54'21"W, 31 December 2013 / In red-rotten moist wood of fallen pine in mixed forest" (2); same data except "38°55'25"N, 76°54'22"W, 20 March 2014 / In red-rotten pine log, mixed forest edge" (1); "MARYLAND: Pr. Geo. Co., Nat. Agr. Research Ctr. near Beltsville, 39°2'N, 76°51'W, 7 Feb. 1999, / WES & JMS collectors / In red-rotten moist wood of fallen pine in mixed forest" (1); "MARYLAND: Pr. Geo. Co., Greenbelt, 39°59'35"N, 76°53'46"W, 28 October 2011, coll. WES & JMS / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (1); "MARYLAND: Pr. Geo. Co., Greenbelt (forest near Greenbelt Lake), 39°0'04"N, 76°53'30"W, 22 April 2000, coll. WES / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (6); same data except "11 September 2001" (6), 19 February 2011 (7); "MARYLAND: Pr. Geo. Co., Landover, 38°56'N, 76°54'W, 24 December 1993, WES & JMS / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (1); same data except "19 Jan. 1998 / WES, JMS, M. J. & R. Molineaux collectors" (3); "MARYLAND: Pr. Georges Co., Snowden Pond area, 39°02'42"N, 76°49'53"W, 13 March 2015, coll. WES / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (8).

Talbot County: "MARYLAND: Talbot Co., 5 km WSW Cordova near Woodlawn Park, 38°51'35"N, 76°03'33"W, 16 March 2015, coll. WES / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (13); "Md. Talbot Co., 2 mi. N. Easton, under bark, 26 IV 1970, M. Druckenbrod" (1); "MARYLAND: Talbot Co., 3 km SE Easton, Seth Forest, 38°45'N, 76°02'W, 25 Oct. 1997 / WES, J. M. McCann, JMS collectors / In red-rotten moist wood of fallen pine in mixed forest" (2); "MARYLAND: Talbot Co., St. Michaels; forest near Perry Cabin, 38°47'40"N, 76°13'40"W, 21 February 2012, coll. WES / In red-rotten moist wood of fallen pine in mixed forest" (1); "MARYLAND: Talbot Co., Wittman, 7 Mar. 1982, WES" (1); same data except "38°48'N, 76°17'W, 25 Dec. 1992 / WES & JMS collectors / In red-rotten moist wood of fallen *Pinus taeda*" (6); same data except "29 March 1993" (31); same data except "16 October 1993 / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (1); same data except "24 May 1997" (4); same data except "12 October 2002 / In red-rotten moist wood of fallen *Pinus taeda* in mixed forest" (2); same data except "11 September 2004" (2); same data except "18 November 2007 / In red-rotten moist wood of fallen pine in mixed forest" (1).

Queen Anne's County: "MARYLAND: Q. Annes Co., Stevensville, 38°58'57"N, 76°19'20"W, 31 December 2011, K. Kanda & WES / In moist red-rotten wood of crumbling prostrate oak log, mixed mature forest" (3).

Washington County: "MARYLAND: Washington Co., Ferry Hill area 4 km SW Sharpsburg, 39°26'22"N, 77°47'50"W, 30 April 2015, In moist red-rotten wood of

crumbling prostrate oak log, mixed open forest slope; Colls. WES & JMS" (4); "Hagerstown, Md., May 15, [19]19 / C M Packard Collector" (2).

Locality unknown: "Reed's, Md., Apr. 22. [19]19 / C M Packard Collector" (2); same data except "W B Turner Collector" (3).

District of Columbia Records

Ulke (1902) listed *D. punctatus* as "very common under bark". More recent specimens in USNM include a large series labeled "in red rotten oak, March 13, 1938, Washington, D.C." (6 point-mounted and 100+ loose specimens in gelatin capsule on pin). The collector is not identified, but specimens in alcohol with similar data, "Red rotten oak log, very abundant, D.C., 13-III-1938, Coll. Wm. H. Anderson" include 10 adults and 94 larvae. Other records include: "Washington D.C., VII [19]20 / HFWickham Collector / Wickham Colln." (1); "Rock Cr. Prk., Washington DC, Mar. 6, '[19]30, W. H. Ball" (1); "DISTRICT OF COLUMBIA, NW Washington, Soldiers Home, 38°55'N, 77°01'W, 28 May 1997 / WES et al. / In corky moist wood of large oak log in shade, forest edge" (14); same data except "5 June 1997" (1).

In addition to the label data, excerpts from field notes (WES) help define the niche of *D. punctatus*. On 1 November 1992, in a forest tract in Cheverly, MD, "some time picking at an old fallen Va. pine after finding *Dioedus* larvae in the rotten wood—tree had broken over ~2 m. above base + the mid-section of trunk was leaning ~30° from horizontal; most of bark gone. At a section ~2 m. off ground were loose chunks of rotten wood in a side cavity—broke some of these out + split them to find many larvae of all sizes, + several adult *Dioedus*, mostly still teneral; all in a damp, red-rotten layer 3-6 cm deep in sapwood, not in outer brown dry wood or in harder interior. Trunk here is about 3 dm. diameter." On 3 January 1993, "the same tree, still leaning…Pulled out another chunk of the red-rotten wood layer + got another series of *Dioedus* adults + larvae; one of the few tenebs. that occurs in both stages, in the same microhabitat, throughout the year" and on 31 December 1993 "wood still frozen hard but took some red-rotten chunks back [indoors]—got a few adults, 1 still teneral had apparently not survived freeze, but another and several larvae were lively when thawed."

DISCUSSION

Identification: *Dioedus punctatus* in general appearance resembles a miniature member of *Uloma* Dejean of which several species occur in Maryland and are also commonly found in the same rotten wood with *D. punctatus*. *Dioedus punctatus* is a shining oblong beetle with large punctures (Figures 1A and B) and with antennae bearing a distinct 2-segmented club (Figure 1C). Color varies from yellow-brown in teneral individuals to nearly black in older specimens. In keys to genera of Tenebrionidae (Aalbu et al. 2002; Dunford et al. 2005), *Dioedus* runs to couplets 18 and 13, respectively, but with difficulty, because some ventral features are difficult to see. The scutellum is small; elytra are without scutellar striae. The front tibiae have a slightly widened apex and the sharp outer (posterior) edge bears a few small teeth (Figure 1D).

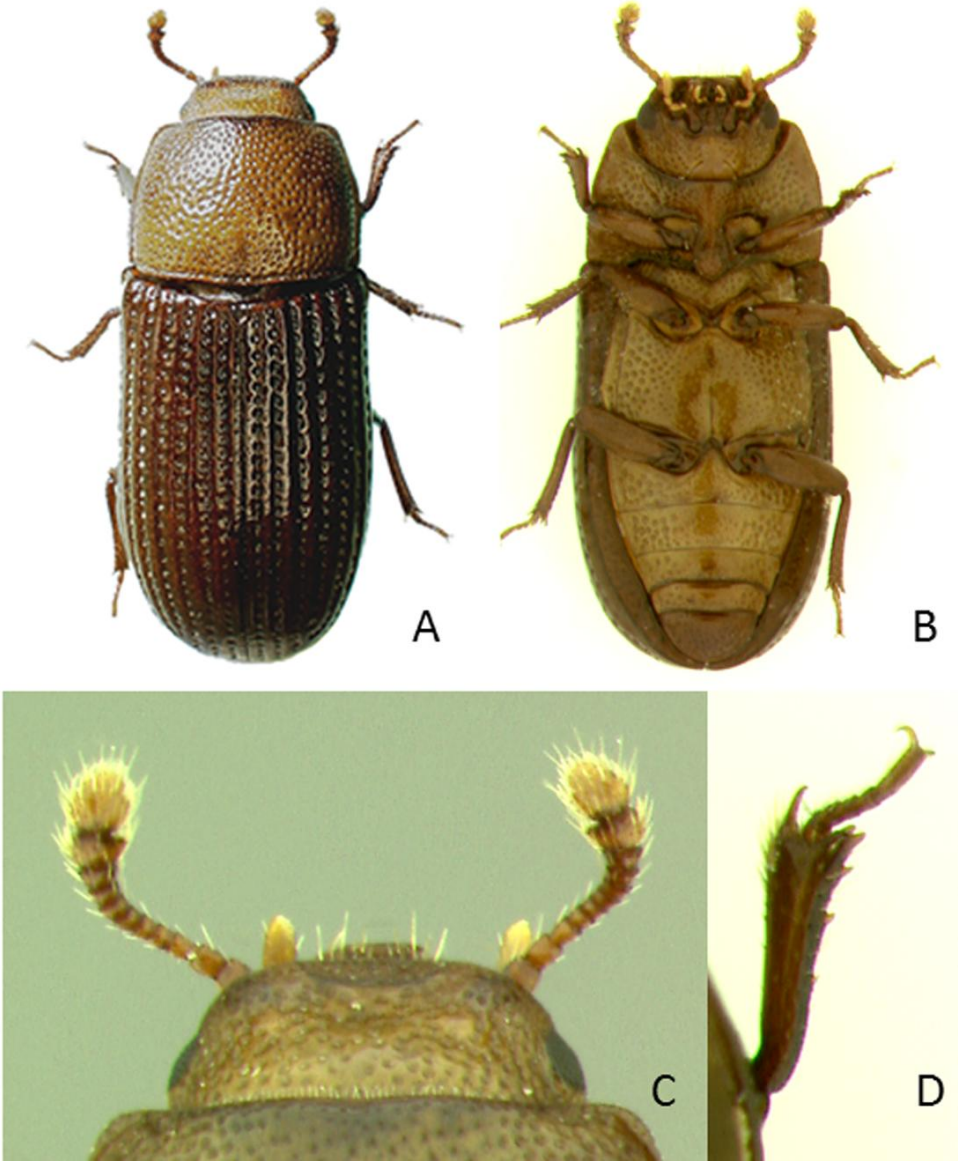

Figure 1. ***Dioedus punctatus*** **LeConte, adult images.** A, dorsal habitus; B, ventral view; C, head and antennae, dorsal view; D, right front tibia. Length of beetle 3 mm [0.12 in]. Specimen from Wittman, Maryland.

The slender whitish larvae, often associated with adults in the same wood (Figure 2A), are unique in having the abdominal apex (9th tergum) concave, spoon-shaped, with a pair of darkly sclerotized, fixed, slender, sinuate processes with sharp tips which arc posteriorly over the concavity (Figures 2B, C, and D). Whether these processes are homologous to the urogomphi in other beetle larvae is open to question. While incapable of any pinching action, they likely serve to defend the larva from small predators coming from behind in the narrow tunnel, as described for other wood-inhabiting larvae of Tenebrionidae (Steiner 2014). The globular head (Figure 2E) is unpigmented except for the very dark apices of the mandibles. Pupae are rarely collected, but occur in small cells prepared by the larva in the soft wood (Steiner 1995); abdominal segments laterally bear paired, tapered, spine-tipped appendages, with a fine, sub-apical seta; urogomphi are slender, tapered, and widely separated by a U-shaped cleft.

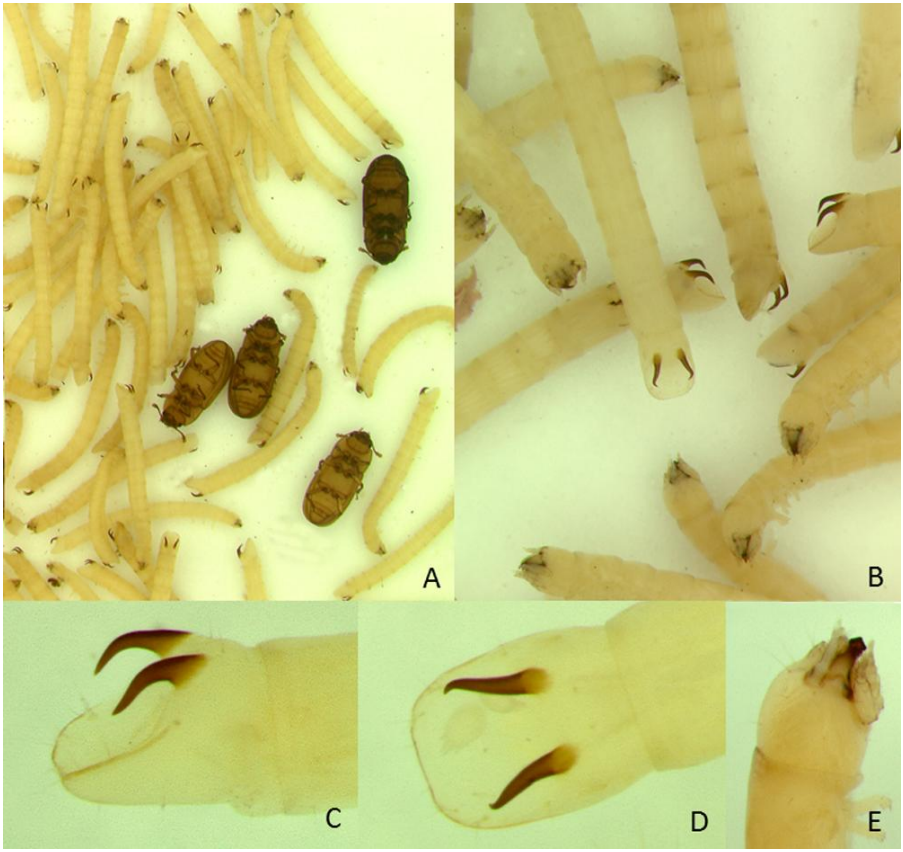

Figure 2. ***Dioedus punctatus*****, larval images.** A, larvae with adults; B, larvae enlarged; C, abdominal apex, oblique lateral view; D, abdominal apex, dorsal view; E, head, lateral view, showing sclerotized mandibles. Length of larvae 6-8 mm [0.24-0.31 in]. Specimens from Washington, DC, collected by W. H. Anderson, 1938.

Habitat: Many references list "under bark" for the principal habitat of *D. punctatus*, for example, Ciegler (2014) in South Carolina, Dunford and Young (2004) in Wisconsin, Spilman (1973) in Michigan, and Triplehorn (1952) in Ohio. However, label data, field notes, and our observations indicate that the beetles are found much more often and sometimes abundantly within the wood of rotten logs, as described by Young (1976) for wood containing associated larvae. The term "red-rotten" has been often used by collectors, referring to the rusty red color of such logs (Figure 3) in late stages of decay, which typically have no bark remaining, making tree species identification difficult. In Maryland, *D. punctatus* have been found in logs of both pines (*Pinus* L. spp. [Pinaceae]) and oaks (*Quercus* L. spp. [Fagaceae]), suggesting that they are more specific to the type and stage of wood decay and not the species of wood. Apparently beetles most commonly breed in prostrate logs, but stump wood is occasionally inhabited, as are elevated, leaning trunks, as described above. A multi-year study of the successional insect fauna of dead standing Virginia pine, *Pinus virginiana* Mill., in College Park (Howden and Vogt 1951) did not find *D. punctatus*.

Figure 3. Red-rotten wood habitat. Left, prostrate oak trunk where *Dioedus punctatus* was found, Snowden Pond, Anne Arundel County, March 2015; Right, detail of crumbling wood.

Logs in this late stage of deterioration fit the "decay class 4" of coarse woody debris classification (Woodall and Williams 2005). The wood is soft, easily pulled apart by hand into chunks; beetles are most often found several centimeters deep between split layers, sometimes at the interface of sapwood and hardwood, and the wood is typically moist. The slender larvae (Figures 2A and 2B) have been seen in tunnels undoubtedly made by them, the diameter matching that of the body. They apparently consume the wood tissue as they burrow, probably getting nourishment from fungal tissue. What makes beetles colonize particular logs is unknown; many logs appearing suitable for *D. punctatus* have been examined but with no specimens discovered. More study is needed to identify the fungi, slime molds, and other agents that create the red-rotten wood.

Among the more common beetles recorded in a study of loblolly pine logs, *Pinus taeda* L., subjected to fire (Ulyshen et al. 2010), *D. punctatus* was the only species not found following a burn (low-intensity surface fire), suggesting that it may suffer from drying of the wood substrate with exposure to sunlight due to the removal of undergrowth and surrounding litter. Collections of *D. punctatus* all have been from wood in shaded situations of interior forest tracts.

Life history: It is unusual for a beetle to occur in both larval and adult stages throughout the year. Breeding colonies can be very large and last for several years. Pupation is probably limited to warmer months; small cells in the rotten wood are formed by the larvae before pupation (Steiner 1995). Pale, teneral adults are found frequently, suggesting that hardening of the cuticle is taking a long time compared to the typically rapid sclerotization in most other beetles.

Dioedus punctatus is known for having mineralized cuticular calcium, found in other members of the Phrenapatinae but not in any other Coleoptera (Leschen and Cutler 1994). Perhaps this is the source of a white encrustation commonly seen on ventral surfaces of dry specimens after being mounted from alcohol.

Specimens have been collected only by hand or by sifting rotten wood material. We have found many Tenebrionidae at black lights and other artificial light traps, but never a specimen of *D. punctatus*. Beetles are fully winged; it is thought that dispersal to new breeding logs is diurnal, probably on warm summer days, but this has not been documented. *Dioedus punctatus* is a member of a specialized assemblage of saproxylic beetles that appear to target the late decay, red-rotten wood, a subject needing more survey and study.

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LITERATURE CITED

Aalbu, R.L., C.A. Triplehorn, J.M. Campbell, K.W. Brown, R.E. Somerby, and D.B. Thomas. 2002. Tenebrionidae Latreille 1802. Pages 463-509 in: Arnett, R.H., Jr., M.C. Thomas, P.E. Skelley, and J.H. Frank (Editors), *American Beetles, Volume 2, Polyphaga: Scarabaeoidea through Curculionoidea*. CRC Press, Boca Raton, Florida. 861 pp.

Bousquet, Y., P. Bouchard, A.E. Davies, and D.S. Sikes. 2013. *Checklist of Beetles (Coleoptera) of Canada and Alaska*. Second edition. Pensoft, Sofia. 402pp.

BugGuide. 2015. *Dioedus punctatus*. http://bugguide.net/node/view/157666. Accessed: 7 July 2015.

Ciegler, J. 2014. *Tenebrionoidea of South Carolina*. Biota of South Carolina 8. Clemson University, Clemson, SC. 243pp.

Dunford, J.C., M.C. Thomas, and P.M. Choate, Jr. 2005. The Darkling Beetles of Florida and Eastern United States (Coleoptera: Tenebrionidae). http://entnemdept.ufl.edu/teneb/index.htm. Accessed: 7 July 2015.

Dunford, J. C., and D.K. Young. 2004. An annotated checklist of Wisconsin darkling beetles (Coleoptera: Tenebrionidae) with comparisons to the western Great Lakes fauna. *Transactions of the American Entomological Society* 130(1):57-76.

Howden, H.F. and G.B. Vogt. 1951. Insect communities of standing dead pine (*Pinus virginiana* Mill.). *Annals of the Entomological Society of America* 44(4):581-595.

Leschen, R.A.B., and B. Cutler. 1994. Cuticular calcium in beetles (Coleoptera: Tenebrionidae: Phrenapetinae [sic]). *Annals of the Entomological Society of America* 87(6):918-921.

Maryland Biodiversity Project. 2015. Maryland Checklist – Order: Coleoptera. http://marylandbiodiversity.com/viewChecklist.php?order=Coleoptera. Accessed: 26 March 2015.

Matthews, E.G., J.F. Lawrence, P. Bouchard, W.E. Steiner, Jr., and S.A. Ślipiński. 2010. Tenebrionidae Latreille, 1802. Pages 574-659 in: Leschen, R.A.B., R.G. Beutel, and J.F. Lawrence (Editors), *Handbook of Zoology. Volume IV, Arthropoda: Insecta. Part 39, Coleoptera, Beetles. Volume 2: Morphology and Systematics (Elateroidea, Bostrichiformia, Cucujiformia partim)*. Walter de Gruyter, Berlin. 786 pp.

Peck, S.B., and M.C. Thomas. 1998. *Arthropods of Florida and Neighboring Land Areas Volume 16: A Distributional Checklist of the Beetles (Coleoptera) of Florida*. Florida Department of Agriculture and Consumer Services, Division of Plant Services, Gainesville, FL. 180 pp.

Spilman, T.J. 1973. A list of the Tenebrionidae of Michigan (Coleoptera). *The Great Lakes Entomologist* 6(3):85-91.

Steiner, W.E. 1995. Structures, behavior and diversity of the pupae of Tenebrionidae (Coleoptera). Pages 503-539 in: Pakaluk, J., and S.A. Ślipiński (Editors), *Biology, Phylogeny, and Classification of Coleoptera: Papers celebrating the 80th birthday of Roy A. Crowson, Volume 1*. Muzeum i Instytut Zoologii PAN, Warszawa. 558 pp.

Steiner, W.E., Jr. 2008. A checklist of the darkling beetles (Insecta: Coleoptera: Tenebrionidae) of Maryland, with notes on the species recorded from Plummers Island through the 20th Century. *Bulletin of the Biological Society of Washington* 15:133-140.

Steiner, W.E., Jr. 2014. Larvae and pupae of two North American darkling beetles (Coleoptera, Tenebrionidae, Stenochiinae), *Glyptotus cribratus* LeConte and *Cibdelis blaschkei* Mannerheim, with notes on ecological and behavioural similarities. In: Bouchard, P. and A.D. Smith (Editors), *Proceedings of the Third International Tenebrionoidea Symposium, Arizona, USA, 2013*. *ZooKeys* 415(Special Issue):311–327.

Triplehorn, C.A. 1952. The Darkling Beetles of Ohio (Coleoptera: Tenebrionidae). Master of Science thesis, The Ohio State University, Columbus, OH. 159 pp.

Young, D.K. 1976. Description of the larva of *Dioedus punctatus* LeConte (Coleoptera: Tenebrionidae). *Great Lakes Entomologist* 9(1):79–81.

Ulke, H. 1902. A list of the beetles of the District of Columbia. *Proceedings of the United States National Museum* 25(1275):1-57.

Ulyshen, M.D., S. Horn, B. Barnes, and K.J.K. Gandhi. 2010. Impacts of prescribed fire on saproxylic beetles in loblolly pine logs. *Insect Conservation and Diversity* 3(4):247-251.

Woodall, C., and M.S. Williams. 2005. *Sampling Protocol, Estimation, and Analysis Procedures for the Down Woody Materials Indicator of the FIA Program*. General Technical Report NC-256. United States Department of Agriculture, Forest Service, North Central Research Station, St. Paul, MN. 47 pp. (+ 3 errata pages, February 2007).